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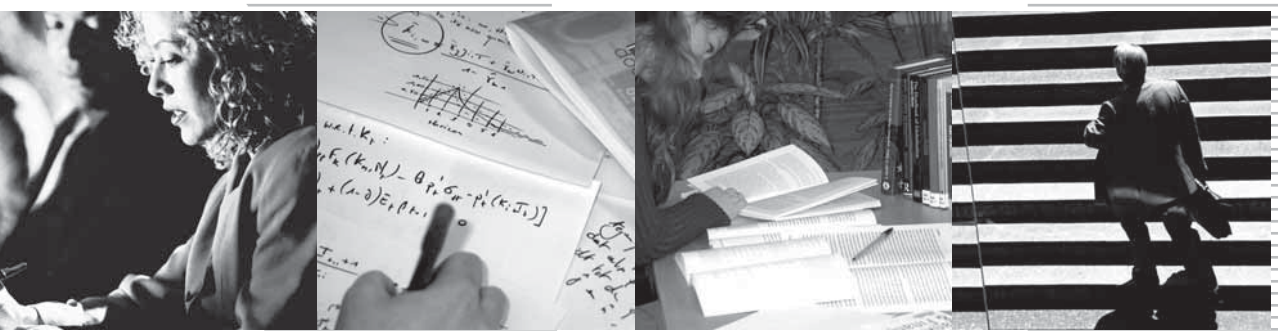

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ECONOMIC IMPACT OF PORT ACTIVITY: A DISAGGREGATE ANALYSIS

The case of Antwerp

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Abstract

The economic impact of the port sector is usually measured at an aggregate level by indicators such as value added, employment and investment. This paper tries to define the economic relevance for the regional as well as for the national economy at a disaggregate level. It attempts to identify, quantify and locate the mutual relationships between the various port players themselves and between them and other Belgian industries. Due to a lack of information foreign trade is only tackled very briefly but the method outlined in this paper can be used to measure the national effects of changes in port activity at a detailed level.

A sector analysis is made by compiling a regional[1] input-output table, resorting to microeconomic data: a bottom-up approach. The main customers and suppliers of the port's key players or stakeholders are identified. A geographical analysis can also be carried out by using data at a disaggregate level. Each customer or supplier can be located by means of their postcode. In so doing, the economic impact of the port is quantified, both functionally and geographically.

In the case of the port of Antwerp, the results show important links between freight forwarders and agents. The geographical analysis suggests the existence of major agglomerating effects in and around the port of Antwerp, referred to as a major transhipment location point.

Key words: port economics, regional input-output table, sector analysis, geographical analysis.

JEL classification: C67, L90, R12, R15 and R41.

1 Regional as geographically opposed to national, not to be mistaken for the Belgian Regions (Brussels, Flanders and Wallonia).

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1. INTRODUCTION

Every year, the Microeconomic Analysis unit of the National Bank of Belgium publishes a report on the economic importance of the Belgian ports (see Lagneaux, 2006), in which the socio-economic importance of the Flemish ports is considered, measured by indicators such as value added, employment and investment. It also explicitly addresses both the direct and indirect impact of port activity. First, a division between a maritime and non-maritime cluster is made; next, the non-maritime cluster is further subdivided in trade, industry, land transport and other logistic services. In this way, one gets a rather complete picture of the economic importance of the Belgian port sector.

However, on the basis of these aggregate results, a number of questions cannot be precisely answered. In the spring of 2002, for instance, MSC took the decision to transfer approximately 200,000 TEU from Felixstowe to Antwerp (Port of Antwerp, 18 April 2003). The consequences for the Antwerp and Flemish economy exceeded the direct turnovers and costs as a result of the handling of those additional containers. This type of decisions created a chain reaction within the port structure, having consequences for approximately all players who are active in the port, but undoubtedly also outside that port. So far, such impact cannot be dynamically outlined. For the estimation of the indirect effects (Lagneaux, 2006), the national input-output table is used, assuming that the national sector-to-sector relation pattern applies to the domain studied, i.e. the ports. This approach is called "top-down". Therefore a shift in methodology is needed: a "bottom-up" approach is followed in this paper in order to define the actual relation pattern between the different port players and with other Belgian sectors, on the basis of microeconomic data restricted to the area or sector under review, in this case the port of Antwerp. In so doing, the impact of those changes can be elaborated more accurately.

Furthermore, it is important to know in which geographical surroundings these relations take place. The concentration of port companies is especially attributed to the present port infrastructure. Accessibility by means of water, the quays and their infrastructure, and the connections with the hinterland are presented as a major agglomerating factor. The question to be answered is to what extent the presence of the other port companies has an agglomerating effect. What are their mutual relations? To what extent can a port company survive outside the port area and to what extent can reference be made to subharborisation[2]? These elements are important to measure or predict the pace at which port areas extend. Is more territory needed in the port area or outside the port area? The customers and suppliers of the port companies - which themselves are not necessarily port actors - are also analysed. This implies that an answer can be found to the question as to the type of 'non-port actors' for which space should be reserved in or close to the port area.

Switching from an aggregate to a disaggregate port analysis opens up a relatively new research area. The contribution of this research consists in building a method and an instrument, which makes it possible to calculate the direct and indirect impact of modifications in the port activity more precisely and in greater detail.

- The economic relationships among port actors are derived from a regional input-output table (IOT). The regional IOT is constructed using a bottom-up approach. Formerly, regional input-output analyses started from a top-down or non-survey approach. Canning (2005) uses a flexible mathematical approach. Oosterhaven (2003) showed the existence of estimation errors in non-survey approaches, which are assessed in relation to the full-survey method.
- But port activity goes well beyond the port perimeter. Therefore Notteboom (2005) has included a port regionalization phase, which raises the perspective of the port to a higher geographical scale, i.e. beyond the port perimeter. This research aims to measure these links with the hinterland, by a disaggregate geographical analysis. Customers and suppliers of the port actors located in places benefiting from agglomeration effects (Weber, 1909) play an important role.
- Furthermore, the port actors and other sectors are brought into connection. Therefore the scope of this research goes beyond port economics.

In chapter 2 the available data are listed, allowing a disaggregate analysis and the methodology used for the sectoral as well as the geographical analyses is defined. A regional input-output table

2 This term depicts the rise of port-based activities in the hinterland of the port, along with a stagnation of these activities in the port itself. See ESPO (2005).

quantifies the relations between the port actors and with respect to other sectors in the economy. In chapter 3, the results for these sectoral and geographical analyses are presented for the case of Antwerp and its economic impact on a national level. The sectoral and geographical analyses conclusions are summarized in a final paragraph.

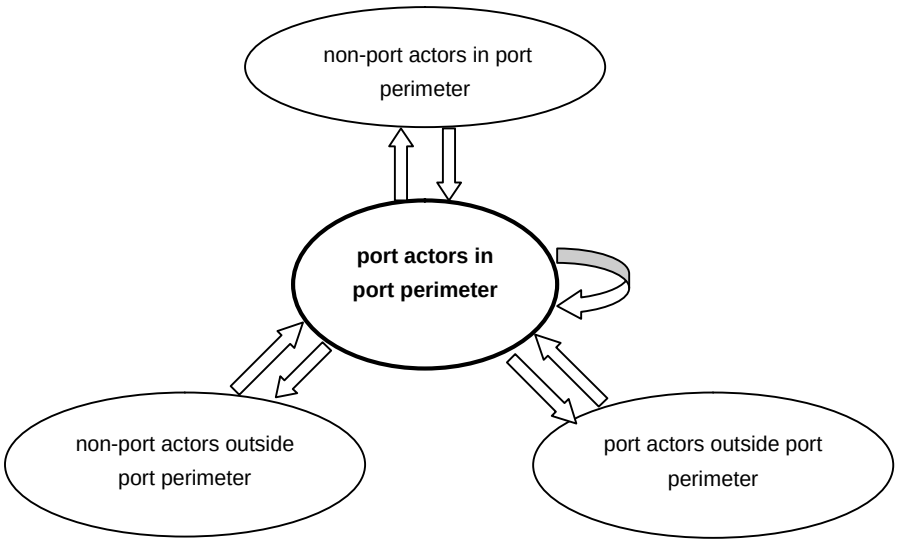
It was decided first to focus the research on the case of the port of Antwerp, which is the main seaport in Belgium, encompassing most of the maritime and industrial activities. This exercise can be carried out for other ports as well. It also focuses on the year 2000, as the latest version of the national input-output table, which will be used for validating our regional IOT, pertains to 2000. The official IOT is indeed published every five years, the latest version being that of 2000. But the IOT can also be constructed on the basis of more recent supply and use tables (SUT), which brings new perspectives towards updating our calculations.

In this study, the relations between the different port actors are examined in a first part. Next, the relations between port actors and other sectors are formally determined. They provide an answer to the question: Which sector supplies which port actor (and vice versa) and in what quantity?

Furthermore, it is important to examine the spatial impact of port activity, where the relations take place and in which geographical surroundings. In the case of Antwerp, a distinction is made in the Antwerp port perimeter, in the districts ("arrondissementen") of Antwerp and in the provinces of Belgium. This results in either agglomeration or dispersal effects of port activity.

For both the sectoral and geographical analyses, the following questions have to be considered: Who are the customers of the port actors in the port perimeter? Who are the suppliers of the port actors in the port perimeter? Answers to these questions will give us an insight into the relations between the port actors in the port perimeter and into the relations between the port actors in the port perimeter and port actors outside the port perimeter, other sectors (non-port actors) in the port perimeter and other sectors (non-port actors) outside the port perimeter (figure 1.1).

FIGURE 1.1: RELATIONS OF PORT ACTORS



2. METHODOLOGY

In order to measure the importance of the transport or distribution sector for the regional and the national economy, the literature often has recourse to (regional) input-output analysis (Oosterhaven and Stelder, 2000). The input-output analysis has been made applicable to our research by constructing a regional input-output table by means of disaggregate data sources. Therefore each firm is classified as being situated inside or outside the port perimeter and as port actor or non-port actor. The geographical analysis depicting the relations of the port actors with their hinterland also requires disaggregate data to assign customers and suppliers of the port actors to the different spatial entities.

2.1. Available data

The research pertains to a disaggregate analysis and therefore, insofar as possible, use is made of microeconomic data. To that end, processed data were used by the National Bank of Belgium (NBB). In view of the confidentiality of the microeconomic data files the mediation of the NBB was necessary to ensure that anonymous research files could be set up.

The microeconomic data concerning the supply of goods and services between the port actors in the Antwerp port perimeter and between them and the rest of the Belgian national economy are obtained from the database of the NBB, which was derived from the national accounts of 2000.

- The microeconomic data concerning the companies belonging to the port actors in the Antwerp port perimeter were taken from the NBB Central Balance Sheet Office.
- The most disaggregate data are collected from the Value Added Taxes (VAT) suppliers' listing[3], which contains the net amounts of the supplies, i.e. the intermediary consumption recorded in Belgium for sales of goods and services, but also the investments and several costs.
- The VAT declaration file provides information, by company, concerning the components of the turnover, also including foreign trade.

These three sources are combined in order to constitute a regional input-output table (paragraph 2.2.1).

Some deviations were pointed out between the figures from those different sources. The reliability of the data used was extensively examined on the national level by means of the 2000 input-output table, compiled by the National Accounts Institute (NAI). The verification of the sources shows that the detailed file gives results that are coherent with the national input-output table.

2.2. Sectoral analysis: relations between port actors and with the rest of the economy

Within the port sector several important decision makers are active: shipping companies, port authorities, terminal operating companies, agents, industrial and producing companies. The various market players, each with their own objectives, create a strong heterogeneity, both within the port and in the economic relations with the hinterland.

The aim of this sectoral analysis is to give a detailed overview of the underlying relations between all parties involved in port activities, inside and outside the port area. The paper distinguishes two sorts of relations: the first among the port actors in the port perimeter and the second between these port actors and the rest of the economy, i.e. the rest of the Belgian economy and the rest of the world.

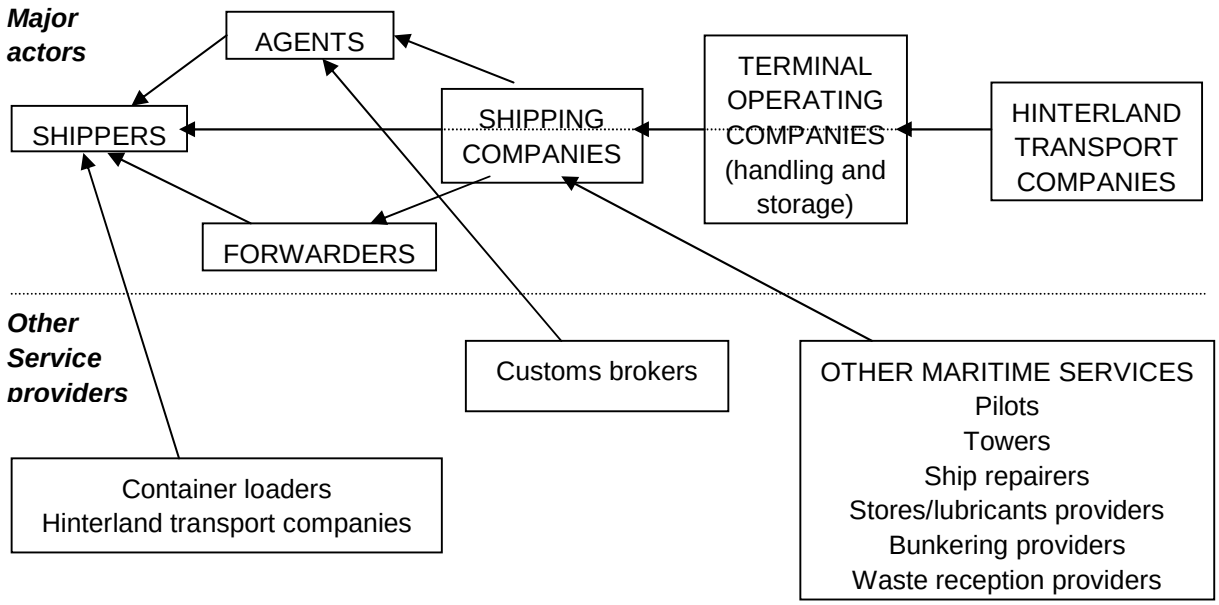
In a given port, the subdivision of the entire process involves several main actors. Jansson and Shneerson define seven partial processes (1982, p. 9). First, the ship approaches via river or canal and moors at the quay. During this process, the shipping company is assisted by pilots and towing services which steer the ship safely along shallow and dangerous places. Then, the cargo is discharged from the ship's holds and stored onto the quay, by terminal operating companies, which also transport the cargo to the transit storage and afterwards to loading platforms. The cargo is then

[3] Source: Belgian Federal Public Service Economy - Directorate-general Statistics Belgium .

loaded onto inland transport modes. Finally, the inland transport vehicle leaves the port and the cargo is transported to its final destination in the hinterland, by rail, inland waterways or road.

Figure 2.1 indicates the relations between the different actors within the port from a commodity-flow point of view. This angle should provide an answer to the most important question to be examined in this study: which sector supplies which port actor and in what quantity? This means that, first of all, each possible relation between the different actors is defined. The purpose of this research is, among other things, to verify and quantify the relations presented in figure 2.1.

FIGURE 2.1: RELATIONS BETWEEN PORT ACTORS, COMMODITY-FLOW POINT OF VIEW



Source: Meersman, Van de Voorde and Vanelslander (2003), p. 4

The port groups several important actors[4]. Shippers ensure the cargo which must be transported by ship. These are industrial ventures which want their products to be transported by ship or wholesalers or third parties operating the freight transport. A shipper contacts either an agent or a forwarder. The agent works for the shipper and in partnership with a shipping company. The forwarder works on his own account and groups commodities. Then, the shipping company addresses terminal operating companies for the transfer of goods. Finally, hinterland transport companies ensure the supply of the goods in the hinterland. The shipping companies are assisted by pilots, towing services, ship repairers, etc., all under the heading "other maritime services".

For this analysis, the interactions among port actors and between port actors and the rest of the economy are measured. A well-known tool to analyse intersectoral relations is the input-output table. Yet a Belgian input-output table (IOT) for 2000 is only available at the national level. Therefore, a disaggregate IOT has to be compiled.

Already in 1964 the Study Centre for Expansion of the port of Antwerp published an input-output table for the city of Antwerp. It concluded that although the district ('arrondissement') of Antwerp accounted for no more than 9 p.c. of the Belgian population, it contributed almost 12 p.c. to the gross national product. Furthermore, the non-commodity-producing sectors represent a substantial share in the generation of Antwerp's income. This means that the port plays an important role as a generator of activity for other transport modes. Moreover, the dominant industries in Antwerp's local economy were all linked to some extent to the port. But this analysis was unfortunately never made up again, because statistical data at the local level were difficult to obtain (Suykens, 1989, p. 443). However, the

[4] Figure 2.1 considers the interactions between the main port players in accordance with the work of the above-mentioned authors. This set of sectors encompasses a wider range of activities than the so-called maritime cluster as defined in Lagneaux (2006), which does not include the hinterland transport companies nor some additional other maritime services such as the oil trade and the supporting activities.

latest report of the Flemish seaports[5] clearly shows that the port of Antwerp directly represents 2.9 p.c. of Belgian GDP and 5 p.c. of Flemish GDP. Taking the indirect effects into account, these figures respectively climb to 5.7 and 9.8 p.c., following a top-down approach.

As disaggregate data for the port of Antwerp in 2000 are available, a bottom-up approach is made possible in order to carry out a disaggregate input-output analysis, aiming at the description of the port's structure and the impact and influence it has on the different actors inside and outside its perimeter.

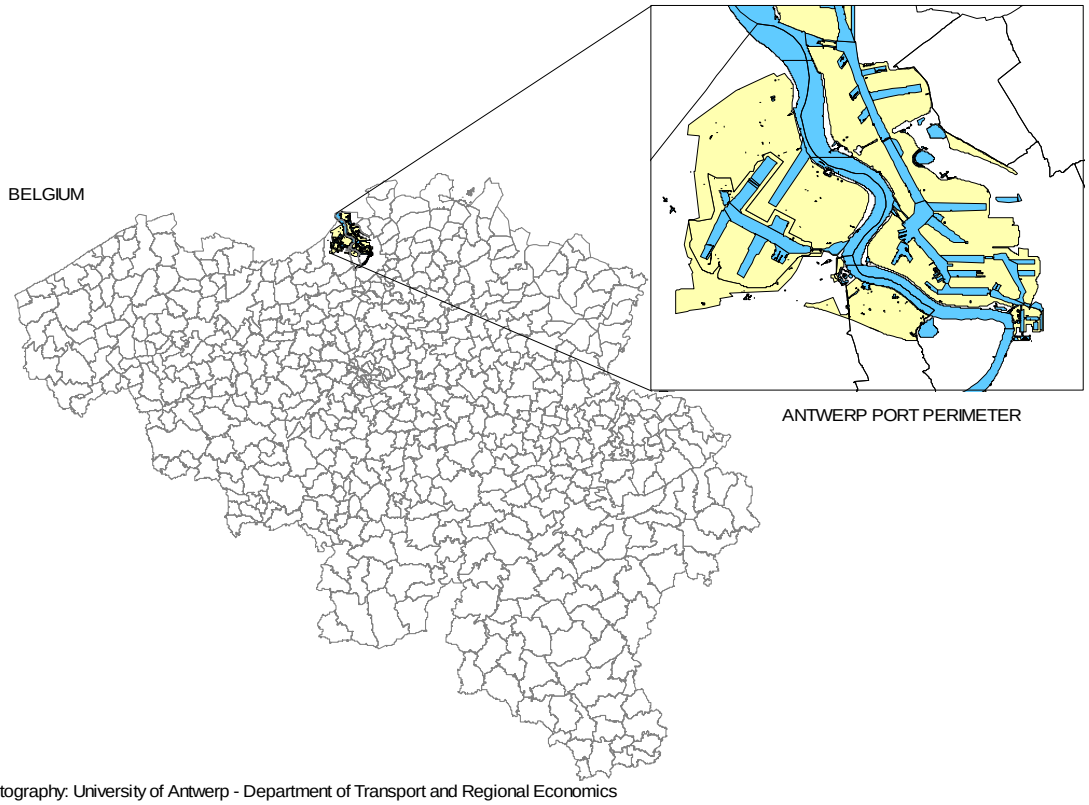
2.2.1. The construction of a disaggregate input-output table

The goal is to build an input-output table for the Antwerp port actors. This table models the supplies from all industries to these port actors and vice versa. The table takes into account five broad categories:

1. The port actors in the Antwerp port area (AN-PA)
2. The port actors outside Antwerp port area (NOAN-PA)
3. The non-port actors in the Antwerp port area (AN-NOPA)
4. The non-port actors outside Antwerp port area (NOAN-NOPA)
5. The rest of the world, regardless of economic activity

The Antwerp's port area is defined by the port perimeter and visualised in figure 2.2. Groups 1, which forms the heart of this research, and 3 are located within the port perimeter. Groups 2 and 4 are located outside the port perimeter, though still in Belgium. Groups 2, 3 and 4 (NOAN-PA, AN-NOPA and NOAN-NOPA) are generally referred to as "the rest of the Belgian economy". The relations between these last three groups are not developed any further in this paper. The linkages with the rest of the world are not presented either.

FIGURE 2.2: ANTWERP PORT PERIMETER IN BELGIUM



Cartography: University of Antwerp - Department of Transport and Regional Economics

The Antwerp port perimeter delimitation was settled by the Royal Decree of 2 February 1993 (see appendix 1). According to this law, the set of postcodes seem to coincide more or less with the port

5 Lagneaux, 2006.

perimeter. On that basis, customers and suppliers of the Antwerp port actors are assigned to the Antwerp port perimeter[6].

The companies, which are defined as port actors for the port of Antwerp, are taken from the file of the report of the Flemish seaports. This file was processed and updated by the NBB Microeconomic analysis unit, on the basis of data from the Central Balance Sheet Office. For the year 2000, there are all in all 1,689 companies in the Antwerp port perimeter, 907 of which belonging to the port actors.

The allocation of the companies to the port actors or to other economic branches has been made on the basis of the NACEBEL codes from the NAI.

- Seven main types of port actors are active in the port of Antwerp, with a further distinction between 5 subsectors among the other maritime services, as presented in table 2.1.

TABLE 2.1: PORT ACTORS BY NACEBEL CODE

Port actor	Codes	NACEBEL	Activity
Agents	AGEN	63.402	chartering
		63.403	ships' agencies
Customs brokers	CUST	63.404	customs agencies
Forwarders	FORW	63.401	forwarding offices
		63.405	transport mediation
Hinterland transport companies	HTC	60.100	transport via railways
		60.230	other land passenger transport
		60.241	furniture removal by road
		60.242	freight transport by road
		60.300	transport via pipelines
		61.200	inland water transport
		63.406	other activities of transport agencies
		64.120	courier activities other than national post activities
		71.210	renting of other land transport equipment
Other maritime services	OMS		
Shipbuilding and repair	OMS-SHIP	35.110	building and repairing of ships
		35.120	building and repairing of pleasure and sporting boats
Dredging	OMS-BAG	45.241	dredging
		45.242	other construction of water projects
Fuel trade	OMS-COFU	51.120	agents involved in the sale of fuels, ores, metals and industrial chemicals
		51.510	wholesale of solid, liquid, gaseous fuels and related products
Other trade	OMS-CO	51.700	other wholesale
Supporting activities	OMS-SUP	63.220	other supporting water transport activities
		90.002	collection and processing of household refuse
		90.003	collection and processing of agricultural and industrial refuse
Shipping companies	SHIP	61.100	sea and coastal water transport
		71.220	renting of water transport equipment
Terminal operating companies	TOC	63.111	cargo handling in seaports
		63.112	other cargo handling
		63.122	other storage and warehousing

- The non-port actors are further subdivided into 14 groups: food industry (NOPA-VO), land transport (NOPA-TP), public services (NOPA-PU), oil industry (NOPA-PE), electronics

6 The classification of the Antwerp port actors is based on their full address (postcode and street name).

(NOPA-MP), metallurgy (NOPA-ME), energy (NOPA-EN), construction (NOPA-CS), trade (NOPA-CO), chemical industry (NOPA-CH), car manufacturing (NOPA-AU), other industries (NOPA-AI), other services (NOPA-AD) and all the other activities belonging to none of the above-mentioned industries (Others). For the classification of these other sectors by means of NACEBEL codes, see appendix 2. The input-output table (IOT) appears in a schematic way in table 2.2.

TABLE 2.2: SCHEMATIC L-SHAPED INPUT-OUTPUT TABLE

to deliveries from	AN-PA	NOAN-PA	AN-NOPA	NOAN-NOPA	Rest of the world
AN-PA	(1)	(2)	(3)	(4)	(X)
NOAN-PA	(5)				
AN-NOPA	(6)				
NOAN-NOPA	(7)				
Rest of the world	(M)				

Supplies to Antwerp port actors -[(1), (5), (6), (7), (M)] sub-matrices- are derived from the NAI's company database. Broadly speaking, the same logic as in the construction of the supply-use tables is applied. This means that, at a first stage, total purchases of the port actors from all the other sectors are computed. This yields the marginal column totals of the regional IOT. Then, at a second stage, these marginal totals (excluding imports) are distributed over the individual cells of the table using distribution weights computed from the VAT suppliers' listing.

Similarly, the sales from port actors to port actors and to the other sectors are computed -[(1), (2), (3), (4), (X)] sub-matrices-. Marginal row totals (excluding exports) are computed and these totals are redistributed over the individual cells of the IOT, using data from the VAT suppliers listing.

The main developments focus on the findings made inside the national economy since the available data do not allow any consistent breakdown of import (M) and export (X) into sectors and locations in the rest of the world. Therefore foreign trade is merely very briefly tackled in this paper, whose main purpose is to present the relative figures of supplies and uses within a national framework.

2.2.2. Input-output analysis

Having constructed an input-output table, the relations among port actors as well as the relations with the rest of the national economy can be analysed. The relations between port actors are calculated by means of technical coefficients and backward and forward linkage measures. Key sector indicators measure the relative impact of one port actor on the others. The relations of the port actors with other sectors or with port actors outside the port perimeter are measured by external demand and external inputs.

The theory behind this model is explained in appendix 4.

By way of example, box (1) of the L-shaped input-output table set out in table 2.2, once filled up with the technical coefficients of the sectors studied -i.e. the Antwerp port actors-, is the following:

TABLE 2.3: INPUT-OUTPUT SUB-TABLE (BOX (1)) FOR THE CASE OF THE ANTWERP PORT ACTORS (2000 DATA):

(percentages)

	AGEN	CUST	FORW	HTC	OMS-BAG	OMS-CO	OMS-COFU	OMS-SHIP	OMS-SUP	SHIP	TOC
AGEN	15.5	3.3	20.4	2.4	0.0	2.1	0.0	0.5	0.0	4.8	1.9
CUST	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
FORW	5.1	3.5	7.9	2.2	0.1	3.0	0.3	0.1	0.1	5.4	4.4
HTC	1.7	5.7	2.1	2.9	0.6	0.3	1.5	0.6	0.8	0.9	1.0
OMS-BAG	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.2	0.0	0.0
OMS-CO	0.5	0.0	0.2	0.7	0.0	5.1	0.0	1.1	0.1	0.6	0.3
OMS-COFU	0.1	0.0	0.0	0.2	0.0	1.8	12.0	0.0	0.0	0.1	0.0
OMS-SHIP	0.1	0.2	0.0	0.1	3.5	0.8	0.0	3.1	0.1	0.0	0.1
OMS-SUP	5.8	13.6	1.1	5.2	2.0	0.3	0.6	0.7	8.1	3.1	4.5
SHIP	15.2	1.3	9.3	1.1	0.0	3.9	0.2	0.0	0.3	22.6	2.1
TOC	8.5	10.8	6.1	1.2	0.0	0.2	0.2	0.2	0.1	7.7	10.1

The technical coefficients aim to represent the *direct* impact one sector has on another. They are defined by the deliveries from one sector to another divided by the total output of the former (technical output coefficients)[7]. For instance, 3.3 p.c. of the Antwerp agents' output is delivered to the Antwerp customs brokers.

This table is thus restricted to the first-level relations inside sub-matrix (1), while linkages go well beyond the first level of relations represented by the technical coefficients. More details about the linkages between these 11 sectors are given at point 3.2.1. As far as the relations between the Antwerp port actors and the other Belgian sectors are concerned (boxes (2) to (7)), the so-called external demand and external inputs are presented at point 3.2.2, with further details in appendix 5.

a) Relations between the port actors

Table 2.4 gives an overview of the input-output indicators used to describe the relations between the Antwerp port actors. Three different indicators are measured: Cai and Leung linkages, decomposed linkages and key sectors. Forward linkages give the total effect of a certain port actor on its customers within the Antwerp port actors. Backward linkages, on the other hand, describe the total effect a certain port actor has on its suppliers.

TABLE 2.4: INPUT-OUTPUT INDICATORS REGARDING THE RELATIONS BETWEEN THE ANTWERP PORT ACTORS

Cai and Leung linkages (all levels)	backward	$BL_j = \frac{\sum_{i=1}^{n} l_{ij}}{l_{jj}}$	linkage of industry *j* to its suppliers	in relation to the output of industry *j*
	forward	$FL_i = \frac{\sum_{j=1}^{n} g_{ij}}{g_{ii}}$	linkage of industry *i* to its customers	in relation to the output of industry *i*
Decomposed linkages (all levels)	backward	$BDec_{ij} = \frac{g_{ij}}{g_{jj}}$	linkage of industry *j* to its supplier *i*	in relation to the output of industry *i*
	forward	$FDec_{ij} = \frac{l_{ij}}{l_{ii}}$	linkage of industry *i* to its customer *j*	in relation to the output of industry *j*
Key sectors	$\frac{\text{Leontief multiplier of j} \times \text{final demand of j}}{\text{output of j}} > 1$		sector *j* is more important for the other sectors than vice versa	

7 For further explanation, see theory in appendix 4.

The linkages of Cai and Leung give the effect relative to the output of the considered port actor, whereas the decomposed linkages analyse the effect relative to the output of the customer or supplier. If this ratio is greater than 1, the considered Antwerp port actor is more important for the other port actors, than the other port actors are for him.

b) Relations with the rest of the Belgian economy

In order to find the main customers and suppliers of the Antwerp port actors within the rest of the Belgian economy, two different measures can be used: external demand and external inputs (see table 2.5). Considering the customers which do not belong to any Antwerp port actor, the so-called external customers, we resort to external demand. In our schematic example in table 2.2, external demand is found in (2), (3) and (4). We then calculate t_{ie}, depicting the external demand for the port actors. Similarly, based on sub-matrices (5), (6) and (7), we find the main suppliers by calculating r_{ie}, which represents the external inputs for the port actors.

TABLE 2.5: OVERVIEW OF INPUT-OUTPUT INDICATORS FOR THE RELATIONS WITH THE REST OF THE BELGIAN ECONOMY

External demand	$t_{ie} = \frac{\text{deliveries from port actor i to external sector e}}{\text{total output of i}}$
External inputs	$r_{ie} = \frac{\text{payments from port actor i to external sector e}}{\text{total output of i}}$

c) Relations with the rest of the world

Percentages of output accounted for by import and export are also computed. These incoming and outward deliveries are brought together under two single entities, in addition to the Belgian sectors: one additional row and one additional column to the L-matrix respectively named "M" and "X" vectors. This restriction stems from the fact that no appropriate distinction could be made as to the transactions origins or destinations. In other words, no further indication concerning the sectors or countries in question is available. These two vectors of coefficients M and X are set out in section 3.2.3.

2.3. Geographical analysis: relations between port actors and the hinterland

By means of the sectoral analysis, the relations between the actors in the port and their customers and suppliers can be described. Moreover, the impact of changes in this relation pattern can be quantified, for example as a result of a government decision. So far, this tool leaves aside the spatial dimension of the industrial-economic structure. It is important to know in which geographical surroundings the relations take place: local, regional, national or international dimensions. Thus, one gets an insight into the effects of the decisions of governments or market parties, e.g. concerning spatial planning. The impact of the port activity can locally agglomerate or spread out.

In order to gain insight into the spatial dimension, the operations of the port activity must be localized. It is important to distinguish the following spatial entities in the case of Antwerp: the port area (with a distinction between the right and the left bank of the river Scheldt), the rest of the district of Antwerp and the rest of the province of Antwerp and the province of East-Flanders.

This detailed analysis aims to answer to simple following questions: Where are the main customers and suppliers of the port actors located?

The optimal spatial analysis method imposes strict requirements on the data. Address data (street and postcode) of the companies established in the Antwerp port are detailed in the annual accounts filed with the NBB Central Balance Sheet Office. After "geocoding", i.e. assigning data to different locations on maps, a very precise geographical database is available through which significant spatial analyses can be carried out.

The importance of customers and suppliers of the Antwerp port actors is measured by the net value of their purchases or of sales by the port actors. This net value is located on a map where various spatial entities are defined. Figure 2.3 shows Belgium with its ten provinces and the Brussels-Capital Region, the province of Antwerp with its three districts and the Antwerp port perimeter with the left and right banks of the river Scheldt.

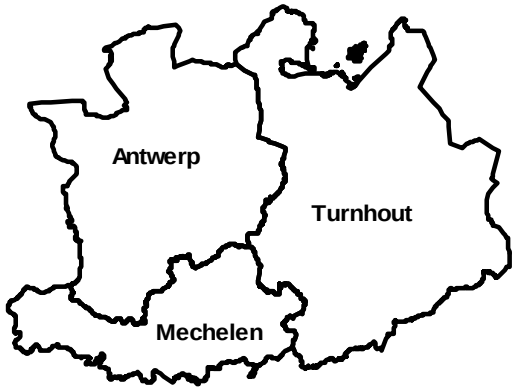
In the analysis a distinction is made between the different provinces through postcodes. This method is also used for the distinction between the various districts (Antwerp, Turnhout, Mechelen) within the province of Antwerp. The location of customers and suppliers inside or outside the Antwerp port perimeter is done by postcodes and NSI[8] codes. The set of postcodes 2000, 2020, 2030, 2040, 2060, 2070, 9120, 9130 more or less coincides with the port perimeter. As a consequence, the companies can be classified according to their address information.. Furthermore, it is possible to make a distinction between the left and right bank of the river Scheldt through NSI codes. These are shown in figure 2.3 in the section "Antwerp port perimeter". Companies with NSI code 46003 and 11056 are located on the left bank of the river Scheldt and companies with NSI code 11002 on the right bank. As can be seen in figure 2.3 one part of the left bank is situated in the province of East-Flanders (NSI code 46003) and the other part in the province of Antwerp (NSI code 11056).

The port perimeter being situated in two different provinces increases the complexity of the analysis and of spatial planning. The provinces of Antwerp and of East-Flanders each provide their own spatial planning for, respectively, the right bank and the left bank of the river Scheldt (Meersman et al., 2006).

8 National Statistics Institute, currently called the Belgian Federal Public Service Economy - Directorate-general Statistics Belgium.

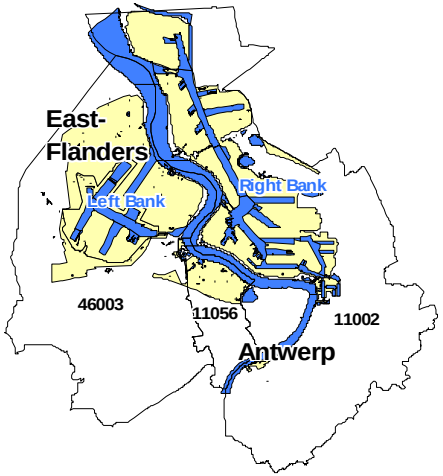
FIGURE 2.3: SPATIAL ENTITIES

BELGIUM



PROVINCE OF ANTWERP

ANTWERP PORT PERIMETER



Cartography: University of Antwerp - Department of Transport and Regional Economics

3. EMPIRICAL ANALYSIS: CASE OF ANTWERP

3.1. Relative importance of the Antwerp port actors

Before proceeding with the analysis of the relations between the Antwerp port actors and the other sectors of the economy, the relative importance of every Antwerp port actor in 2000, the year covered in this research, should be reviewed in terms of value added (VA) and employment. These data were calculated for the paper on the Economic importance of the Flemish maritime ports[9].

Sectors, such as terminal operating companies, fuel trade, supporting activities and forwarders play a major part in the Antwerp port economy. Their value added and employment are quite high. The percentages refer to their share in the *overall economic activity directly recorded in the port of Antwerp in 2000* (table 3.1).

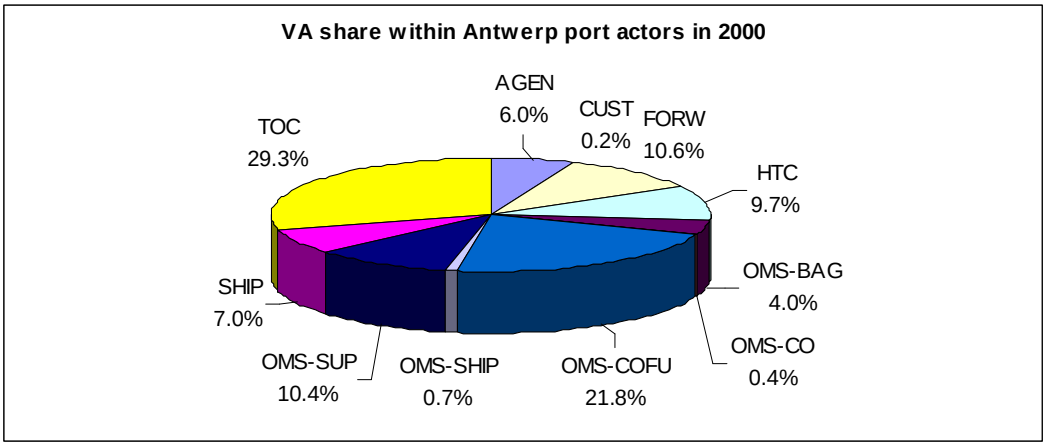
TABLE 3.1: VALUE ADDED AND EMPLOYMENT OF ANTWERP PORT ACTORS

	Value Added		Employment	
	(mio. euro)	(percentage)	(FTE)	(percentage)
Agents	149.5	2.15	2,037	3.36
Customs Brokers	5.8	0.08	109	0.18
Forwarders	264.2	3.80	3,671	6.06
Hinterland Transport Companies	242.1	3.48	3,717	6.14
Other Maritime Services	930.9	13.37	3,882	6.41
Dredging	99.7	1.43	603	1.00
Fuel trade	544.1	7.82	205	0.34
Other trade	9.5	0.14	132	0.22
Shipbuilding and repair	17.4	0.25	388	0.64
Supporting activities	260.1	3.74	2,553	4.21
Shipping Companies	175.0	2.51	484	0.80
Terminal Operating Companies	731.7	10.51	10,919	18.03
TOTAL	**2,499.1**	**35.91**	**24,818**	**40.97**

For the non-port actors in the port of Antwerp, the same information can be found in the study of the Flemish ports.

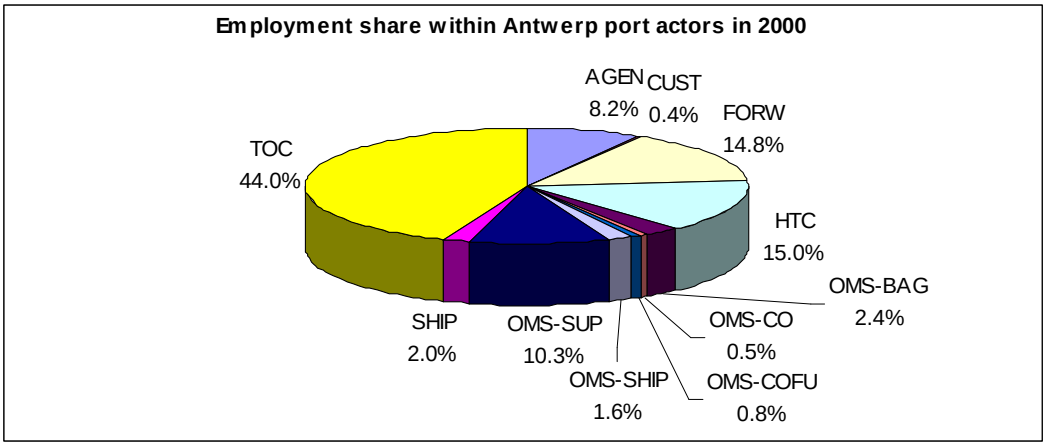
The following two figures provide an overview of the relative importance of each of these Antwerp port actors in 2000 compared with the total value added and employment of the *Antwerp port actors*.

FIGURE 3.1: VALUE ADDED SHARE OF THE ANTWERP PORT ACTORS IN 2000



9 Lagneaux (2006).

FIGURE 3.2: EMPLOYMENT SHARE OF THE ANTWERP PORT ACTORS IN 2000



Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

Figure 3.1 shows that the main part of that value added[10] comes from the terminal operating companies (29.3 p.c.). The fuel trade companies rank second with 21.8 p.c.

As to the employment, figure 3.2 offers a clear picture of the main employers among the Antwerp port actors: terminal operating companies rank first with 44 p.c., while hinterland transport companies rank second with 15 p.c. Fuel trade companies are less important in terms of employment than in terms of value added. These figures have to be taken into account in the analysis of the intersector relations set out below.

3.2. Sectoral relations of the Antwerp port actors

In this paragraph the relations between the Antwerp port actors and their relations with the rest of the Belgian economy are analysed for 2000 by means of input-output analysis. An input-output table in the form presented in paragraph 2.2.2 is built to highlight the relations between the Antwerp port actors and the relations with the rest of the Belgian economy. This is done by distributing the total deliveries and consumption over the different sectors in proportion to microeconomic data.

3.2.1. Relations between the Antwerp port actors

The analysis starts with the calculation of the Leontief and Ghosh multipliers. The net multipliers indicate respectively backward and forward linkages. This corresponds to the analysis of part (1) in table 2.2. Finally the key sectors among the port actors are depicted.

a) Relations to the customers

The influence an Antwerp port actor has on its customers (other Antwerp port actors) is measured by forward linkages.

The linkage of industry *i* to its customer *j*, relative to the output of customer *j*, is measured by means of the decomposed forward linkage. It measures the total effect an industry has on its customers.

[10] For the definition of the VA, see Lagneaux (2006).

TABLE 3.2: DECOMPOSED FORWARD LINKAGE OF THE ANTWERP PORT ACTORS (IN PERCENTAGES)

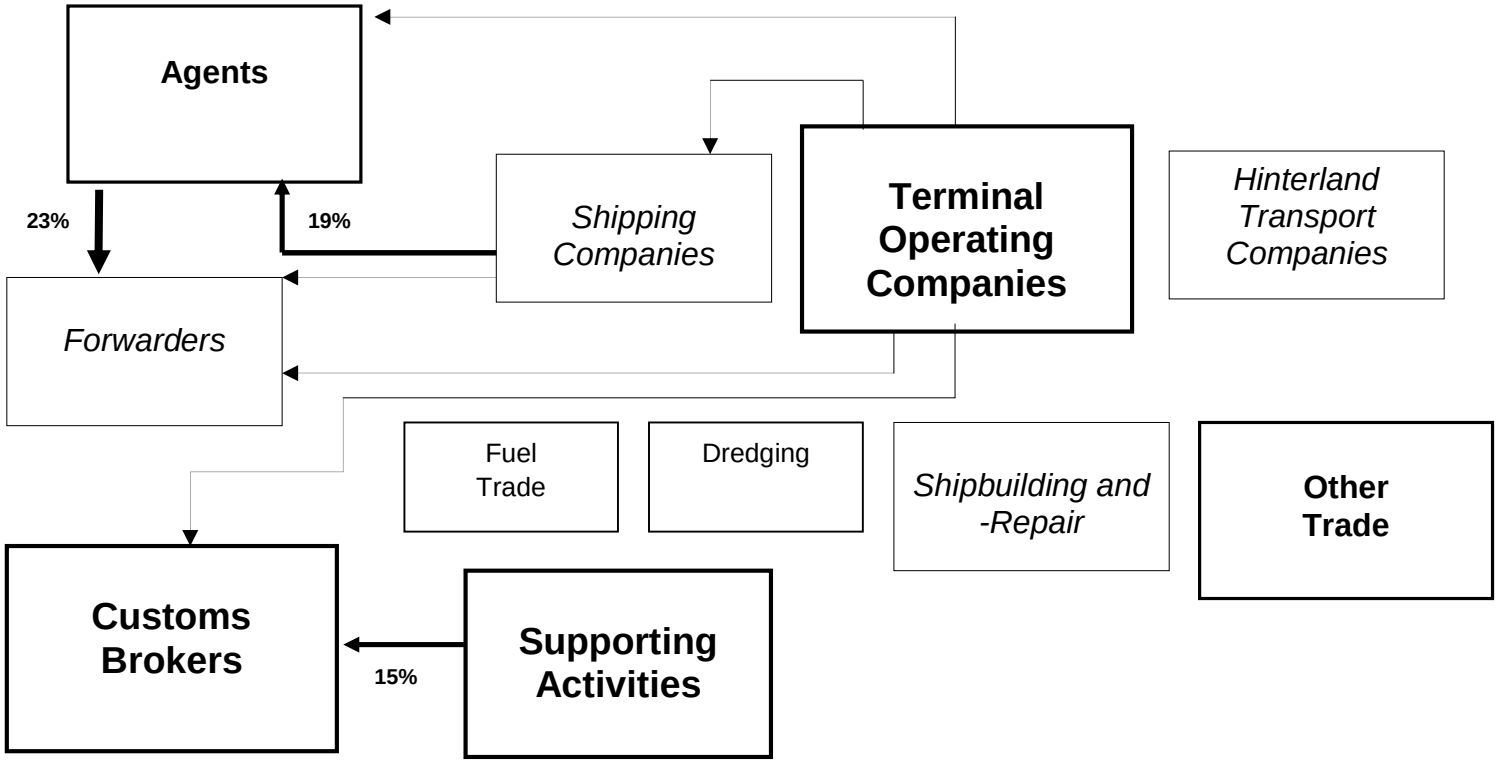
	AGEN	CUST	FORW	HTC	OMS-BAG	OMS-CO	OMS-COFU	OMS-SHIP	OMS-SUP	SHIP	TOC	**FL Cai & Leung**
AGEN	100.00	4.80	23.25	3.13	0.07	3.26	0.17	0.59	0.13	8.25	3.45	**152.24**
CUST	0.15	100.00	0.41	0.09	0.00	0.02	0.00	0.00	0.01	0.08	0.18	**176.72**
FORW	8.07	4.59	100.00	2.64	0.12	3.66	0.44	0.18	0.14	8.09	5.28	**114.43**
HTC	2.75	6.15	3.17	100.00	0.73	0.57	1.68	0.70	0.85	1.68	1.36	**133.41**
OMS-BAG	0.02	0.04	0.01	0.02	100.00	0.04	0.00	0.01	0.18	0.01	0.01	**101.14**
OMS-CO	0.91	0.19	0.61	0.78	0.08	100.00	0.02	1.12	0.11	0.93	0.39	**150.83**
OMS-COFU	0.12	0.04	0.06	0.18	0.04	1.88	100.00	0.02	0.03	0.10	0.04	**100.46**
OMS-SHIP	0.16	0.23	0.09	0.11	3.68	0.81	0.01	100.00	0.14	0.10	0.17	**135.92**
OMS-SUP	8.85	15.09	4.22	5.79	2.23	0.87	0.84	0.85	100.00	5.52	5.60	**187.00**
SHIP	19.35	3.03	14.69	2.08	0.04	5.01	0.28	0.22	0.36	100.00	3.53	**139.72**
TOC	12.82	11.92	10.73	2.00	0.04	1.29	0.38	0.29	0.15	11.53	100.00	**164.34**

Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and -repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

The decomposed forward linkages are shown in table 3.2. The last column gives the aggregate forward linkages as defined by Cai and Leung, i.e. relative to the output of the port actor, while the decomposed linkages are relative to the output of the customer. To give an overview of the information contained in table 3.2, figure 3.3 highlights the main relations between the Antwerp port actors based upon the decomposed linkages. These are represented by means of arrows, while the forward linkage of Cai and Leung is represented by the size of the boxes.

FIGURE 3.3: RELATIONS BETWEEN THE ANTWERP PORT ACTORS, BASED ON DECOMPOSED FORWARD LINKAGES



Legend:

- decomposed forward linkage > 20 p.c.
- 15 p.c. < decomposed forward linkage < 20 p.c.
- 10 p.c. < decomposed forward linkage < 15 p.c.
- related to the forward linkage from Cai and Leung

The port actors with the strongest forward influence on their customers are the supporting activities, the customs brokers and the terminal operating companies, according to the size of the boxes in figure 3.3, i.e. relative to their own output.

The arrows show the deliveries from one port actor to the other. The percentages show the effect of the deliveries relative to the output of the customer, i.e. the decomposed forward linkage. We see that customs brokers have no strong decomposed forward linkage. Supporting activities with a very strong forward linkage, relative to their own output, have only a strong influence on customs brokers, relative to the latter's output. Shipping companies, who don't have any strong forward linkage relative to their own output, do have a strong decomposed forward linkage with agents and, to a lesser extent, with forwarders. Terminal operating companies have a fairly strong downstream influence on agents, customs brokers, forwarders and shipping companies. Agents show a substantial decomposed forward linkage with forwarders.

b) Relations to the suppliers

The influence an Antwerp port actor has on its suppliers (other Antwerp port actors) is defined by backward linkages.

Decomposed backward linkages give the linkage of industry *j* to its supplier *i*, relative to the size of the supplier *i*. It measures the total effect an industry has on its suppliers.

TABLE 3.3: DECOMPOSED BACKWARD LINKAGE OF THE ANTWERP PORT ACTORS (IN PERCENTAGES)

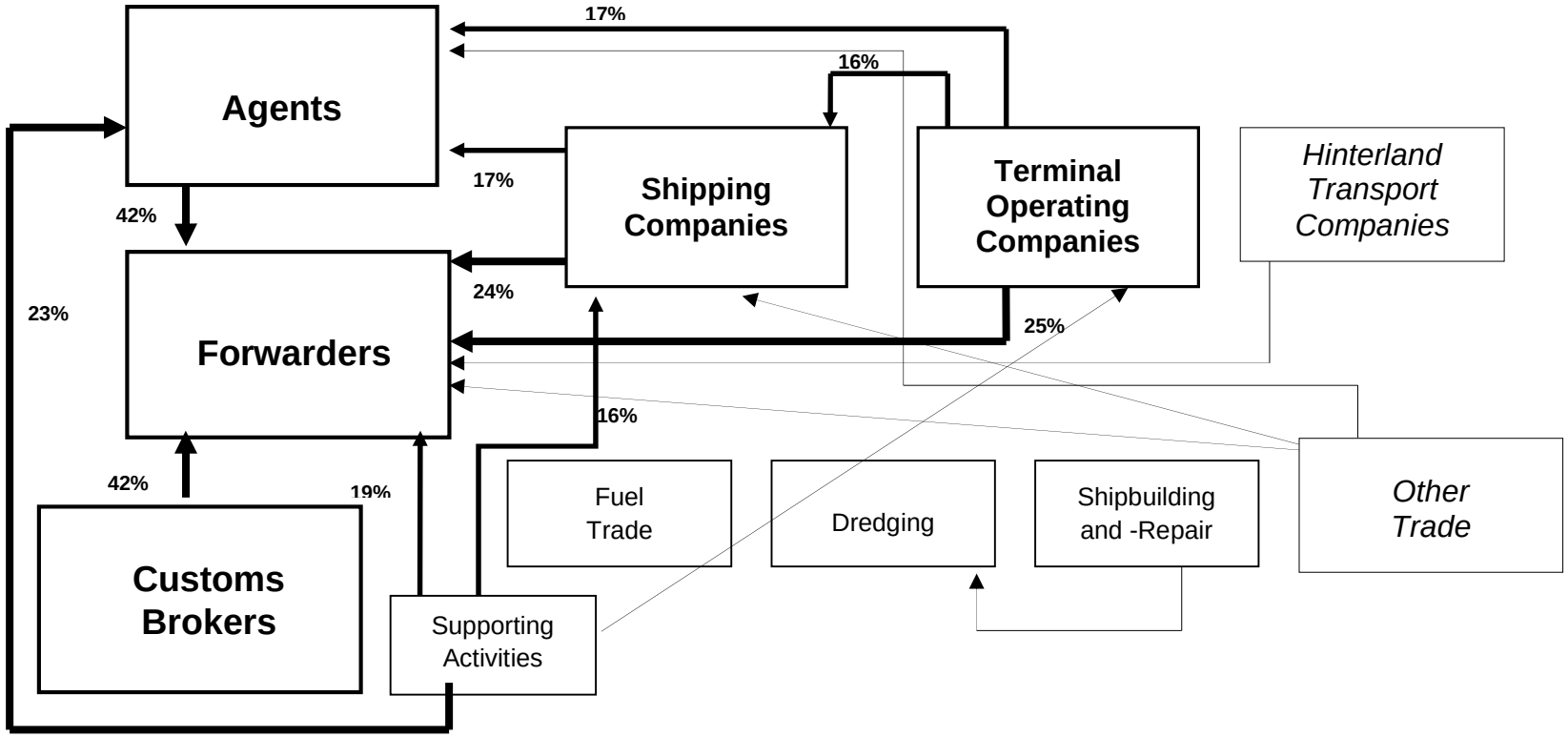
	AGEN	CUST	FORW	HTC	OMS-BAG	OMS-CO	OMS-COFU	OMS-SHIP	OMS-SUP	SHIP	TOC
AGEN	100.00	0.08	41.58	1.51	0.01	0.28	0.23	0.02	0.05	9.12	2.68
CUST	8.65	100.00	42.05	2.59	0.01	0.10	0.30	0.00	0.13	4.99	8.18
FORW	4.51	0.04	100.00	0.71	0.01	0.18	0.34	0.00	0.03	5.01	2.29
HTC	5.68	0.22	11.72	100.00	0.20	0.10	4.81	0.05	0.69	3.85	2.19
OMS-BAG	0.14	0.01	0.12	0.06	100.00	0.03	0.02	0.00	0.55	0.09	0.06
OMS-CO	10.68	0.04	12.75	4.39	0.13	100.00	0.38	0.49	0.51	12.06	3.58
OMS-COFU	0.09	0.00	0.08	0.06	0.00	0.12	100.00	0.00	0.01	0.08	0.02
OMS-SHIP	4.18	0.10	4.25	1.41	12.79	1.84	0.49	100.00	1.48	3.02	3.44
OMS-SUP	22.57	0.66	19.23	7.14	0.75	0.19	2.97	0.08	100.00	15.57	11.08
SHIP	17.50	0.05	23.74	0.91	0.01	0.39	0.35	0.01	0.13	100.00	2.47
TOC	16.54	0.27	24.76	1.25	0.01	0.14	0.67	0.01	0.08	16.46	100.00
BL Cai & Leung	**151.51**	**151.72**	**161.76**	**118.76**	**106.97**	**119.70**	**103.69**	**104.27**	**102.15**	**131.01**	**120.59**

Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and -repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

Table 3.3 shows the relations between the different port actors on the basis of decomposed backward linkages. The last row shows the backward linkages as defined by Cai and Leung, to give an aggregate number per port actor. To gain a clear view of the relations in question, figure 3.4 shows the greatest backward linkages between the port actors.

FIGURE 3.4: RELATIONS BETWEEN THE ANTWERP PORT ACTORS, BASED ON DECOMPOSED BACKWARD LINKAGES



Legende:

decomposed backward linkage > 20 p.c.

15 p.c. < decomposed backward linkage < 20 p.c.

10 p.c. < decomposed backward linkage < 15 p.c.

related to the backward linkage from Cai and Leung

From the size of the boxes in figure 3.4 it is obvious that the agents, forwarders and customs brokers have the most influence on their suppliers, relative to their own output.

The arrows on the figure represent the deliveries (mostly services) from one port actor to the other. The percentages show the effect of the deliveries on the supplier, relative to its output, i.e. the decomposed backward linkage. From these it is obvious that forwarders have a very strong influence on their suppliers relative to their own output: agents, customs brokers, supporting activities, shipping companies and terminal operating companies. Agents have an important influence on terminal operating companies, shipping companies, supporting activities and other trade. Dredging has a great upstream influence on shipbuilding and -repair and shipping companies on terminal operating companies, supporting activities and other trade. Terminal operating companies have an influence on supporting activities.

c) Key sectors

To calculate the main sector among the Antwerp port actors, that having, regardless of its size, the highest impact on its commercial partners, we use the definition of key sector. If this multiplier is greater than 1, it means that a particular port actor is more important for the rest of the port actors than vice versa.

TABLE 3.4: KEY SECTORS

AGEN	CUST	FORW	HTC	OMS-BAG	OMS-CO	OMS-COFU	OMS-SHIP	OMS-SUP	SHIP	TOC
0.80	0.71	1.49	0.91	1.06	0.82	1.03	0.77	0.45	0.87	0.67

Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and -repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

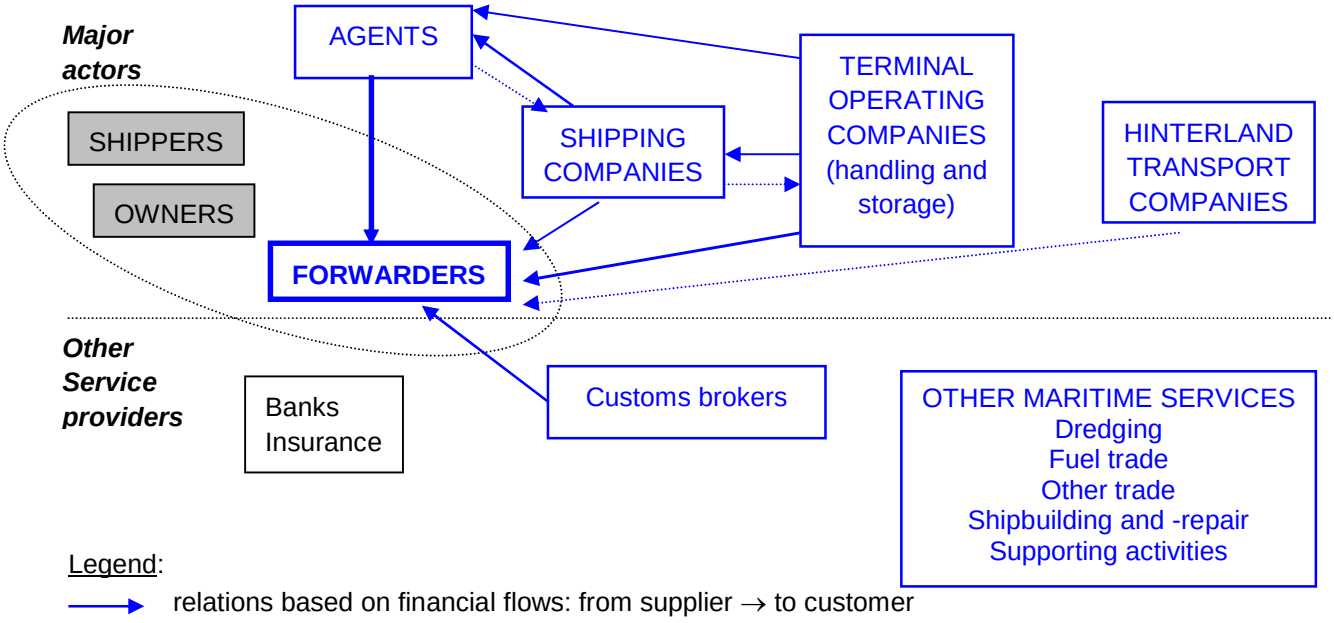
Table 3.4 indicates that Antwerp forwarders, dredging and fuel trade are key sectors, i.e. they generate more effects to the other Antwerp port actors than the opposite.

d) Relations between the Antwerp port actors: conclusion

To summarize our findings we can use figure 2.1 again. It has been slightly altered in order to represent the relations based on financial flows among the Antwerp port actors. On that figure, the black arrows depicted the commodity flow. In its altered version (figure 3.5) the blue boxes circumscribe the port actors considered in this research. The blue arrows are the new relations based on the financial flows, representing the deliveries or services performed from one port actor to the other. These figures are based on the financial data which resulted in the backward and forward linkage measures.

In figure 3.5 the forwarders are emphasized because their output is relatively high as well as their value added and employment, they are a major key sector for the other port actors and play a very important role for the other port actors as their customers.

FIGURE 3.5: ADJUSTED RELATIONS BETWEEN PORT ACTORS, FINANCIAL FLOW POINT OF VIEW



The circle drawn around shippers, owners of the goods and forwarders represents the fact that often these activities are found within one single company. Though in our study the forwarders are strictly defined forwarders in the sense that their reported NACEBEL code is a forwarding activity (see table 2.1).

Banks and insurance companies are not considered as actual port actors, but as other services. Nevertheless they are also very important for the activity in the port.

A conclusion from the sectoral analysis is the relation between the agents and the forwarders, the former as supplier and the latter as customer. Forwarders often contact agents instead of turning directly to the shipping companies, while agents deal directly with those companies. When this happens the payments from the forwarders for the services of the shipping companies are made via the agents and therefore the arrow from the shipping companies to the agents just accounts for the financial flow from the agent to the shipping company, although there actually exists no physical service between those two for the payment. In some cases, this may still happen that shipping companies directly deliver services to forwarders.

The financial relation between terminal operating companies and forwarders originates from terminal handling charges, which are levied by the shipping company on the shipper – or forwarder – but which run through the terminal operating company, who usually collects the charge on behalf of the shipping company. And therefore there is also a relation from the shipping company to the terminal operating company, whereby the terminal operating company pays the charge to the shipping company. These relations are just financial; there is no service against it.

The deliveries from customs brokers to forwarders mainly account for the customs documents, taxes, etc. With respect to the relation between customs brokers and forwarders, it should be noted that our starting position indicates a relationship between agents and customs brokers. This relation is however not found in the financial flow. The reason is mainly definitional: in the starting position, it was assumed that agents sometimes also act on behalf of the shipper, whereas in financial definition handled in the accounts data, they only act on behalf of the shipping company. In the latter sense, agents do indeed not have any link with customs brokers. There is then a link between customs brokers and forwarders.

Terminal operating companies deliver services to the shipping companies, concerning the loading and unloading of the goods on the ship. This service may financially be arranged via the agents. Therefore arrows exist from the terminal operating company to the agent and then from the agent to the shipping company.

Hinterland transport companies are also important because they ensure the supply of the goods in the hinterland and therefore deliver services to the forwarders.

Different co-operation agreements between various port actors can explain relations between some predominant port actors. Heaver et al. (2000) sum up some possible agreements in table 3.5. below.

TABLE 3.5: CO-OPERATION AGREEMENTS BETWEEN VARIOUS MARKET PLAYERS

Market players	Shipping companies	Stevedores	Hinterland transport	Port authorities
Shipping companies	- vessel sharing agreements - joint ventures - conferences / cartel agreements - consortia - strategic alliances - mergers			
Stevedores	- financial stake of shipping company in stevedore - joint ventures - dedicated terminals	- participation in capital		
Hinterland transport	- block trains and capacity sharing - alliances	- joint ventures	- takeover strategy of railway companies	
Port authorities	- dedicated terminals	- financial stakes port authorities	- combined traffic terminals (Hamburg Hafenbahn, Rail Service Centra in Rotterdam)	- alliances

Source: Heaver et al. (2000, p. 365), www.hafen-hamburg.de and www.portofrotterdam.com

Shipping companies, stevedores (terminal operating companies), hinterland transport companies and port authorities (subset of the supporting activities) are considered as the predominant maritime market players. The strong co-operation between shipping companies in the Antwerp port perimeter is clear from our analysis of the technical coefficients[11]. Almost 23 p.c. of its inputs comes from shipping companies. Also the link between the terminal operating companies and the shipping companies can be found in Antwerp.

11 The analysis of the technical coefficients itself is not shown, because the linkages incorporate the total effects, whereas the technical coefficients only take the direct effects into account.

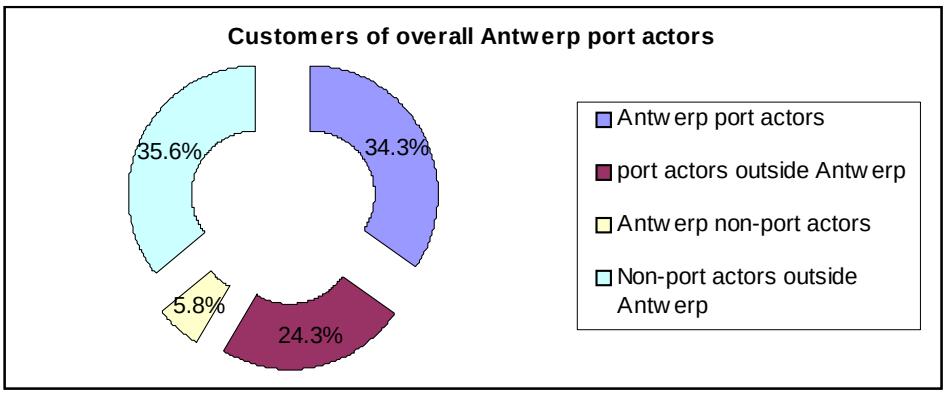
3.2.2. Relations of the Antwerp port actors with the rest of the Belgian economy

In this paragraph the relations of the Antwerp port actors with the rest of the Belgian economy are analysed, by external demand and external inputs, calculated by means of t_{ie} and r_{ie}. In appendix 5 charts illustrate these two indicators in more detail.

a) External demand

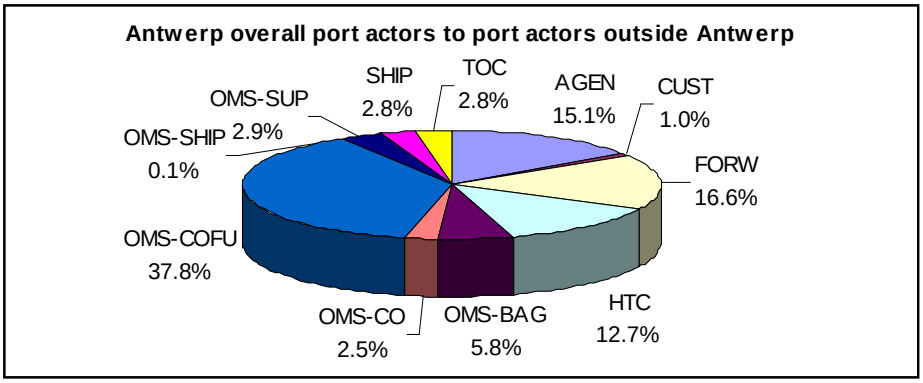
The following figures give an overview of the customers of the overall Antwerp port actors, i.e. the port actors in the Antwerp port perimeter. They are calculated by means of t_{ie}, i.e. the ratio of the deliveries from port actor 'i' to external sector 'e' on the total output of port actor 'i'. A difference is made between port actors outside Antwerp (i.e. outside the Antwerp port perimeter), Antwerp non-port actors (i.e. inside the Antwerp port perimeter) and non-port actors outside Antwerp. In appendix 5 a distinction is made per port actor.

FIGURE 3.6: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS: SUMMARY



Most customers of the Antwerp port actors are found outside Antwerp among non-port actors (35.6 p.c., figure 3.6) and among the Antwerp port actors (34.3 p.c.). From appendix 5 we can see that especially agents, customs brokers, supporting activities, shipping companies and terminal operating companies have the major part of their customers among the Antwerp port actors. This is intuitively correct, as each of these actors' basic services are port-related. Forwarders, hinterland transport companies and shipbuilding and -repair have most of their customers among the non-port actors located outside Antwerp. This too is consistent with common sense, as their services are basically directed towards non-port actors. Antwerp dredging delivers 83 p.c. of its output to port actors outside the Antwerp port perimeter. The main reason is that Antwerp-based dredging companies supply many Belgian customers with their services.

FIGURE 3.7: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS: PORT ACTORS OUTSIDE ANTWERP

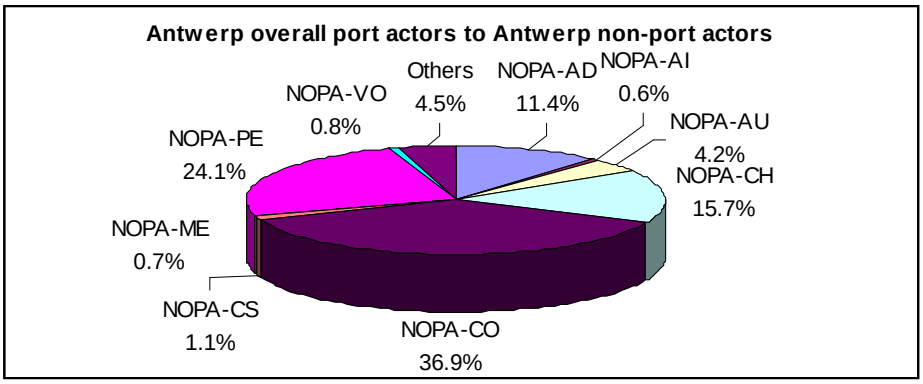


Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and -repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

The fuel trade port actor is the main port actor - customer outside Antwerp for the overall Antwerp port actors (figure 3.7). This high percentage goes on the account of Antwerp fuel trade companies. Almost 90 p.c. of their customers among the port actors outside Antwerp are in fuel trade themselves. Forwarders outside the Antwerp port perimeter come on a second place as customers of overall Antwerp port actors. As the port serves a large hinterland, it is indeed correct that many of the forwarders are located outside the local port perimeter. When each port actor is analysed separately, we see that indeed forwarders are important customers of Antwerp agents, customs brokers and forwarders. On the other hand, agents outside Antwerp are important customers for terminal operating companies, shipping companies and other trade companies, whereas customers of Antwerp-based dredging companies are nearly all dredging companies. The former observation is logical in view of the commodity flow through the port. The latter implies that Antwerp-based dredging companies subcontract a lot to non-Antwerp dredging companies.

FIGURE 3.8: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS: ANTWERP NON-PORT ACTORS

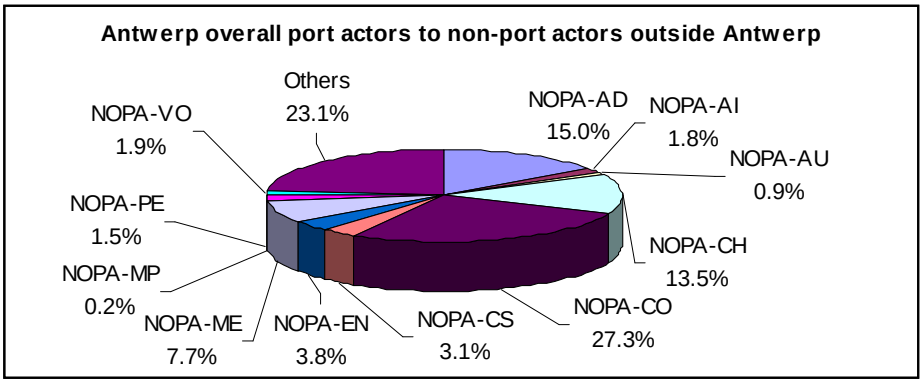


Legend:

NOPA-AD	Non-port actor - Other services	NOPA-ME	Non-port actor - Metallurgy
NOPA-AI	Non-port actor - Other industries	NOPA-MP	Non-port actor - Electronics
NOPA-AU	Non-port actor - Car manufacturing	NOPA-PE	Non-port actor - Oil industry
NOPA-CH	Non-port actor - Chemical industry	NOPA-PU	Non-port actor - Public services
NOPA-CO	Non-port actor - Trade	NOPA-TP	Non-port actor - Land transport
NOPA-CS	Non-port actor - Construction	NOPA-VO	Non-port actor - Food industry
NOPA-EN	Non-port actor - Energy	Others	

Almost 37 p.c. of the Antwerp non-port actors – customers are trade-related (figure 3.8). Trade is the greatest Antwerp non-port actor – customer of Antwerp agents, customs brokers, other trade companies, fuel trade, shipbuilding and –repair, shipping companies and terminal operating companies. Within Antwerp also the oil industry is of great importance, especially for forwarders and hinterland transport companies. Almost 16 p.c. of the non-port customers are Antwerp companies in the chemical industry, mainly because of the great supply by liquid bulk handling companies. For dredging and supporting activities other services are the main Antwerp non-port actor – customer. The car manufacturing industry, one of the main industries in the port of Antwerp is mainly dependent on the terminal operating companies and other trade (see details in appendix 5). This is to be explained by the high volume of cars passing through the Port of Antwerp and requiring handling.

FIGURE 3.9: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS: NON-PORT ACTORS OUTSIDE ANTWERP



Legend:

NOPA-AD	Non-port actor - Other services	NOPA-ME	Non-port actor - Metallurgy
NOPA-AI	Non-port actor - Other industries	NOPA-MP	Non-port actor - Electronics
NOPA-AU	Non-port actor - Car manufacturing	NOPA-PE	Non-port actor - Oil industry
NOPA-CH	Non-port actor - Chemical industry	NOPA-PU	Non-port actor - Public services
NOPA-CO	Non-port actor - Trade	NOPA-TP	Non-port actor - Land transport
NOPA-CS	Non-port actor - Construction	NOPA-VO	Non-port actor - Food industry
NOPA-EN	Non-port actor - Energy	Others	

More than 27 p.c. of the non-port customer outside Antwerp of overall Antwerp port actors are in trade (figure 3.9), which is also true for the Antwerp agents, forwarders, other trade and fuel trade. Customs brokers, hinterland transport companies and the supporting activities have other services as an important customer. For dredging, the construction industry is the biggest non-port customer outside the Antwerp port perimeter, for shipping companies these are energy companies and for terminal operating companies the chemical industry is the most important customer.

b) External inputs

Following figures show the calculated r_{ie} for the suppliers of overall Antwerp port actors. It corresponds to the ratio of the payments from port actor 'i' to external sector 'e' on the total output of port actor 'i'.

FIGURE 3.10: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS: SUMMARY

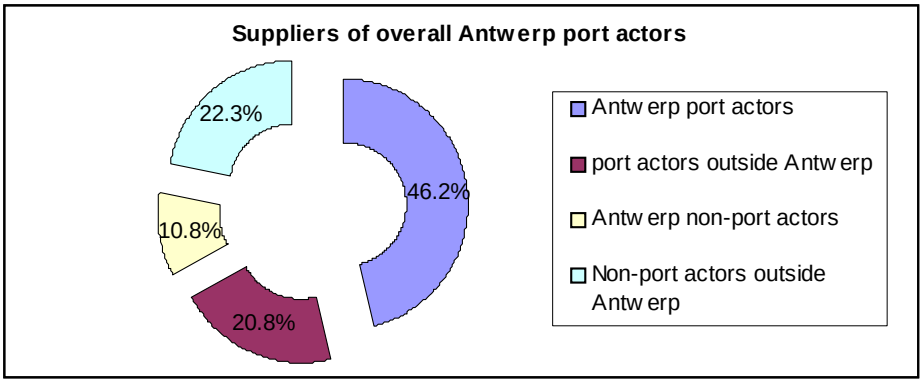
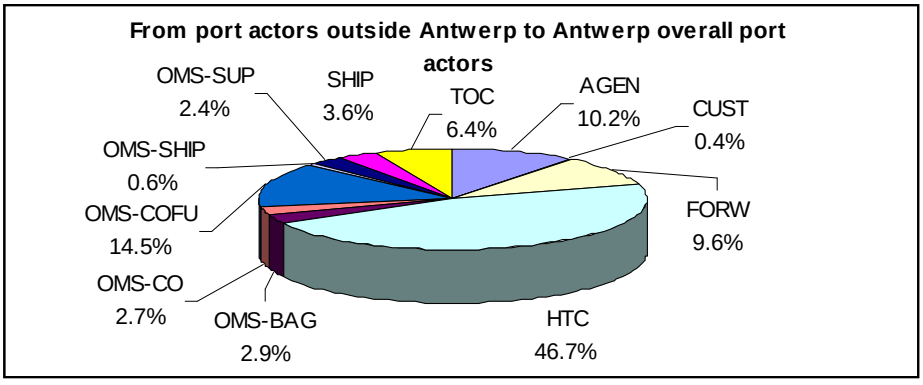


Figure 3.10 entails that most suppliers of Antwerp port actors are Antwerp port actors (46.2 p.c.). In appendix 5 the different Antwerp port actors are viewed separately concerning their suppliers. Agents, forwarders, customs brokers, shipping companies and terminal operating companies indeed mainly have suppliers which are port actors within the Antwerp port perimeter. This is obvious in view of the commodity flow through the port. Hinterland transport companies, dredging, other trade and supporting activities mainly have suppliers which are non-port actors outside Antwerp. This is largely due to the non-port character of their activities. Fuel trade and shipbuilding and -repair have mostly Antwerp non-port suppliers.

FIGURE 3.11: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS: PORT ACTORS OUTSIDE ANTWERP

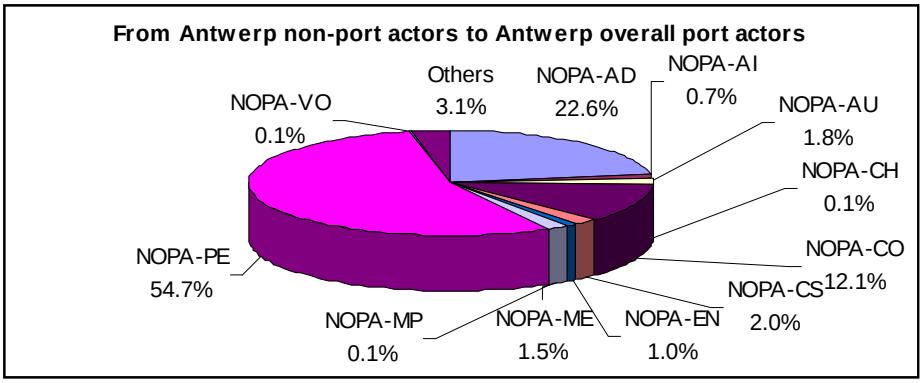


Legend:

AGEN	Agents	OMS-BAG	Other maritime services - Dredging
CUST	Customs brokers	OMS-COFU	Other maritime services - Fuel trade
FORW	Forwarders	OMS-CO	Other maritime services - Other trade
HTC	Hinterland transport companies	OMS-SHIP	Other maritime services - Shipbuilding and -repair
SHIP	Shipping companies	OMS-SUP	Other maritime services - Supporting activities
TOC	Terminal operating companies		

Most port actors outside Antwerp supplying to overall Antwerp port actors are hinterland transport companies (figure 3.11). This is also true for the Antwerp agents, customs brokers, forwarders, hinterland transport companies and shipping companies. Fuel trade is the second largest supplier outside Antwerp for overall Antwerp port actors and is the main supplier for Antwerp fuel and other trade.

FIGURE 3.12: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS: ANTWERP NON-PORT ACTORS

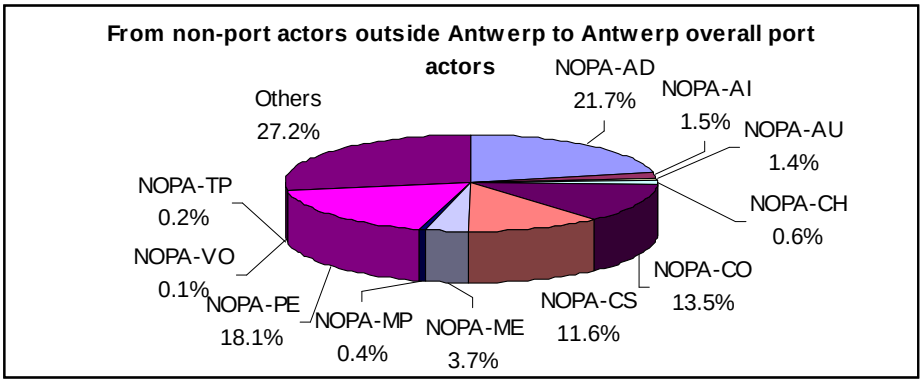


Legend:

NOPA-AD	Non-port actor - Other services	NOPA-ME	Non-port actor - Metallurgy
NOPA-AI	Non-port actor - Other industries	NOPA-MP	Non-port actor - Electronics
NOPA-AU	Non-port actor - Car manufacturing	NOPA-PE	Non-port actor - Oil industry
NOPA-CH	Non-port actor - Chemical industry	NOPA-PU	Non-port actor - Public services
NOPA-CO	Non-port actor - Trade	NOPA-TP	Non-port actor - Land transport
NOPA-CS	Non-port actor - Construction	NOPA-VO	Non-port actor - Food industry
NOPA-EN	Non-port actor - Energy	Others	

Oil industry is the largest Antwerp non-port supplier for the overall Antwerp port actors (figure 3.12). This is consistent because 98 p.c. of the Antwerp non-port suppliers of fuel trade is in the oil industry. Other services account for 23 p.c. of the supply from non-port actors within the Antwerp port perimeter. Other services are the main suppliers of Antwerp agents, forwarders, dredging, shipping companies and terminal operating companies.

FIGURE 3.13: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS: NON-PORT ACTORS OUTSIDE ANTWERP



Legend:

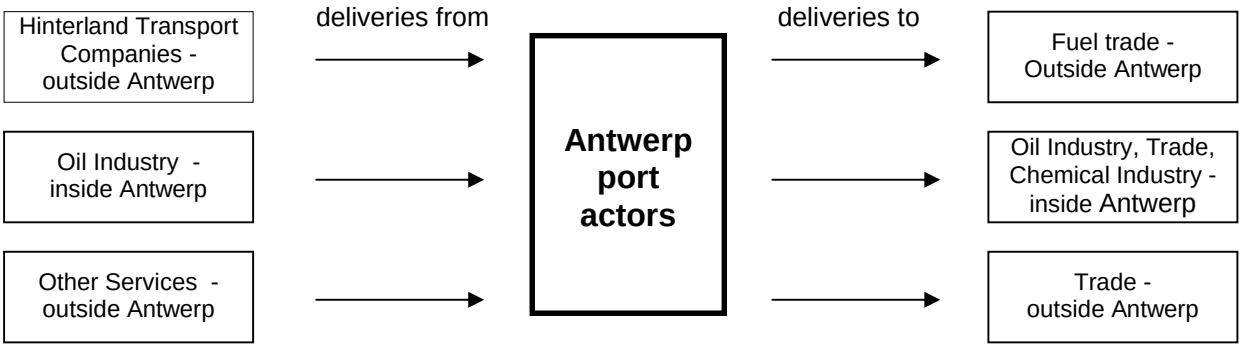
NOPA-AD	Non-port actor - Other services	NOPA-ME	Non-port actor - Metallurgy
NOPA-AI	Non-port actor - Other industries	NOPA-MP	Non-port actor - Electronics
NOPA-AU	Non-port actor - Car manufacturing	NOPA-PE	Non-port actor - Oil industry
NOPA-CH	Non-port actor - Chemical industry	NOPA-PU	Non-port actor - Public services
NOPA-CO	Non-port actor - Trade	NOPA-TP	Non-port actor - Land transport
NOPA-CS	Non-port actor - Construction	NOPA-VO	Non-port actor - Food industry
NOPA-EN	Non-port actor - Energy	Others	

Other services and oil industry are the important suppliers outside the Antwerp port perimeter. Oil industry is important because 75 p.c. of the non-port suppliers outside Antwerp of Antwerp fuel trade is in the oil industry (figure 3.13). Other services are the biggest suppliers outside the Antwerp port perimeter for Antwerp customs brokers, hinterland transport companies, other trade, shipping companies and terminal operating companies.

Considering the main customers and suppliers of the Antwerp port actors in the rest of the Belgian economy, a distinction was made between port actors outside the Antwerp port perimeter, non-port actors within the Antwerp port perimeter and non-port actors outside the Antwerp port perimeter.

Figure 3.14 summarizes the main customers and suppliers of the Antwerp port actors which are themselves no Antwerp port actors.

FIGURE 3.14: MAIN EXTERNAL DEMAND AND EXTERNAL INPUTS OF THE ANTWERP PORT ACTORS



Most customers (36 p.c.) of the Antwerp port actors are located outside the port perimeter and are no port actors. In this category the most important sector is trade, which is also important within the port perimeter. On the second place we find port actors inside the Antwerp port perimeter with 34 p.c. Fuel trade is the first customer outside the port perimeter among the port actors especially for Antwerp fuel trade. The main customers of Antwerp dredging among the port actors in the port perimeter are dredging companies with 99 p.c. Important customers in the port perimeter but non-port actors are trade and oil industry.

Most suppliers of the Antwerp port actors are situated among the port perimeter and are port actors (46 p.c.). Hinterland transport companies are the main customers outside the port perimeter among the port actors. But for Antwerp fuel trade the first supplier is fuel trade and for Antwerp dredging companies it is dredging. Considering the non-port actors in Antwerp, oil industry is the main supplier with 55 p.c. It is more important within Antwerp than outside the port perimeter.

Oil industry and other services are also important suppliers outside Antwerp. The port of Antwerp is the second largest petrochemical[12] complex in the world, after Houston. These industrial companies are clustering in the port because of agglomeration advantages (Port of Antwerp, 2001).

3.2.3. Relations of the Antwerp port actors with the rest of the world

A last part of the L-shaped matrix (see table 2.2) has to be empirically examined: the (M) and (X) boxes. According to VAT declarations of the year 2000, the Antwerp port actors have imported and exported a substantial part of their output. Yet import represents a much higher share of it than export, since the port actors are first and foremost supporting activities to the port businesses and have therefore little to deliver to foreign companies.

Since no indication is widely available as far as the origin or destination of these goods and services are concerned, this presentation is restricted to the percentages of the Antwerp port actors' output accounted for by their foreign trade (table 3.6):

12 This petrochemical cluster is mainly formed by the chemical industry, oil industry and fuel trade.

TABLE 3.6: OUTPUT'S PERCENTAGE REPRESENTED BY FOREIGN TRADE

Port actor	Import	Export
Agents	1.1	0.5
Customs Brokers	0.8	0.5
Forwaders	0.4	0.3
Hinterland Transport Companies	2.6	0.2
Other maritime services: Dredging	6.9	0.4
Other maritime services: Other trade	17.5	0.0
Other maritime services: Fuel trade	17.3	6.6
Other maritime services: Shipbuilding and repair	9.3	4.2
Other maritime services: Supporting activities	1.6	0.0
Shipping companies	0.1	0.0
Terminal Operating Companies	1.9	0.0
Average	4.3	1.4

Fuel trade and other trade and, to a lesser extent, shipbuilding and repair as well as dredging are quite dependent on import. These last two port actors regularly deal with subcontractors established in Belgium, which can explain the more moderate recourse to import. The rather low import figures for agents, customs brokers, forwarders, supporting activities, shipping companies and terminal operating companies stem from the fact that these companies are mainly supplied by entities from the same group. Therefore they officially do not mobilize third parties so often, such as foreign corporations.

Fuel trade is the only Antwerp port actor depending significantly on export. Antwerp port actors indeed supply goods and services to many foreign companies but these transactions mainly occur with their Belgian subsidiaries. For instance most shipping companies own branches in the countries where they operate, generally for fiscal reasons.

3.3. Geographical analysis

The relations between the Antwerp port actors and their customers and suppliers are presented by different figures. First, these figures were made for every port actor separately (appendix 6). From which a similar geographical pattern was visible. Therefore a principal component analysis (PCA) was done to confirm the results. PCA is a statistical technique which reduces a big set of variables (in our case the different port actors) into a set of components. In this research PCA is used to find out whether all port actors have a similar geographical pattern. If they do the result of the PCA would be one component for the different port actors. The more mathematical explanation of the PCA is found in appendix 7.

The results of the two components kept for the customers and the suppliers are shown in table 3.7. From this table it is clear that most customers and suppliers of the port actors are found in component 1. This means that they all have similar geographical patterns. The straightforward exceptions are found within dredging and fuel trade. Suppliers of shipbuilding and -repair, supporting activities and hinterland transport companies show some minor deviations from the overall pattern. We conclude that all customers and suppliers can be discussed together, except dredging and fuel trade.

TABLE 3.7: ROTATED COMPONENT MATRICES FOR CUSTOMERS' AND SUPPLIERS' PCA

Customers

	Component	
	1	2
Supporting Activities	.97	-.12
Other trade	.95	
Agents	.95	-.18
Hinterland Transport Companies	.99	
Forwarders	.92	-.19
Terminal Operating Companies	.90	-.15
Customs Brokers	.90	
Shipping Companies	.82	-.14
Shipbuilding and -Repair	.80	.24
Dredging	.15	.93
Fuel trade	.12	-.21

Suppliers

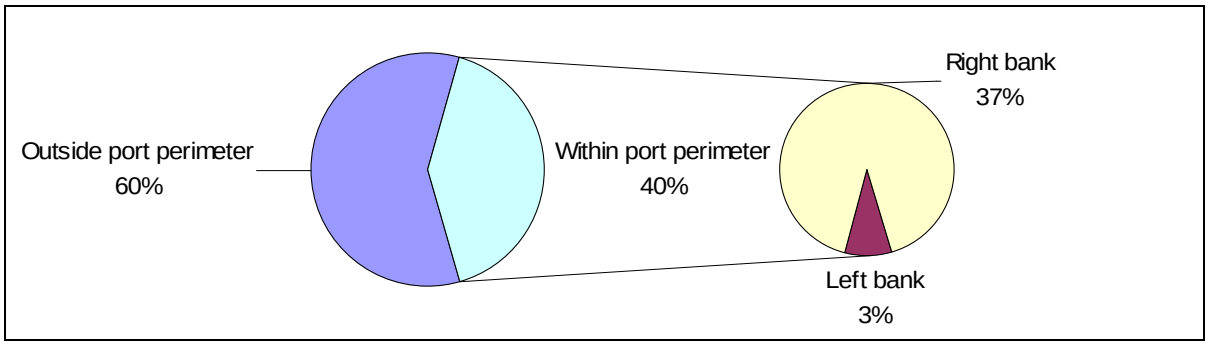
	Component	
	1	2
Shipping Companies	.97	
Agents	.94	.32
Other trade	.93	.18
Terminal Operating Companies	.93	.30
Forwarders	.87	.41
Customs Brokers	.84	.51
Fuel trade		.87
Shipbuilding and -Repair	.44	.86
Supporting Activities	.51	.80
Hinterland Transport Companies	.59	.76
Dredging		.51

First a distinction is made between in or outside the Antwerp port perimeter and on the left or right bank of the river Scheldt (see figure 2.3), calculated by the net value of purchases or sales from the Antwerp port actors. Next, maps are presented for the part outside the port perimeter. And finally some charts per province and per district within the province of Antwerp are shown separately for customers and suppliers.

3.3.1. Customers of the Antwerp port actors

Figures 3.15, 3.16 and 3.17 give an indication of the location of the customers of overall Antwerp port actors (including dredging and fuel trade).

FIGURE 3.15: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS WITHIN THE ANTWERP PORT PERIMETER



60 p.c. of the customers of the Antwerp port actors are located outside the port perimeter. Of the customers situated within the port perimeter only few are located on the left bank.

FIGURE 3.16: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS PER PROVINCE

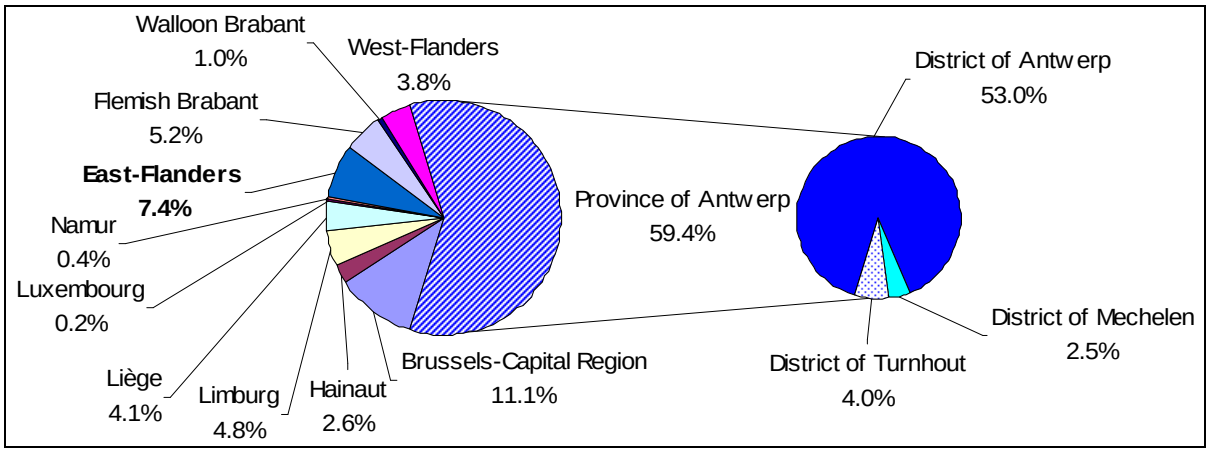


Figure 3.16 shows all the customers per province and within the province of Antwerp per district. Most customers of the Antwerp port actors are situated in the province of Antwerp (59 p.c.), mostly located in the district of Antwerp. Only 7.4 p.c. are situated in East-Flanders, but more than 11 p.c. in Brussels. The latter can be explained by the fact that many companies have their head-offices in Brussels from where they are paid.

Some differences from this overall pattern exist among a few port actors, such as dredging and fuel trade. Customers of dredging are situated for more than 10 p.c. in the district Turnhout and for 56 p.c. in West-Flanders and only for 36 p.c. in Antwerp and a merely 0.2 p.c. in the Brussels-Capital Region. Fuel trade has for more than 9 p.c. customers in Limburg.

Figure 3.17 shows the 60 p.c. outside the port perimeter on a map of Belgium. It can be seen that Antwerp and Brussels are the prime regions for the customers of the Antwerp port actors. Furthermore, relatively important concentrations of customers in the other Belgian port areas are retrieved, such as Ghent, Zeebrugge, Liège and Ostend.

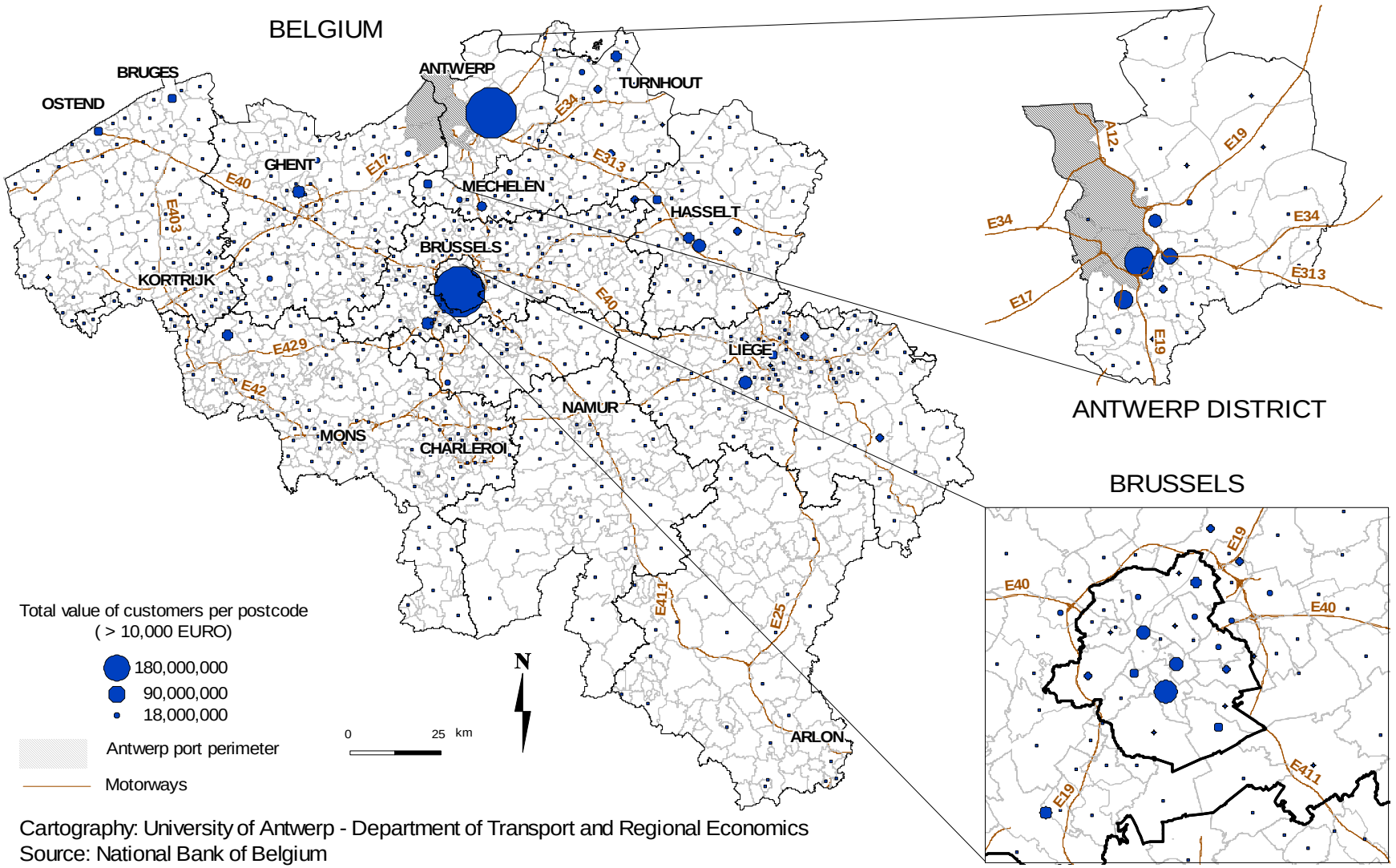
Some other concentrations can be found in the rest of the province of Antwerp, especially in the district of Turnhout and in the province of Limburg. These latter two can take the advantage of the good connections with the hinterland by motorways E34 and E313. Motorway E313 and the canal between Antwerp and Liège (Albertkanaal) are considered to be gateways, i.e. strategic places within an economic structure. The network 'Albertkanaal' has a functional relation with the port of Antwerp and this needs to be further developed (Provincie Antwerpen, 2001, p. 153-154).

Mechelen and Turnhout can be considered as an indication of subharborization. This means that because of growing congestion, lack of space and rising land prices and labour costs, footloose and logistics firms have to make space for port-related companies and relocate to the hinterland (Buck Consultants International, 2002).

Within the district of Antwerp, we find the city of Antwerp, Wilrijk, Deurne and Merksem to be most significant. In the Brussels region we find Ixelles-Elsene, Etterbeek and the city of Brussels with concentrations of customers.

We can conclude that though 60 p.c. of the customers are located outside the port perimeter, the customers are located very close to the port perimeter: 60 p.c. are found in the province of Antwerp, even 53 p.c. in the district of Antwerp.

FIGURE 3.17: CUSTOMERS OF OVERALL ANTWERP PORT ACTORS IN BELGIUM

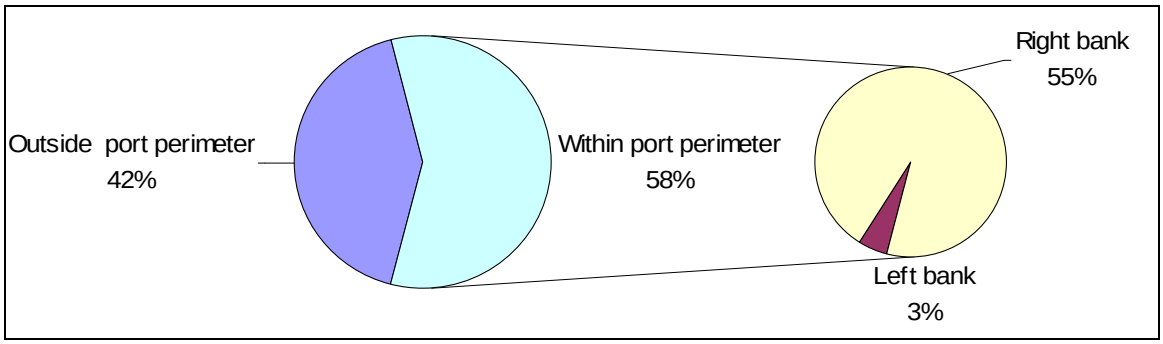


Cartography: University of Antwerp - Department of Transport and Regional Economics
Source: National Bank of Belgium

3.3.2. Suppliers of the Antwerp port actors

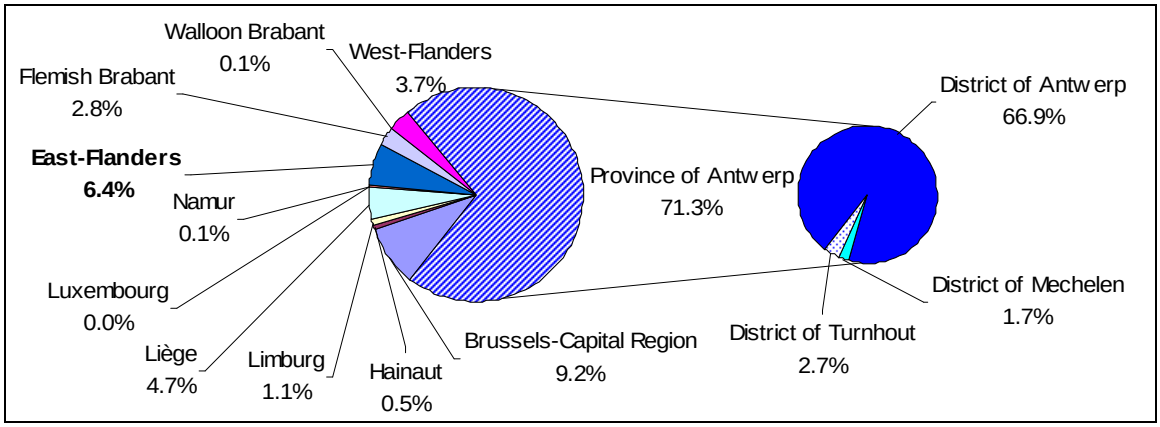
Figures 3.18, 3.19 and 3.20 show the location of the suppliers of overall Antwerp port actors.

FIGURE 3.18: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS WITHIN THE ANTWERP PORT PERIMETER (CHART)



In contrast to the customers, most suppliers are located inside the Antwerp port perimeter (58 p.c.). Most suppliers within the port perimeter are situated on the right bank of the river Scheldt.

FIGURE 3.19: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS PER PROVINCE



Concerning the suppliers of the Antwerp port actors, a similar conclusion as with the customers is possible. Most suppliers are located in the district of Antwerp (99.9 p.c.). Only 6.4 p.c. of the suppliers are situated in East-Flanders. As we compare figure 3.19 with figure 3.16, we see that much more suppliers than customers are located in the province of Antwerp, and more customers than suppliers in the province of Limburg.

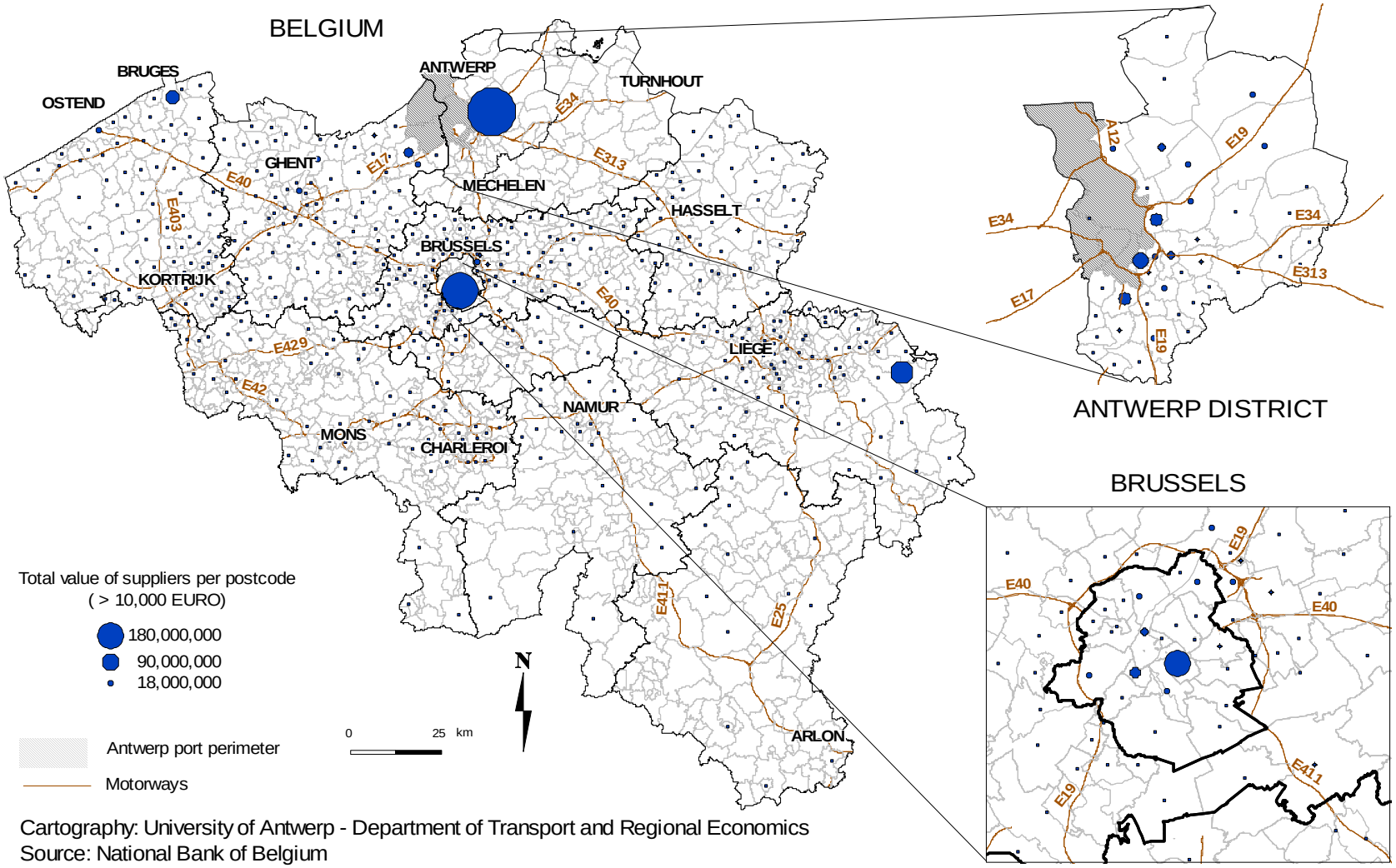
Also for the suppliers of the Antwerp port actors, analysed separately, a different geographical picture can be found for some port actors. Suppliers of Antwerp dredging are for 21 p.c. situated in West-Flanders. Fuel trade has more than 25 p.c. of its suppliers in Brussels.

Figure 3.20 shows the 42 p.c. suppliers outside the Antwerp port perimeter. Almost no suppliers are situated in Mechelen or Turnhout. Some suppliers are also situated in Eupen and Zeebrugge. The importance of Eupen is mainly due to Herbesthal, there an intermodal railterminal is located.

The city of Antwerp, Wilrijk and Merksem are also important concerning the suppliers. Whereas in Brussels, Etterbeek and Sint-Gillis are important.

We conclude that also the suppliers of the Antwerp port actors concentrate mainly in the close vicinity of the port perimeter.

FIGURE 3.20: SUPPLIERS OF OVERALL ANTWERP PORT ACTORS IN BELGIUM



Cartography: University of Antwerp - Department of Transport and Regional Economics
Source: National Bank of Belgium

3.3.3. Geographical relations of the Antwerp port actors

The Antwerp port actors' customers and suppliers are for the greater part located in the province of Antwerp and the Brussels-capital region. Inside the port perimeter, most of them are situated on the right bank of the river Scheldt. This is in line with the National Bank concluding in its report for 2000 that the economic importance of the right bank of the river Scheldt is larger than that of the left bank. Oil industry and car manufacturing companies for example, two very important sectors, are located on the right bank (NBB, 2002).

Most port actors have more or less the same geographic spread concerning their customers and suppliers, an important concentration in or near the port perimeter. But some small differences are noted. Forwarders have relatively more customers in East-Flanders than overall Antwerp port actors. Customers as well as suppliers of dredging are to a large extent located in West-Flanders, where as terminal operating companies have a substantial part of their suppliers in West-Flanders.

From this we can assume that agglomeration effects are important for the customers and suppliers of the Antwerp port actors, as they are mostly located in Antwerp. Weber has already drawn the attention to agglomeration advantages in his location theory from 1909. Agglomeration whereby the firm expands can generate lower costs by producing on a bigger scale. Furthermore, by agglomerating, the firm can also benefit from sharing capital goods and services with other firms (Van de Voorde, Witlox, 1992, p. 259). This agglomeration of economic activity can also be seen as the concentration on a transhipment point location (Hoover and Giarratani, 2006), where scale economies in transfer and terminal operations are observed. These locations are provided with specialized facilities for goods handling and storage.

Relating our results to the notion of accessibility, they give a confirmation of the topological and economic accessibility networks known in Belgium. As far as the road infrastructure is concerned, Brussels and Antwerp are very accessible: the north of Brussels can be reached by rail and the triangle with the eastern border, corresponding to the Antwerp-Brussels axis, by inland waterways This corresponds to the locations of most customers and suppliers of the Antwerp port actors in Antwerp and Brussels. When this accessibility measure is weighted to reflect the importance of the economic activity, Thomas et al. (2003) conclude that economic activities are footloose and oriented towards international transport gates, such as the ports of Antwerp, Ghent, Zeebrugge, which also corresponds to our findings.

4. CONCLUSION

By means of disaggregate data, a detailed analysis enabled a description of the relations between the various port players and other sectors in Belgium. A first attempt was made to deal with this new approach, focused on Antwerp for the year 2000. Previously, only a top-down aggregate approach had been followed to describe the relations between the various port players and other sectors in Belgium.

Before starting the analysis, various firms had to be classified as port actor or non-port actor (by means of the NACEBEL codes) and as located inside or outside the port perimeter (by means of postcodes). For the sectoral analysis a regional input-output table was made up, highlighting the relations among the port actors and also between these and the rest of the Belgian economy. Various measures, such as technical coefficients, linkages and external inputs and demand were used to show these relations. Besides the relations of the port actors with their customers and suppliers were analysed geographically. Therefore, the "geocoding" technique was used to map and locate all activity.

Answers are given to three major research questions, formulated at the beginning of this research paper:

How are the Antwerp port actors related?

These relations are described by means of technical coefficients, linkages and key sectors. Technical coefficients (input and output) measure the first-level relations. Backward and forward linkages, defined by Cai and Leung (2004) measure the total impact (infinite level) of a port actor on its suppliers or customers. Decomposed linkages also measure the impact of a port actor on its suppliers or customers, but with respect to the output of the respective supplier or customer. Together, these measurements lead to the conclusion that freight forwarders play a key role among the Antwerp port actors. They are the first customers of Antwerp port actors and have a major influence on their suppliers, such as agents, customs brokers, shipping companies and terminal operating companies. Some of the relations between the different port actors can be explained by co-operation agreements, like dedicated terminals, strategic alliances and mergers. Some very close relations such as those linking forwarders to agents or to terminal-operating companies can be explained by co-operation agreements, dedicated terminals, strategic alliances and, increasingly, by mergers.

Which other sectors are important for the Antwerp port actors?

The relations of the Antwerp port actors with the rest of the Belgian national economy are described by external inputs and external demand. Therefore, a subdivision has been made between port actors outside the port perimeter, non-port actors inside the port perimeter and non-port actors outside the port perimeter. Outside the Antwerp port perimeter, some port actors remain important as customer of or supplier to the Antwerp port actors. Fuel trade provides an important customer for Antwerp port businesses and hinterland transport companies are the main suppliers outside the Antwerp port area. The oil industry supplies mostly to the Antwerp port actors both inside and outside the port perimeter, in line with Antwerp, considered to be "the Houston of Europe". Trade is a very important customer of the Antwerp port actors and acts as the shipper who delivers the goods that need to be transported.

Are agglomeration or dispersion effects of port activity present?

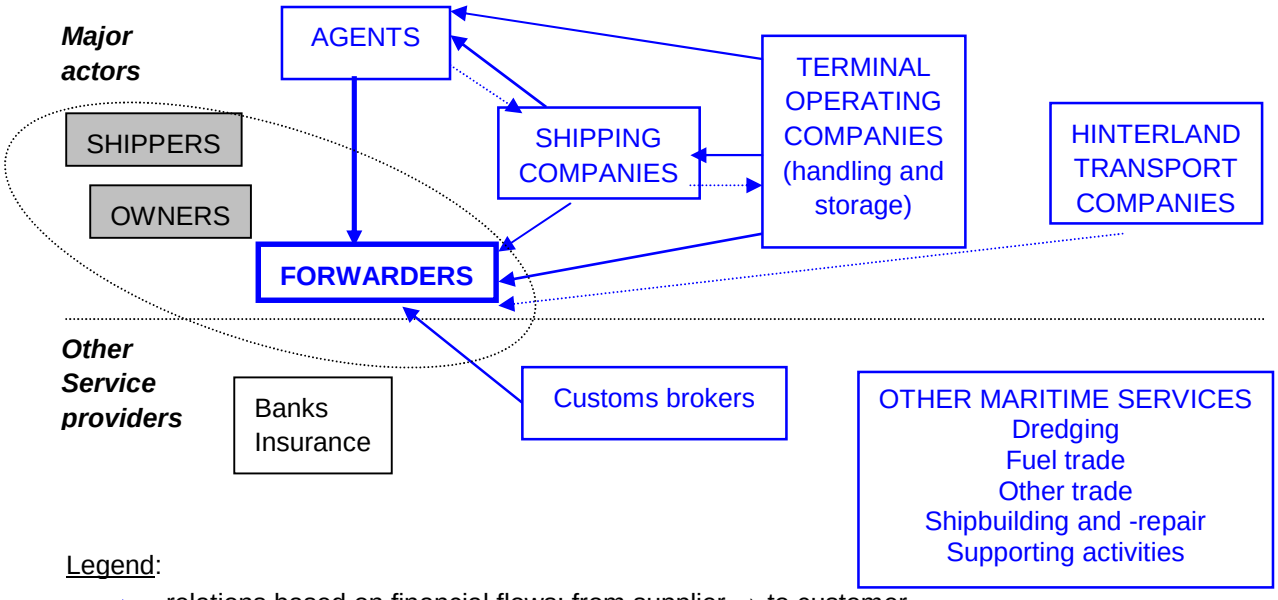
The geographical relations of the Antwerp port actors are described by means of maps, drawn for Belgium and the Antwerp port perimeter. According to recorded postcodes, most customers and suppliers of the Antwerp port actors are located in the province of Antwerp, which tends to confirm the existence of agglomeration effects, on one single transhipment location. Moreover the two prime locations for customers and suppliers of the Antwerp port actors (Antwerp and the Brussels-Capital region) are most easily accessible by road, rail and inland waterway. Furthermore Antwerp is said to be an international transport gate, which attracts economic activity. Other Belgian (sea)ports are linked to the Antwerp port actors through customer-supplier relations. In a traditional way this would be interpreted as dispersion to secondary locations. We choose to

interpret it from a "network" point of view: port actors search optimal locations for their different activities. Networks between these different locations have a linking effect rather than a dispersing one. Likewise we see that locations further away from the port perimeter are very well accessible through motorways, waterways and railways, along with stronger relations with the port actors. Besides, the year 2000 data show how dominant the position of the Scheldt's right bank is in Antwerp, by far outstripping the left bank, in terms of both concentration of port operations and concentration of suppliers and customers.

This study provides us with coefficients which can now be used to outline the potential effects changes in Antwerp port activity might have on port actors as a whole and on the rest of the Belgian economy.

If we take up our example from the introduction, some effects of a change in port activity can be explained. When the Mediterranean Shipping Company (MSC) took the decision to shift 200,000 TEU from Felixstowe to Antwerp it had an impact on the other port actors as well. Figure 4.1 is an adaptation of figure 2.1. The extra 200,000 TEU MSC brought to Antwerp affect the terminal operating companies' output, as well as the forwarders' and the agents': the terminal operating companies load and unload more goods. This service can eventually be arranged by the agents and therefore it also affects the agents' output. The extra TEUs in Antwerp also attract forwarders. MSC made it possible that more loading can be done in Antwerp. Therefore forwarders have an advantage by directly or indirectly contacting MSC via an agent member of the MSC group.

FIGURE 4.1: RELATIONS BETWEEN PORT ACTORS



Legend:

→ relations based on financial flows: from supplier → to customer

The methodology described in this paper can be used for other ports as well as for other important sectors or transport areas, such as airports. Furthermore the methodology can be extended to other years.

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APPENDICES

All data are for the year 2000 !

APPENDIX 1: The Antwerp port perimeter

The port area of Antwerp has been defined in accordance with the Royal Decree of 2 February 1993, signed on the occasion of the transfer of port ownership from the State to the Flemish Region. The definition of the port area is given in Dutch in the appendix to this Royal Decree, issued on 4 March 1993 in the Belgian Law Gazette.

"De begrenzing van de haven van Antwerpen wordt in dit Koninklijk Besluit omschreven als volgt :

Rechteroever

- ten noorden, begrensd door de rijksgrens met Nederland vanaf de grens met de gemeente Beveren (het midden van de stroom) tot, oostwaarts, de snijding met de gemeentegrens Antwerpen-Stabroek

- ten oosten, de grens Antwerpen-Stabroek tot de rijksgrens A12, verder zuidwaarts tot rijksgrens N144a (Ekersesteenweg) via rijksweg N180 (Noorderlaan) tot de noordelijke oever van het Albertkanaal. Oostwaarts tot rijksweg N129 (Minister Delbekelaan) tot aan de Schijnpoort, de Slachthuislaan, Bredastraat, Viaduct Express, Ellermanstraat tot rijksweg N1 (Italiëlei) zuidelijk tot de Tunnelplaats, Ankerrui, Brouwersvliet tot de Tavernierskaai (waterkerende muur inbegrepen)

- ten zuiden, langsheen de waterkerende muur (inbegrepen) van de Scheldekaaien tot Schelde nr. 8.

Vervolgens de Generaal Armstronglaan tot aan de spoorlijn Antwerpen-Zuid-Boom, verder tot de Krugerbrug, Naftaweg, de Grenspacht, de grenzen van lot B en J van de Petroleuminstellingen Zuid en de vroegere stadsgrens Antwerpen-Hoboken tot de grens Antwerpen-Zwijndrecht in de stroom

- ten westen, de grens Antwerpen-Zwijndrecht in de Scheldebedding. Vervolgens de linkerscheldeoever op Antwerps grondgebied tot aan de grens Zwijndrecht-Antwerpen ter hoogte van Pijp Tabak aan de Schelde. Vanaf hier noordwaarts in het midden van de stroom, de gemeentegrens met Zwijndrecht en Beveren tot aan de rijksgrens met Nederland.

Linkeroever

- ten oosten, de grens van de Stad Antwerpen vanaf de rijksgrens met Nederland tot de snijding met rijksweg nr. 617

- ten zuiden, de rijksweg nr. 617, vanaf voormeld snijpunt met de provincieweg nr. 356

- ten westen, de westelijke grens van de groenzone

- ten noorden, de rijksgrens met Nederland

Sinds het opmaken van deze beschrijvende lijst kan het huidige havengebied op bepaalde plaatsen afwijken als gevolg van nieuwe politieke, ruimtelijke of ecologische afspraken en evoluties."

APPENDIX 2: NACE-BEL codes of sectors studied

NACE	Code	Definition
14211	NOPA-AI	Quarrying of sand pits
14300	NOPA-AI	Mining of chemical and fertiliser minerals
14500	NOPA-AI	Other mining and quarrying n.e.c.
15131	NOPA-VO	Production of fresh products made of meat and canned meat
15320	NOPA-VO	Manufacture of fruit and vegetable juice
15420	NOPA-VO	Manufacture of refined oils and fats
15510	NOPA-VO	Fabrication of dairies and cheese making
15520	NOPA-VO	Manufacture of ice cream
15610	NOPA-VO	Manufacture of grain mill products
15710	NOPA-VO	Manufacture of prepared feeds for farm animals
15812	NOPA-VO	Small-scale bread and pastry bakehouses
15830	NOPA-VO	Manufacture of sugar
15840	NOPA-VO	Manufacture of cocoa; chocolate and sugar confectionery
15890	NOPA-VO	Manufacture of other food products n.e.c.
15910	NOPA-VO	Manufacture of distilled potable alcoholic beverages
17110	NOPA-AI	Preparation and spinning of cotton-type fibres
17150	NOPA-AI	Throwing and preparation of silk including from noils and throwing and texturing of synthetic or artificial filament yarns
17402	NOPA-AI	Manufacture of other textile articles
20101	NOPA-AI	Sawmilling and planing of wood
20102	NOPA-AI	Impregnation of wood
20300	NOPA-AI	Manufacture of builders' carpentry and joinery
20400	NOPA-AI	Manufacture of wooden containers
21121	NOPA-AI	Manufacture of paper
21210	NOPA-AI	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
21250	NOPA-AI	Manufacture of other articles of paper and paperboard n.e.c.
22220	NOPA-AI	Printing n.e.c.
22240	NOPA-AI	Composition and plate-making
23200	NOPA-PE	Manufacture of refined petroleum products
24110	NOPA-CH	Manufacture of industrial gases
24120	NOPA-CH	Manufacture of dyes and pigments
24130	NOPA-CH	Manufacture of other inorganic basic chemicals
24140	NOPA-CH	Manufacture of other organic basic chemicals
24151	NOPA-CH	Manufacture of fertilisers
24160	NOPA-CH	Manufacture of plastics in primary forms
24170	NOPA-CH	Manufacture of synthetic rubber in primary forms
24200	NOPA-CH	Manufacture of pesticides and other agro-chemical products
24300	NOPA-CH	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
24410	NOPA-CH	Manufacture of basic pharmaceutical products
24421	NOPA-CH	Manufacture of medicines
24512	NOPA-CH	Manufacture of cleaning and polishing preparations
24520	NOPA-CH	Manufacture of perfumes and toilet preparations
24620	NOPA-CH	Manufacture of glues and gelatines
24640	NOPA-CH	Manufacture of photographic chemical material
24660	NOPA-CH	Manufacture of other chemical products n.e.c.
25120	NOPA-CH	Retreading and rebuilding of rubber tyres
25130	NOPA-CH	Manufacture of other rubber products
25210	NOPA-CH	Manufacture of plastic plates, sheets, tubes and profiles
25220	NOPA-CH	Manufacture of plastic packing goods
25230	NOPA-CH	Manufacture of builders' ware of plastic
25240	NOPA-CH	Manufacture of other plastic products
26110	NOPA-CS	Manufacture of flat glass

NACE	Code	Definition
26120	NOPA-CS	Shaping and processing of flat glass
26510	NOPA-CS	Manufacture of cement
26520	NOPA-CS	Manufacture of lime
26610	NOPA-CS	Manufacture of concrete products for construction purposes
26620	NOPA-CS	Manufacture of plaster products for construction purposes
26630	NOPA-CS	Manufacture of ready-mixed concrete
26640	NOPA-CS	Manufacture of mortars
26700	NOPA-CS	Cutting, shaping and finishing of stone
26820	NOPA-CS	Manufacture of other non-metallic mineral products n.e.c.
27100	NOPA-ME	Manufacture of basic iron and steel and of ferro-alloys (ECSC)*
27220	NOPA-ME	Manufacture of steel tubes
27310	NOPA-ME	Cold drawing
27350	NOPA-ME	Other first processing of iron and steel n.e.c.; production of non-ECSC* ferro-alloys
27422	NOPA-ME	First processing of aluminium
27510	NOPA-ME	Casting of iron
28110	NOPA-ME	Manufacture of metal structures and parts of structures
28120	NOPA-ME	Manufacture of builders' carpentry and joinery of metal
28210	NOPA-ME	Manufacture of tanks, reservoirs and containers of metal
28220	NOPA-ME	Manufacture of central heating radiators and boilers
28300	NOPA-ME	Manufacture of steam generators, except central heating hot water boilers
28401	NOPA-ME	Forging of metal
28510	NOPA-ME	Treatment and coating of metals
28520	NOPA-ME	General mechanical engineering
28741	NOPA-ME	Manufacture of fasteners and screw machine products
28742	NOPA-ME	Manufacture of chain
28743	NOPA-ME	Manufacture of springs
28755	NOPA-ME	Manufacture of other fabricated metal products n.e.c.
29110	NOPA-ME	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
29120	NOPA-ME	Manufacture of pumps and compressors
29220	NOPA-ME	Manufacture of lifting and handling equipment
29230	NOPA-ME	Manufacture of non-domestic cooling and ventilation equipment
29241	NOPA-ME	Manufacture of packaging machinery
29245	NOPA-ME	Manufacture of filter equipment
29247	NOPA-ME	Manufacture of other general purpose machinery n.e.c.
29403	NOPA-ME	Manufacture of machine- tools for woodworking
29710	NOPA-ME	Manufacture of electric domestic appliances
31100	NOPA-MP	Manufacture of electric motors, generators and transformers
31200	NOPA-MP	Manufacture of electricity distribution and control apparatus
	NOPA-MP	Manufacture of electric lamps
32100	NOPA-MP	Manufacture of electronic valves and tubes and other electronic components
32300	NOPA-MP	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
33103	NOPA-MP	Manufacture of orthopaedic appliances
33201	NOPA-MP	Manufacture of electrical instruments and appliances for measuring, checking, testing and navigating
34100	NOPA-AU	Manufacture of motor vehicles
34201	NOPA-AU	Manufacture of bodies (coachwork) for motor vehicles and trailers
34300	NOPA-AU	Manufacture of parts and accessories for motor vehicles and their engines
35110	OMS-SHIP	Building and repairing of ships
35120	OMS-SHIP	Building and repairing of pleasure and sporting boats
35200	NOPA-AI	Manufacture of railway and tramway locomotives and rolling stock
36630	NOPA-AI	Other manufacturing n.e.c.
37100	NOPA-AI	Recycling of metal waste and scrap
37200	NOPA-AI	Recycling of non-metal waste and scrap
40100	NOPA-EN	Production and distribution of electricity

NACE	Code	Definition
40200	NOPA-EN	Manufacture of gas; distribution of gaseous fuels through mains
45111	NOPA-CS	Demolition and wrecking of buildings
45112	NOPA-CS	Earth moving
45211	NOPA-CS	Construction of individual houses
45213	NOPA-CS	Construction of buildings for industrial, commercial or agricultural use
45214	NOPA-CS	Construction of tunnels, bridges, viaducts
45215	NOPA-CS	Construction of pipelines, telecommunication- and high tension conduit
45220	NOPA-CS	Erection of roof covering and frames
45230	NOPA-CS	Construction of highways, roads, airfields and sport facilities
45241	OMS-BAG	Dredging
45242	OMS-BAG	Other construction of water projects
45250	NOPA-CS	Other construction work involving special trades
45310	NOPA-CS	Installation of electrical wiring and fittings
45320	NOPA-CS	Insulation work activities
45331	NOPA-CS	Installation of heating, air conditioning and ventilation
45332	NOPA-CS	Other plumbing
45340	NOPA-CS	Other building installation
45421	NOPA-CS	Joinery installation in wood and synthetic material
45422	NOPA-CS	Joinery installation in metal
45441	NOPA-CS	Painting
45500	NOPA-CS	Renting of construction or demolition equipment with operator
50101	NOPA-CO	Wholesale of motor vehicles
50102	NOPA-CO	Agents involved in the sale of motor vehicles
50103	NOPA-CO	Retail sale of motor vehicles
50200	NOPA-CO	Maintenance and repair of motor vehicles
50301	NOPA-CO	Wholesale of motor vehicle parts and accessories
50500	NOPA-CO	Retail sale of automotive fuel
51110	NOPA-CO	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods
51120	OMS-COFU	Agents involved in the sale of fuels, ores, metals and industrial chemicals
51140	NOPA-CO	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
51170	NOPA-CO	Agents involved in the sale of food, beverages and tobacco
51180	NOPA-CO	Agents specialising in the sale of particular products or ranges of products n.e.c.
51190	NOPA-CO	Agents involved in the sale of a variety of goods
51210	NOPA-CO	Wholesale of grain, seeds and animal feeds
51310	NOPA-CO	Wholesale of fruit and vegetables
51332	NOPA-CO	Wholesale of edible oils and fats
51340	NOPA-CO	Wholesale of alcoholic and other beverages
51381	NOPA-CO	Wholesale of fish, crustaceans and molluscs
51384	NOPA-CO	Specialised wholesale of other food
51391	NOPA-CO	Wholesale of deep-frozen foods
51392	NOPA-CO	Other non-specialised wholesale of food, beverages and tobacco
51410	NOPA-CO	Wholesale of textiles
51421	NOPA-CO	Wholesale of clothing, accessories and fur
51430	NOPA-CO	Wholesale of electrical household appliances and radio and television goods
51442	NOPA-CO	Wholesale of wallpaper and cleaning materials
51460	NOPA-CO	Wholesale of pharmaceutical goods
51478	NOPA-CO	Wholesale of other household goods n.e.c.
51510	OMS-COFU	Wholesale of solid, liquid and gaseous fuels and related products
51520	NOPA-CO	Wholesale of metals and metal ores
51531	NOPA-CO	Wholesale of wood
51532	NOPA-CO	Wholesale construction materials and sanitary equipment
51541	NOPA-CO	Wholesale of hardware
51550	NOPA-CO	Wholesale of chemical products

NACE	Code	Definition
51562	NOPA-CO	Wholesale of other intermediate products n.e.c.
51570	NOPA-CO	Wholesale of waste and scrap
51610	NOPA-CO	Wholesale of machine tools
51620	NOPA-CO	Wholesale of construction machinery
51640	NOPA-CO	Wholesale of office machinery and equipment
51651	NOPA-CO	Wholesale of electric and electronic equipment
51652	NOPA-CO	Wholesale of other machinery for use in industry n.e.c.
51700	OMS-CO	Other wholesale
52230	NOPA-CO	Retail sale of fish, crustaceans and molluscs
52461	NOPA-CO	Retail sale of hardware, paints and glass with sale surface less than 400m2
52481	NOPA-CO	Retail sale of fuels
52482	NOPA-CO	Retail sale of sport goods and camping equipment
52487	NOPA-CO	Retail sale of office machinery and equipment and computers
52498	NOPA-CO	Other retail sale in specialised stores n.e.c.
52502	NOPA-CO	Retail sale of second-hand goods
52621	NOPA-CO	Retail sale of food via stalls and markets
52740	NOPA-CO	Repair n.e.c.
55301	NOPA-CO	Restaurants
55302	NOPA-CO	Fast food, snack bars
55522	NOPA-CO	Taking care of parties and receptions
60100	HTC	Transport via railways
60230	HTC	Other land passenger transport
60241	HTC	Furniture removal by road
60242	HTC	Freight transport by road
60300	HTC	Transport via pipelines
61100	SHIP	Sea and coastal water transport
61200	HTC	Inland water transport
62200	NOPA-TP	Non-scheduled air transport
63111	TOC	Cargo handling in sea ports
63112	TOC	Other cargo handling
63121	TOC	Storage and warehousing in cold-storage buildings
63122	TOC	Other storage and warehousing
63210	NOPA-AD	Other supporting land transport activities
63220	OMS-SUP	Other supporting water transport activities
63301	NOPA-AD	Travel agencies
63401	FORW	Forwarding offices
63402	AGEN	Chartering
63403	AGEN	Ships' agencies
63404	CUST	Customs agencies
63405	FORW	Transport mediation
63406	HTC	Other activities of transport agencies
64120	HTC	Courier activities other than national post activities
64200	NOPA-TP	Telecommunications
66031	NOPA-AD	Direct non-life insurance operations
67130	NOPA-AD	Activities auxiliary to financial intermediation n.e.c.
67201	NOPA-AD	Insurance brokers and agents
67202	NOPA-AD	Damage and risk experts
67203	NOPA-AD	Other activities auxiliary to insurance
70111	NOPA-AD	Development of real estate (residential)
70113	NOPA-AD	Development of real estate (infrastructure)
70201	NOPA-AD	Letting of houses, except. welfare lodging
70203	NOPA-AD	Letting of non-residential buildings
70311	NOPA-AD	Mediation in buying, selling and letting of real estate

NACE	Code	Definition
70321	NOPA-AD	Management of residential buildings
70322	NOPA-AD	Management of other real estate
71100	NOPA-AD	Renting of automobiles
71210	HTC	Renting of other land transport equipment
71220	SHIP	Renting of water transport equipment
71320	NOPA-AD	Renting of construction and civil engineering machinery and equipment
71340	NOPA-AD	Renting of other machinery and equipment n.e.c.
71408	NOPA-AD	Renting of personal and household goods n.e.c.
72200	NOPA-AD	Software consultancy and supply
73100	NOPA-AD	Research and experimental development on natural sciences and engineering
74124	NOPA-AD	Tax consultancy
74131	NOPA-AD	Market research
74142	NOPA-AD	Other business and management consultancy activities
74151	NOPA-AD	Management activities of holding companies
74152	NOPA-AD	Coordination centres
74203	NOPA-AD	Technical consultancy and engineering activities
74302	NOPA-AD	Other technical testing and analysis
74502	NOPA-AD	Temporary employees agencies and providers of temporary personnel
74601	NOPA-AD	Security activities
74700	NOPA-AD	Industrial cleaning
74820	NOPA-AD	Packaging activities
74835	NOPA-AD	Other administrative activities n.e.c.
74849	NOPA-AD	Other business activities n.e.c.
75116	NOPA-PU	Intercommunal companies with general aim
75220	PUBL	Defence activities
90001	NOPA-AD	Effluent water collection and purification
90002	OMS-SUP	Collection and processing of household refuse
90003	OMS-SUP	Collection and processing of agricultural and industrial refuse
91110	NOPA-AD	Activities of business and employers organisations
92613	NOPA-AD	Operation of other sports accommodations
92723	NOPA-AD	Operation of beach, bicycle, pedal boats, ponies infrastructures and similar
99999	Others	Other sectors

Legend:

AGEN	Agents	NOPA-PE	Non-port actor - Oil industry
CUST	Customs brokers	NOPA-PU	Non-port actor - Public services
FORW	Forwarders	NOPA-TP	Non-port actor - Land transport
HTC	Hinterland transport companie	NOPA-VO	Non-port actor - Food industry
NOPA-AD	Non-port actor - Other service	OMS-BAG	Other maritime services - Dredging
NOPA-AI	Non-port actor - Other industri	OMS-CO	Other maritime services - Other trade
NOPA-AU	Non-port actor - Car manufact	OMS-COFU	Other maritime services - Fuel trade
NOPA-CH	Non-port actor - Chemical indu	OMS-SHIP	Other maritime services - Shipbuilding and repair
NOPA-CO	Non-port actor - Trade	OMS-SUP	Other maritime services - Supporting activities
NOPA-CS	Non-port actor - Construction	Others	Other sectors
NOPA-EN	Non-port actor - Energy	SHIP	Shipping companies
NOPA-ME	Non-port actor - Metallurgy	TOC	Terminal operating companies
NOPA-MP	Non-port actor - Electronics		

APPENDIX 3: Relative importance of Antwerp port actors in 2000

1) Agents

Largest companies (top 10):

Ranking	Agents	Value added *(in million euro)*
1	COMPAGNIE BELGE D'AFFRETEMENTS	17.1
2	MEDITERRANEAN SHIPPING COMPANY BELGIUM	11.1
3	CETRACO	9.9
4	COBAM	9.1
5	CONTI-LINES	6.5
6	HAPAG-LLOYD-BELGIUM	5.0
7	AHLERS BRIDGE	4.5
8	VAN OMMEREN ANTWERPEN	4.2
9	OOCL BENELUX	4.1
10	GRIMALDI BELGIUM	3.9
	Total top 10	75.3
	Overall total	149.5

Ranking	Agents	Employment *(in ETP)*
1	CETRACO	189
2	MEDITERRANEAN SHIPPING COMPANY BELGIUM	179
3	COMPAGNIE BELGE D'AFFRETEMENTS	128
4	HAPAG-LLOYD-BELGIUM	96
5	AHLERS BRIDGE	84
6	VAN OMMEREN ANTWERPEN	75
7	GRIMALDI BELGIUM	74
8	INCHCAPE SHIPPING SERVICES (HOLDING)	55
9	POLYTRA	53
10	CANMAR - CONTSHIP AGENCIES	49
	Total top 10	981
	Overall total	2,037

2) Customs Brokers

Largest companies (top 10):

Ranking	Customs brokers	Value added *(in million euro)*
1	HANDLING & DISTRIBUTION COMPANY	2.9
2	KREGSPEDI	0.9
3	ORIENTA	0.6
4	OLIE-SCHEEPVAART AGENTUREN	0.3
5	TOL-EN VERZENDINGSAGENTSCHAP DE BUYSSCHER EN BRENDERS	0.3
6	WIJNNATIE DOUANE-AGENTUUR	0.3
7	MEES EN DE KERF	0.3
8	INTERTRANS	0.3
9	SOTRAMAR	0.1
10	ANTWERPIA NATIE	0.0
	Total top 10	5.9
	Overall total	5.9

Ranking	Customs brokers	Employment *(in ETP)*
1	HANDLING & DISTRIBUTION COMPANY	47
2	KREGSPEDI	19
3	TOL-EN VERZENDINGSAGENTSCHAP DE BUYSSCHER EN BRENDERS	10
4	MEES EN DE KERF	7
5	WIJNNATIE DOUANE-AGENTUUR	7
6	OLIE-SCHEEPVAART AGENTUREN	6
7	DMF	4
8	INTERTRANS	4
9	ORIENTA	4
10	KREGLINGER FINANCE	0
	Total top 10	109
	Overall total	109

3) Forwarders

Largest companies (top 10):

Ranking	Forwarders	Value added *(in million euro)*
1	KATOEN NATIE BULK TERMINALS	12.2
2	SCHENKER BELGIUM	11.3
3	VOPAK TERMINAL ACS	9.3
4	CAST AGENCIES BELGIUM	8.1
5	ECU-LINE	7.5
6	SDV BELGIUM	6.8
7	FRITZ COMPANIES BELGIUM	6.3
8	BELGIAN PAKHOED	6.1
9	TRANSMARCOM	5.6
10	NORTHERN SHIPPING SERVICE	5.5
	Total top 10	78.7
	Overall total	264.2

Ranking	Forwarders	Employment *(in ETP)*
1	SCHENKER BELGIUM	201
2	CAST AGENCIES BELGIUM	164
3	ECU-LINE	107
4	SDV BELGIUM	84
5	BELGIAN PAKHOED	80
6	PANALPINA WORLD TRANSPORT	80
7	TRANSMARCOM	76
8	MAXX LOGISTICS	76
9	FRITZ COMPANIES BELGIUM	75
10	A. MAAS EN CO	64
	Total top 10	1,007
	Overall total	3,671

4) Hinterland Transport Companies

Largest companies (top 10):

Ranking	Hinterland transport companies	Value added *(in million euro)*
1	SNCB - NMBS	85.6
2	UNIE VAN REDDING- EN SLEEPDIENST BELGIE	23.7
3	ANTWERP BULK TERMINAL	19.3
4	DE RIJKE	7.6
5	HESSENATIE LOGISTICS	6.9
6	LVT	5.2
7	A.T.L. - RENTING	4.6
8	HOYER BELGIE	4.6
9	HN TRANSPORT AND DISTRIBUTION	4.3
10	TRACTO	3.7
	Total top 10	165.4
	Overall total	242.1

Ranking	Hinterland transport companies	Employment *(in ETP)*
1	SNCB - NMBS	1,597
2	UNIE VAN REDDING- EN SLEEPDIENST BELGIE	302
3	HESSENATIE LOGISTICS	144
4	DE RIJKE	137
5	LVT	105
6	HOYER BELGIE	88
7	HN TRANSPORT AND DISTRIBUTION	83
8	TRACTO	72
9	NEDLLOYD ROAD CARGO	61
10	TRANSPORT NIJSTHOVEN	47
	Total top 10	2,635
	Overall total	3,717

5) Other Maritime Services

Largest companies (top 10):

Ranking	Other maritime companies	Value added *(in million euro)*
1	KUWAIT PETROLEUM-BELGIUM (Fuel trade)	407.8
2	HAVENBEDRIJF VAN ANTWERPEN (Supporting act.)	174.7
3	BELGISCHE OLIE MAATSCHAPPIJ (Fuel trade)	125.0
4	DREDGING INTERNATIONAL (Dredging)	82.0
5	BRABO. HAVENLOODSEN EN BOOTSLIEDEN VERENIGING (Supporting activity)	25.7
6	INDAVER (Supporting activity)	20.7
7	DEME ENVIRONMENTAL CONTRACTORS (dredging)	13.0
8	INDAVER B (Supporting activity)	9.7
9	ANTWERP SHIPREPAIR (shipbuilding and repair)	7.1
10	UNIE VAN REDDING- EN SLEEPDIENST (supporting activities)	6.2
	Total top 10	871.9
	Overall total	930.9

Ranking	Other maritime companies	Employment *(in ETP)*
1	HAVENBEDRIJF VAN ANTWERPEN (Supporting act.)	1,775
2	DREDGING INTERNATIONAL (dredging)	450
3	BRABO. HAVENLOODSEN EN BOOTSLIEDEN VERENIGING (Supporting activity)	347
4	ANTWERP SHIPREPAIR (shipbuilding and repair)	166
5	INDAVER (Supporting activity)	146
6	KUWAIT PETROLEUM-BELGIUM (fuel trade)	139
7	DEME ENVIRONMENTAL CONTRACTORS (dredging)	119
8	SCHEEPVAART-EN KONSTRUKTIEBEDRIJF (shipbuilding and repair)	69
9	UNIE VAN REDDING- EN SLEEPDIENST (supporting activities)	66
10	VETS SHIPSTORES (other trade)	31
	Total top 10	3,309
	Overall total	3,882

6) Shipping Companies

Largest companies (top 10):

Ranking	Shipping companies	Value added *(in million euro)*
1	SAFMARINE CONTAINER LINES	73.2
2	BOCIMAR INTERNATIONAL	36.1
3	ANTWERP TRANSPORT AND STEVEDORING COMPANY	28.7
4	BELGISCHE SCHEEPVAARTMAATSCHAPPIJ-COMPAGNIE MARITIME BELGE	19.9
5	SAFMARINE BELGIUM	5.2
6	INTER FERRY BOATS	3.1
7	KLEIMAR	2.1
8	PASEC PORT	1.3
9	BOECKMANS BELGIE	1.1
10	HIMALAYA MARITIME	0.9
	Total top 10	171.7
	Overall total	175.0

Ranking	Shipping companies	Employment *(in ETP)*
1	SAFMARINE CONTAINER LINES	233
2	SAFMARINE BELGIUM	104
3	INTER FERRY BOATS	61
4	BOECKMANS BELGIE	32
5	BELGISCHE SCHEEPVAARTMAATSCHAPPIJ-COMPAGNIE MARITIME BELGE	10
6	PASEC PORT	10
7	FAST LINES BELGIUM	9
8	COBELFRET FERRIES	8
9	KLEIMAR	8
10	ALLROUND FORWARDING & LOGISTICS	4
	Total top 10	478
	Overall total	484

7) Terminal Operating Companies

Largest companies (top 10):

Ranking	Terminal operating companies	Value added *(in million euro)*
1	HESSENATIE	146.5
2	NOORD NATIE TERMINALS	35.4
3	SCHELDE CONTAINER TERMINAL NOORD	31.8
4	HAVENBEDRIJF NOORD NATIE	28.8
5	BELGIAN NEW FRUIT WHARF	26.8
6	WESTERLUND CORPORATION	26.0
7	NOVA & HESSENATIE STEVEDORING	25.1
8	A C T (ANTWERP COMBINED TERMINALS)	22.3
9	VOPAK CHEMICALS LOGISTICS BELGIUM	21.9
10	GATX TERMINALS ANTWERPEN	16.9
	Total top 10	381.4
	Overall total	731.7

Ranking	Terminal operating companies	Employment *(in ETP)*
1	HESSENATIE	1,682
2	HAVENBEDRIJF NOORD NATIE	407
3	NOVA & HESSENATIE STEVEDORING	403
4	NOORD NATIE TERMINALS	375
5	A C T (ANTWERP COMBINED TERMINALS)	350
6	WESTERLUND CORPORATION	346
7	BELGIAN NEW FRUIT WHARF	309
8	SEAPORT TERMINALS	225
9	SCHELDE CONTAINER TERMINAL NOORD	222
10	NEW WAVE LOGISTICS (BELGIUM)	189
	Total top 10	4,507
	Overall total	10,919

APPENDIX 4: Input output analysis

The table below provides the basic model for an input-output table. The following methodology will be based on this table.

Input-output table

	1	*2*	...	*n*	*f*	*x*
1	x_{11}	x_{12}	...	x_{1n}	f_1	x_1
2	x_{21}	x_{22}	...	x_{2n}	f_2	x_2
...	...	...	...	...	...	...
n	x_{n1}	x_{n2}	...	x_{nn}	f_n	x_n
m	m_1	m_2	...	m_n	m_f	
va	va_1	va_2	...	va_n		
x	x_1	x_2	...	x_n		

Legend: *n* number of industries in economy
x_{ij} output of industry *i* delivered to industry *j*
va value added
m import
f final demand

Relations between the port actors

The relations between the port actors are measured by technical input and output coefficients - which measure the direct effects of changes in demand and prices - and also by backward and forward linkages, which measure the direct and indirect linkage with suppliers and customers.

Input-output analysis[13] subdivides an economy into a certain number *n* industries and final demand sectors. The final demand sectors are households' and government's expenditures, investments and exports. The output of an industry *i*, for instance the forwarders, (represented by x_i) equals the sum of its supplies to other industries and its supplies to final demand or $x_i = \sum_{j=1}^{n} x_{ij} + f_i$. Defining technical input coefficients as $a_{ij} = x_{ij} / x_j$, with x_{ij} the supply of sector *i* (e.g. the forwarders) to sector *j* (e.g. the agents) and x_j the total output of sector *j*, this can be rewritten as $x_i = \sum_{j=1}^{n} a_{ij} x_j + f_i$ or in matrix notation $x = Ax + f$, in which *A* is a square matrix of technical coefficients, *x* a column vector of industry outputs and *f* a column vector of final demands. This matrix equation is the base equation of the Leontief model. It enables us to compute the total effect of an industry on the economy. Indeed, a change in final demand for products of industry *i* has two kinds of effects:

1. a 'direct' effect that is induced by the second term in the equation $x = Ax + f$, i.e. a change in the output of sector *i*. It can be seen that this direct effect is provided by $\Delta x_i = \Delta f_i$;
2. a series of indirect effects that are caused by this direct effect. The sector *i* has to increase its output and, in order to do so, it has to increase its intermediary purchases. As such, there is a 'first level' indirect effect provided by the first term of the equation $\Delta x^{(1)} = A\Delta x^{(0)}$. These purchases, for their part, generate higher level indirect effects, $\Delta x^{(2)} = A^2 \Delta x^{(0)}$, ...

13 For more details see Miller R.E., Blair P.D. (1985).

The total effect is provided by $\Delta x = \left(I + A + A^2 + A^3 + ...\right)\Delta f = \left(I - A\right)^{-1}\Delta f$. The matrix $L = (I - A)^{-1}$ is called the Leontief inverse. Its column sums are the Leontief multipliers and, under the above reasoning, they provide the total effect of a unit of change in final demand for a sector. If the demand of sector *j* rises, the suppliers of sector *j* will have to produce more.

These Leontief multipliers show the impact of one industry on the rest of the economy via its supply chain. As such, they are a measure of the 'linkage' of an industry to its suppliers. This is called 'backward linkage' and the Leontief multipliers are a measure of backward linkage. As explained in Cai J., Leung P. (2004), this backward linkage measure is not pure, because of intrasectoral and cyclical deliveries. If the Leontief multiplier is considered as a measure for backward linkage, also the effects of purchases by sector *i* at sector *j* and by sector *j* at sector *k*, sector *k* at sector *l*,... and finally sector *m* at sector *i*. Therefore, this measure also contains some forward linkage. It can be 'purified' by dividing each Leontief multiplier by the diagonal element in the same column of the Leontief inverse. The total (direct and indirect) linkage of an industry with all its suppliers can thus be measured by (Cai and Leung):

$$BL_j = \frac{\sum_{i=1}^{n} l_{ij}}{l_{jj}} \qquad \text{(IO1)}$$

where l_{ij} is the *(i,j)* element of the Leontief inverse.

Ghosh[14] developed an alternative input-output model. The output of a sector *j* is equal to its purchases plus its imports plus value added. The two last terms are called the 'primary inputs' and will be noted as *pi*. The base equation of the Ghosh model is thus derived from $x_j = \sum_{i=1}^{n} x_{ij} + pi_j$ by defining technical output coefficients $b_{ij} = x_{ij} / x_i$. The base equation is provided by $x = B'x + pi$ [15].

This Ghosh model can be used to analyse how costs are propagated through the economy[16]. When an industry *i* increases its prices, this has an impact on the costs of all its clients, i.e. the costs of their purchases increases. In order to maintain their value added at the same level, they will also increase their prices, entailing cost increases for their clients.
These effects are provided by the column sums of the transposed Ghosh inverse $G = (I - B)^{-1}$. This means that the column sums of the transposed Ghosh inverse - thus the row sums of the Ghosh inverse - are a measure of linkage to the clients, i.e. forward linkage. Again this is not a pure measure. Dividing the row sums of the Ghosh inverse by the diagonal element in the same row yields a pure measure. Thus forward linkage is measured by:

$$FL_i = \frac{\sum_{j=1}^{n} g_{ij}}{g_{ii}} \qquad \text{(IO2)}$$

in which g_{ij} is the *(i,j)* element of the Ghosh inverse.

It should be pointed out that the measures (IO1) and (IO2) measure linkage of an industry in relation to its own size. It does not provide any information about the absolute impact of an industry. In order to analyse the absolute impact these measures must be decomposed[17]. As such the absolute (purified) total backward impact of an industry *j* on another industry *i* is provided by

14 See Ghosh A. (1958)
15 The apostrophe of B' denotes the transposition of matrix B.
16 See Dietzenbacher E. (1997), Coppens F. (2006)
17 See Coppens F. (2006).

$(l_{ij} / l_{jj})\, x_j$, in relation to the size of industry *i*, yields a measure of dependence of *i* with respect to *j* [18]:

$$BDec_{ij} = \frac{l_{ij}}{l_{jj}} \frac{x_j}{x_i} \qquad \text{(IO3)}$$

It can be shown that this is equal to

$$BDec_{ij} = \frac{g_{ij}}{g_{jj}} \qquad \text{(IO3')}$$

and measures the share of output from industry *i* that is (directly or indirectly) related to industry *j*.

Similarly, the decomposed forward linkage measure can be found:

$$FDec_{ij} = \frac{l_{ij}}{l_{ii}} \qquad \text{(IO4)}$$

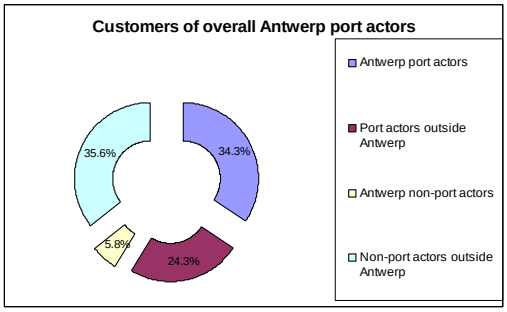
is a measure of the payments of *i* that are attributable to *j*. It is a measure of cost dependence of *i* with respect to *j*.

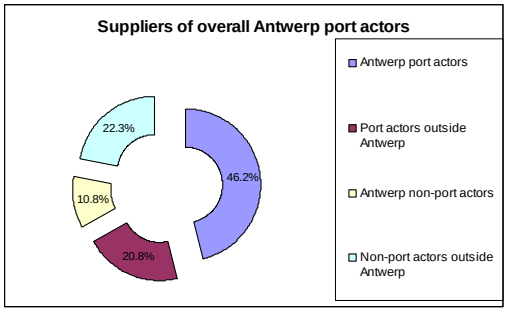
[18] See Coppens F. (2005)

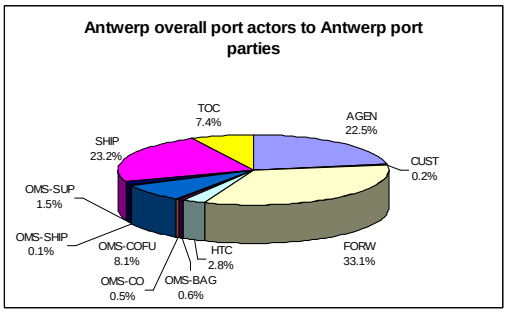
APPENDIX 5: Charts external demand and external inputs in 2000

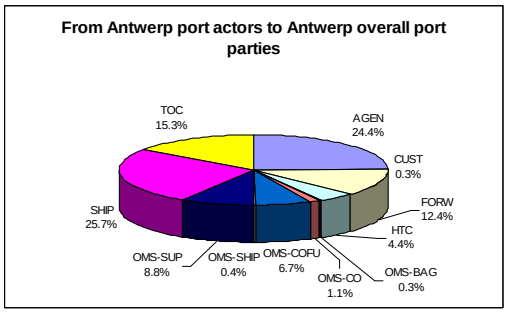
Data restricted to the national economy.

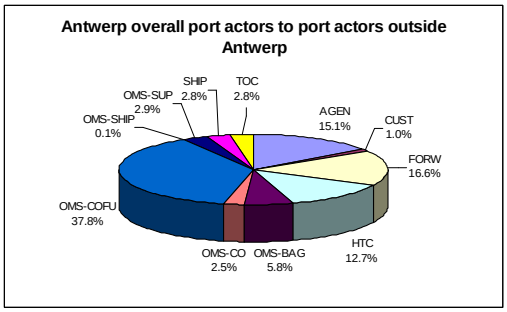
a) Overall Antwerp port actors

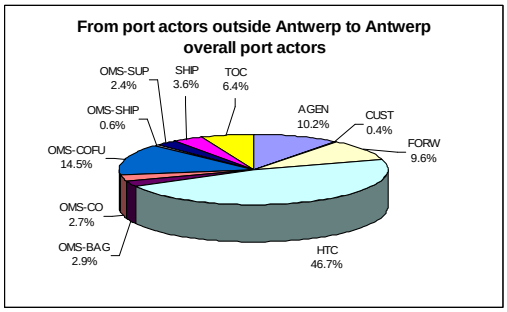


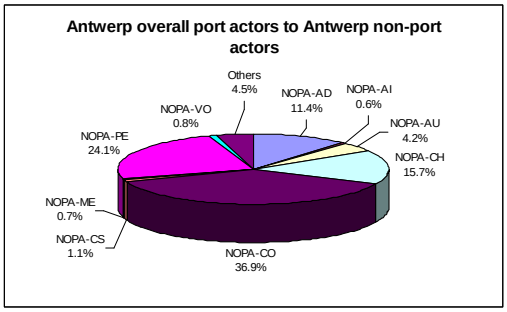


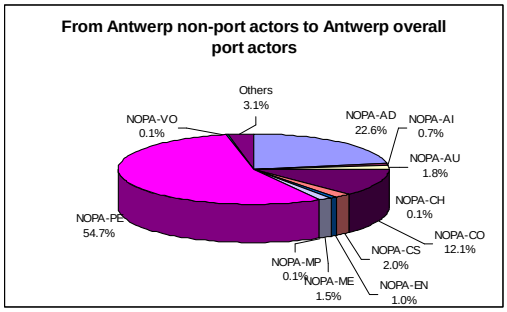


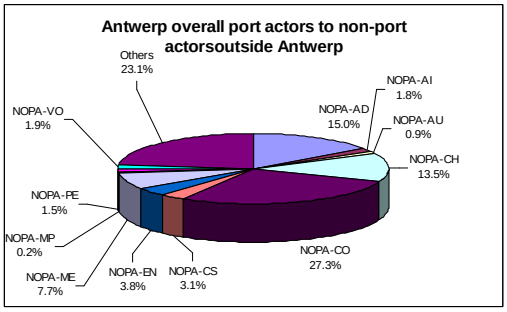


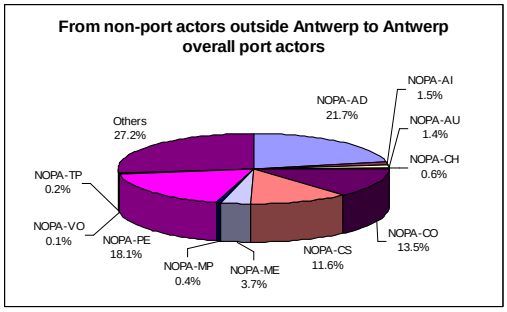




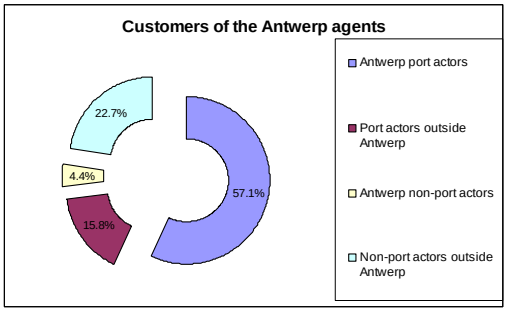


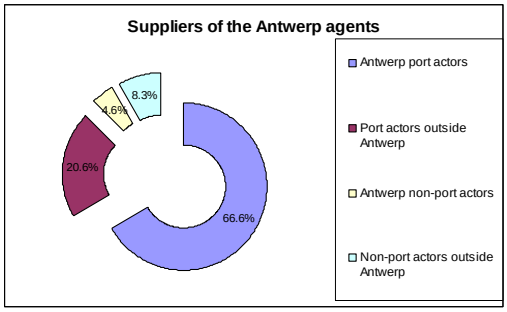


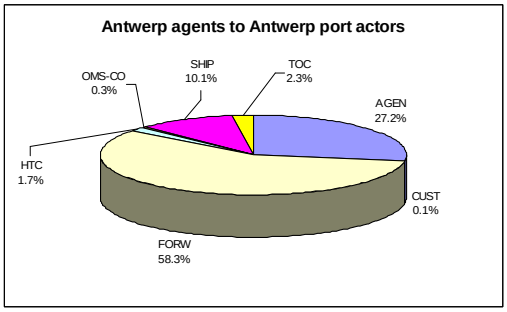


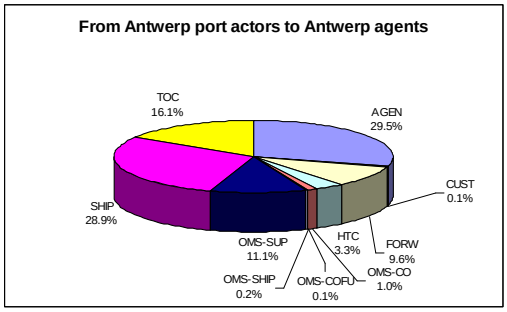


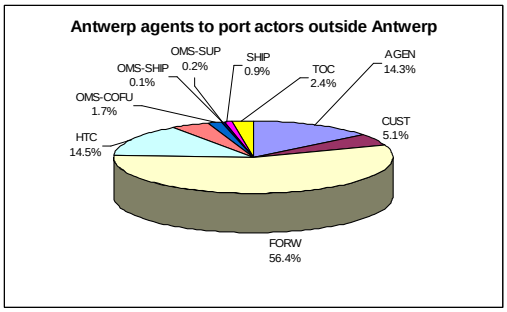
b) Agents

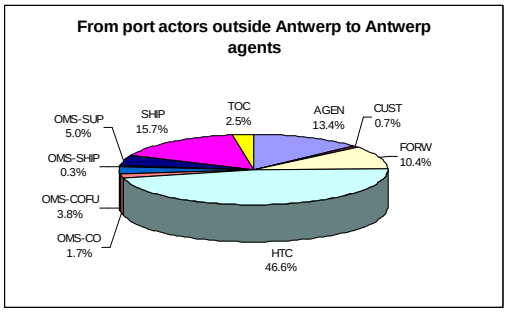

Customers of the Antwerp agents
22.7%
4.4%
15.8%
57.1%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

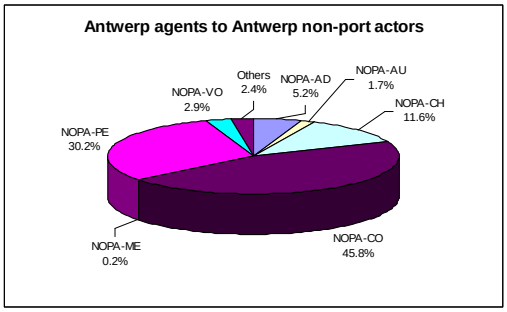

Suppliers of the Antwerp agents
8.3%
4.6%
20.6%
66.6%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

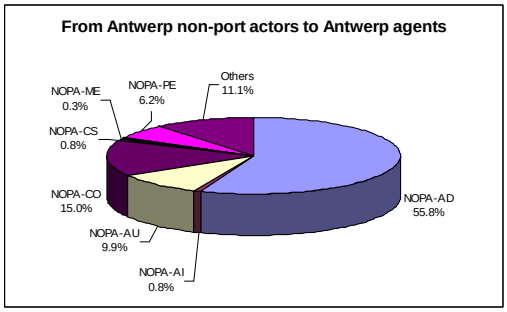

Antwerp agents to Antwerp port actors
OMS-CO 0.3%
SHIP 10.1%
TOC 2.3%
AGEN 27.2%
HTC 1.7%
CUST 0.1%
FORW 58.3%

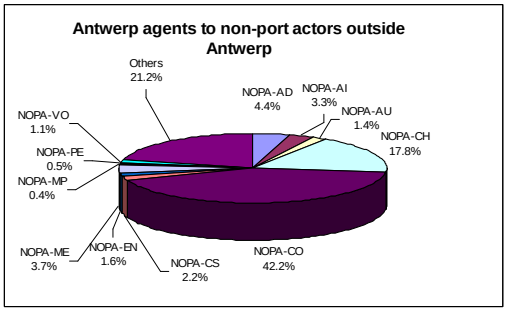

From Antwerp port actors to Antwerp agents
TOC 16.1%
AGEN 29.5%
CUST 0.1%
SHIP 28.9%
OMS-SUP 11.1%
HTC 3.3%
FORW 9.6%
OMS-SHIP 0.2%
OMS-COFU 0.1%
OMS-CO 1.0%

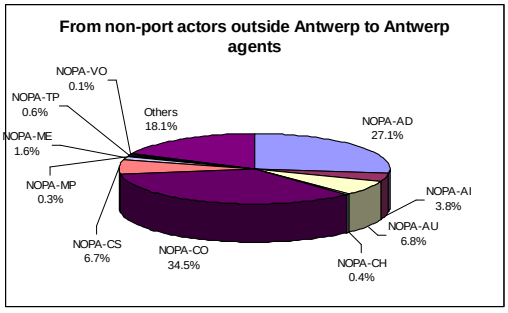

Antwerp agents to port actors outside Antwerp
OMS-SUP 0.2%
SHIP 0.9%
TOC 2.4%
AGEN 14.3%
OMS-SHIP 0.1%
OMS-COFU 1.7%
CUST 5.1%
HTC 14.5%
FORW 56.4%


From port actors outside Antwerp to Antwerp agents
OMS-SUP 5.0%
SHIP 15.7%
TOC 2.5%
AGEN 13.4%
CUST 0.7%
FORW 10.4%
OMS-SHIP 0.3%
OMS-COFU 3.8%
OMS-CO 1.7%
HTC 46.6%

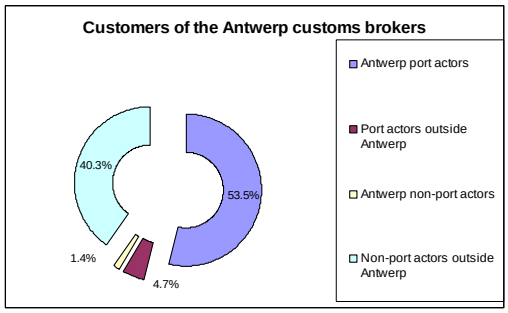

Antwerp agents to Antwerp non-port actors
Others 2.4%
NOPA-AD 5.2%
NOPA-AU 1.7%
NOPA-VO 2.9%
NOPA-CH 11.6%
NOPA-PE 30.2%
NOPA-ME 0.2%
NOPA-CO 45.8%

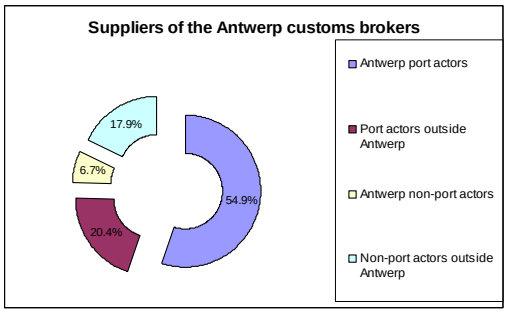

From Antwerp non-port actors to Antwerp agents
NOPA-ME 0.3%
NOPA-PE 6.2%
Others 11.1%
NOPA-CS 0.8%
NOPA-CO 15.0%
NOPA-AD 55.8%
NOPA-AU 9.9%
NOPA-AI 0.8%

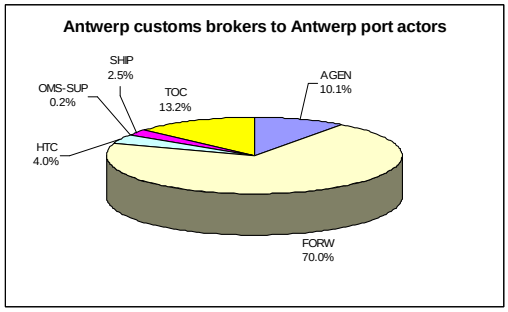

Antwerp agents to non-port actors outside Antwerp
Others 21.2%
NOPA-AD 4.4%
NOPA-AI 3.3%
NOPA-VO 1.1%
NOPA-AU 1.4%
NOPA-CH 17.8%
NOPA-PE 0.5%
NOPA-MP 0.4%
NOPA-ME 3.7%
NOPA-EN 1.6%
NOPA-CS 2.2%
NOPA-CO 42.2%

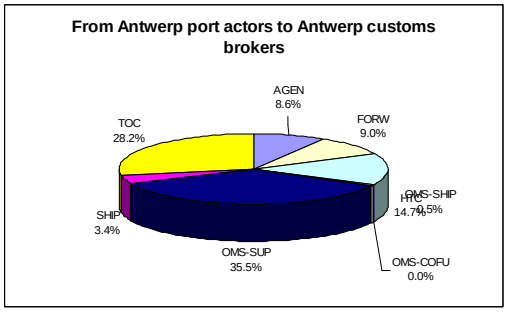

From non-port actors outside Antwerp to Antwerp agents
NOPA-VO 0.1%
NOPA-TP 0.6%
Others 18.1%
NOPA-AD 27.1%
NOPA-ME 1.6%
NOPA-MP 0.3%
NOPA-AI 3.8%
NOPA-AU 6.8%
NOPA-CS 6.7%
NOPA-CO 34.5%
NOPA-CH 0.4%

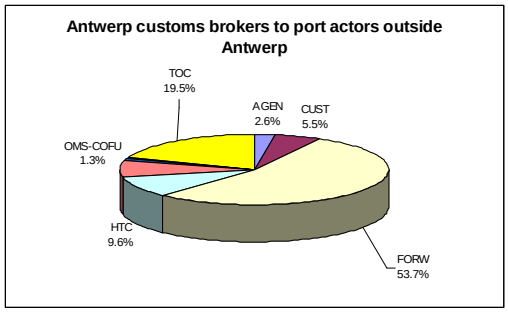
c) Customs brokers

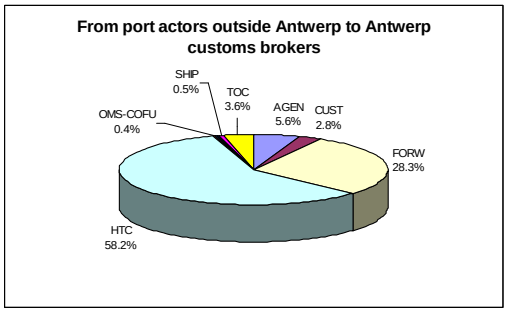


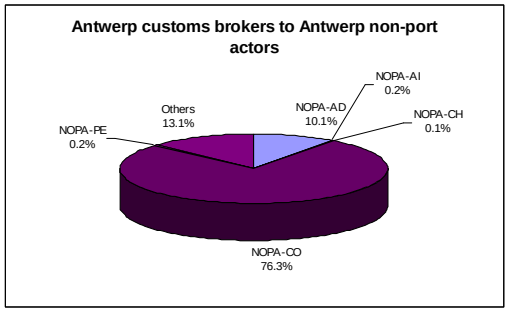


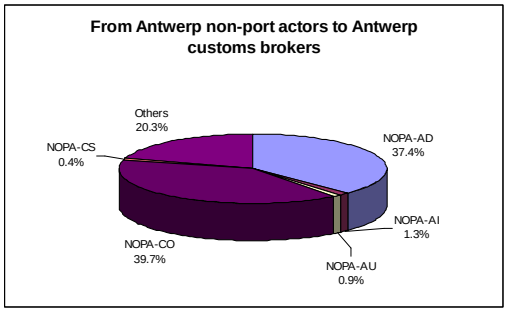


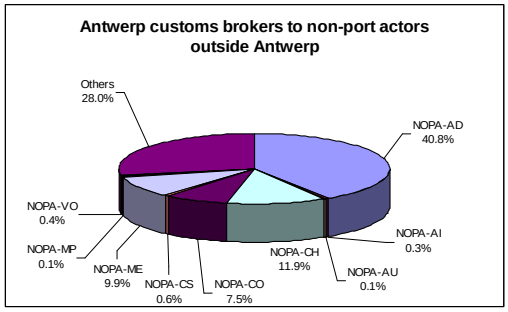


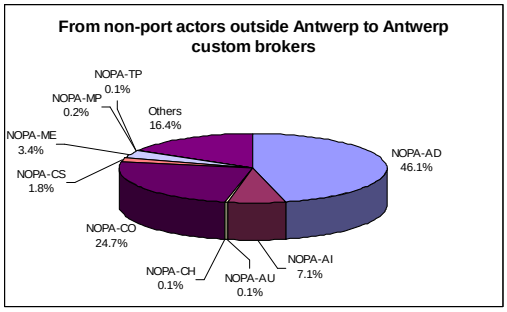




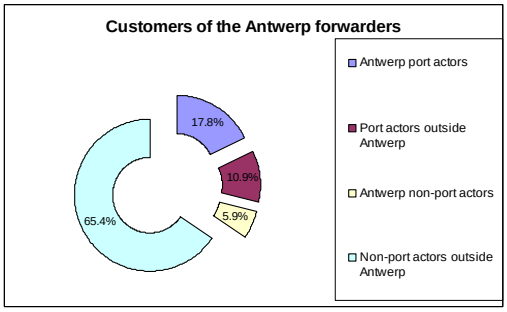


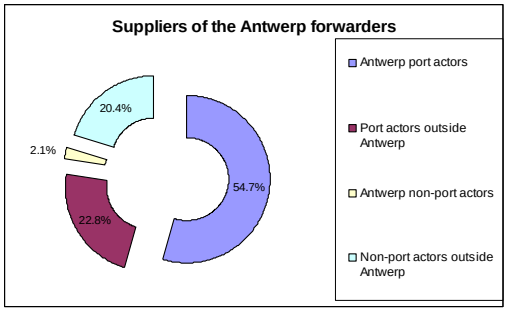


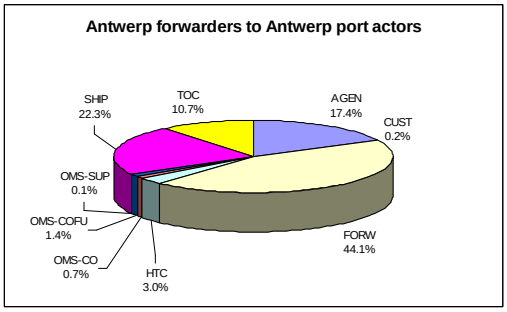


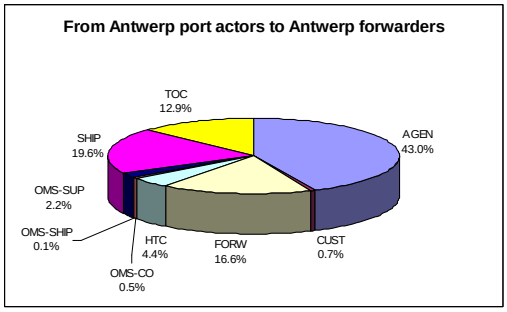


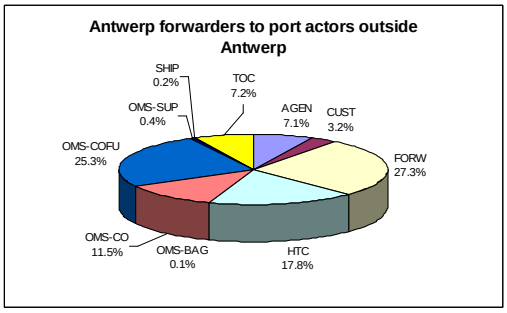
d) Forwarders

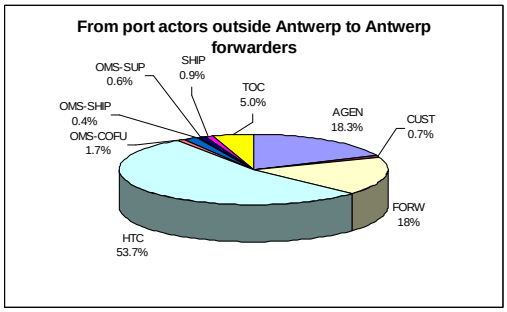


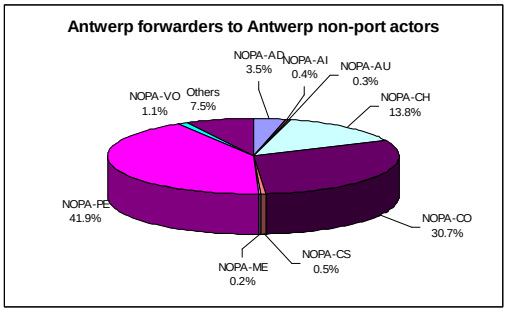


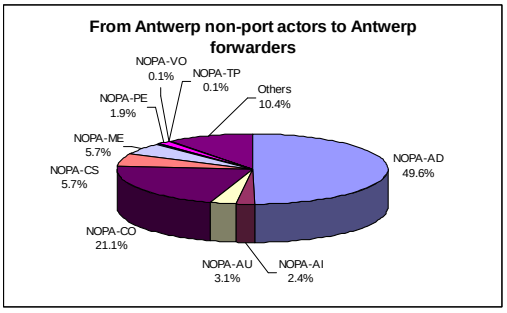


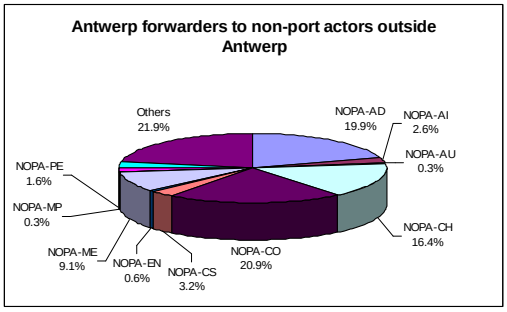


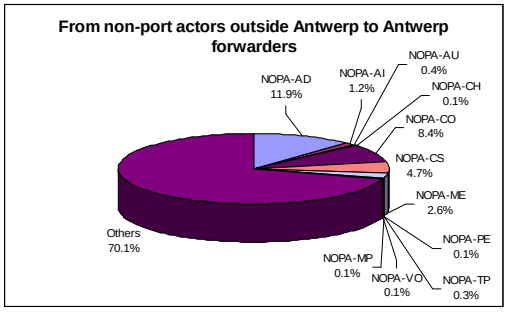




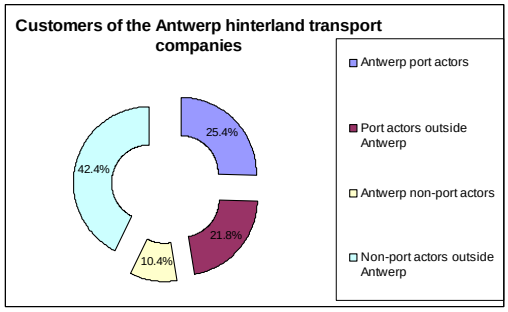


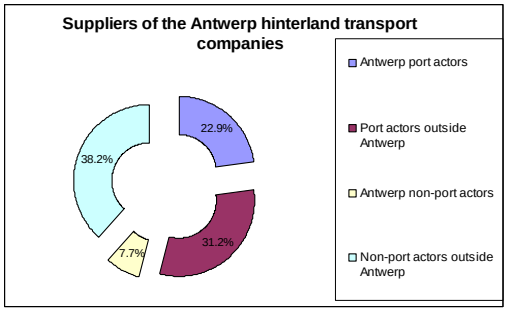


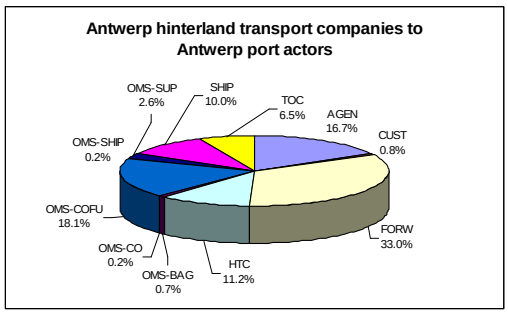


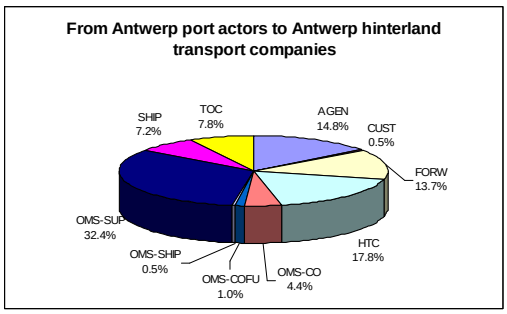


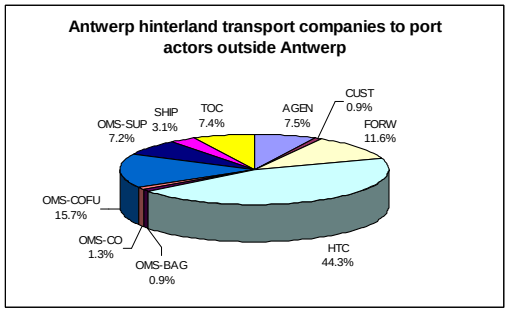
e) Hinterland transport companies

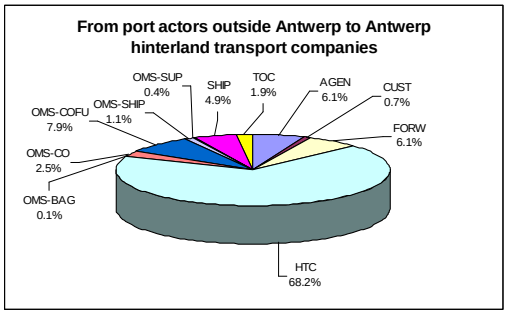


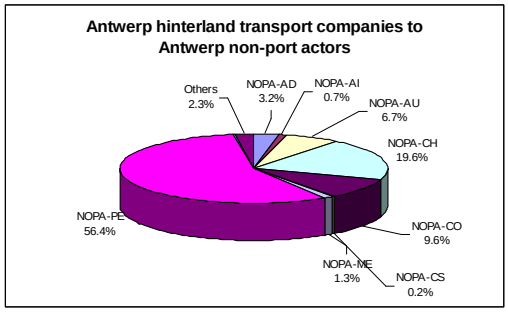


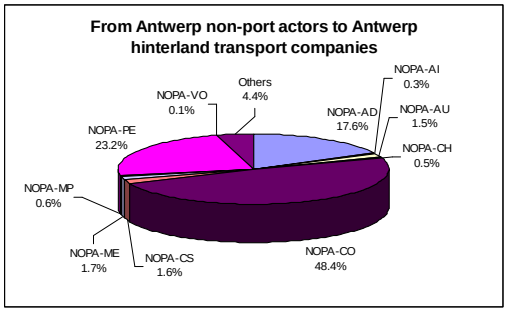


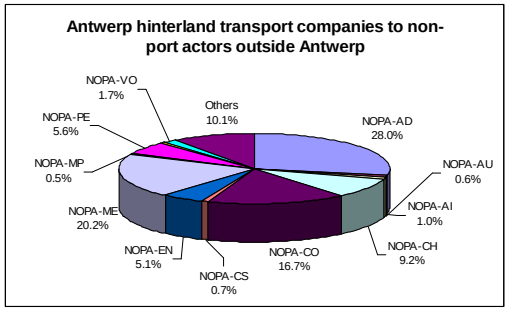


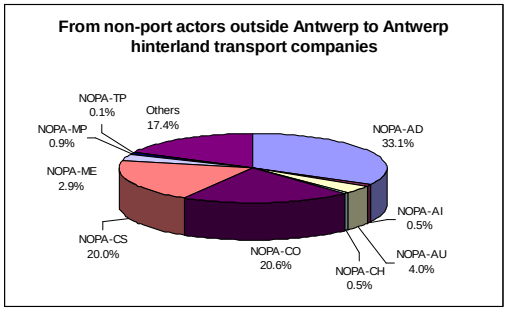






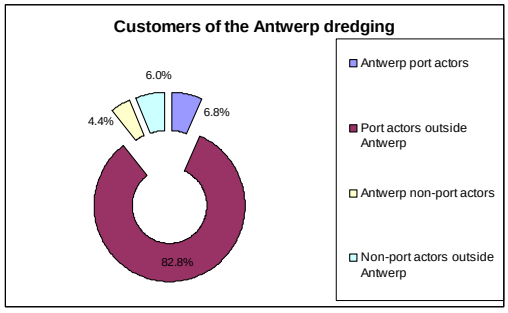


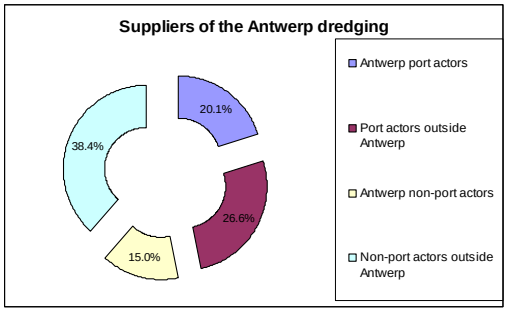


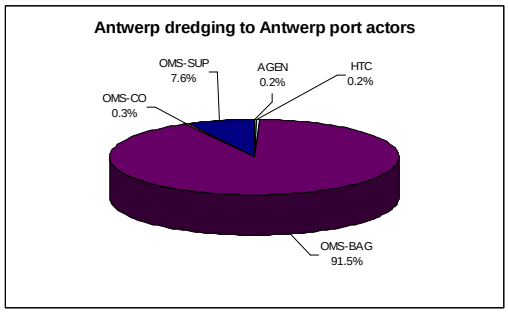


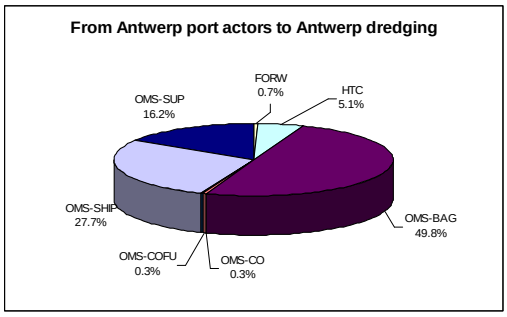
f) Other maritime services

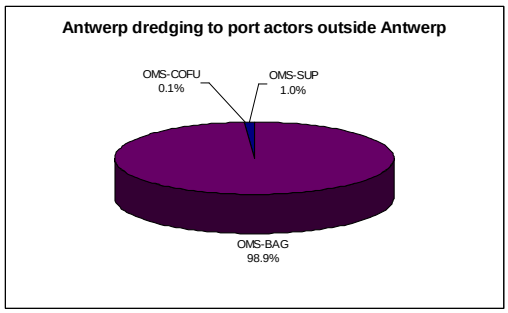
- Dredging

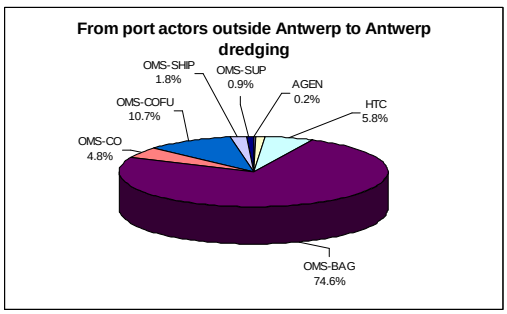


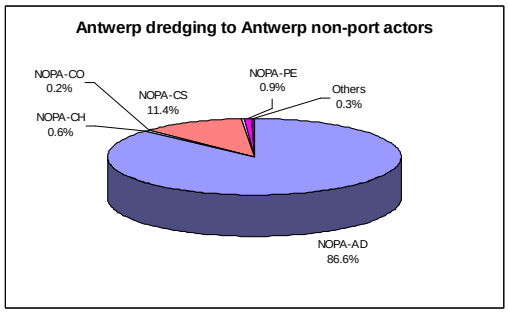


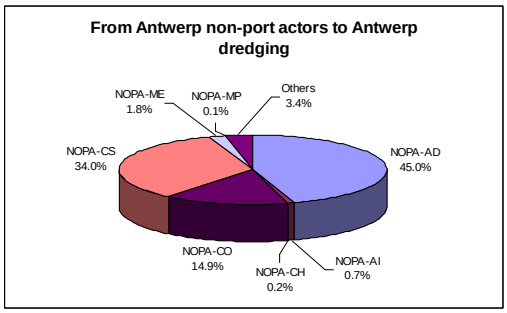


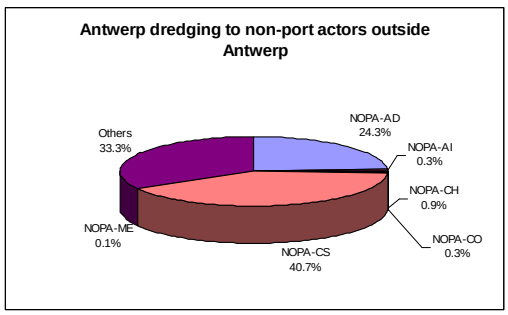


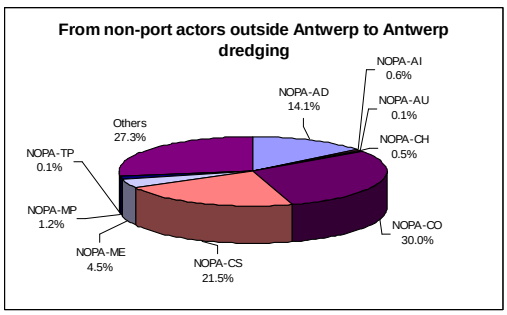




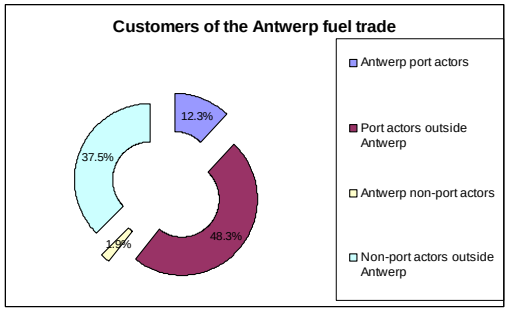


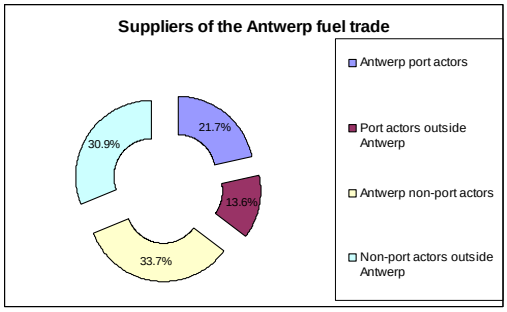


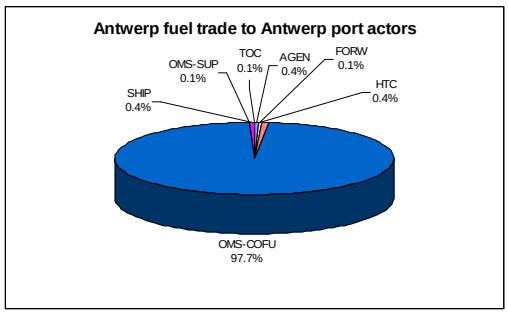


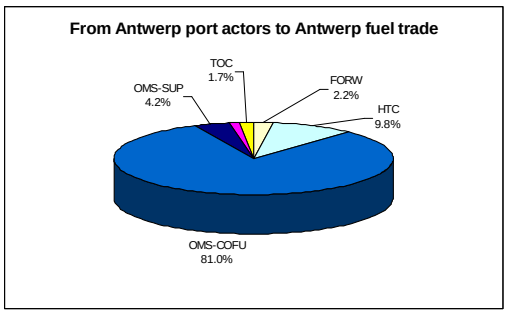


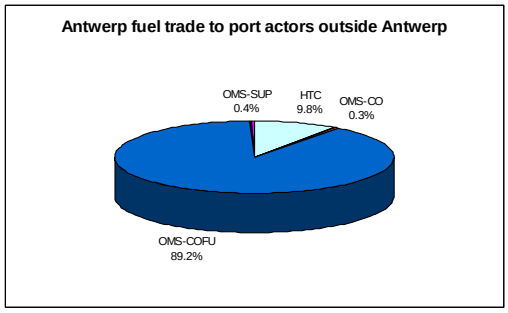
- Fuel trade

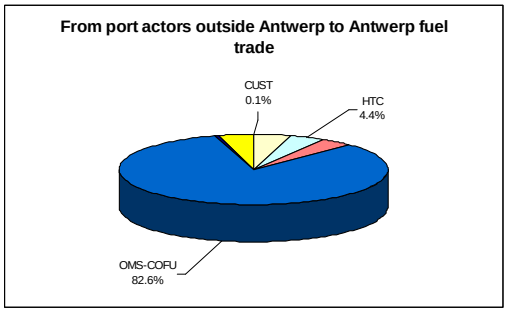

Customers of the Antwerp fuel trade
12.3%
37.5%
48.3%
1.9%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

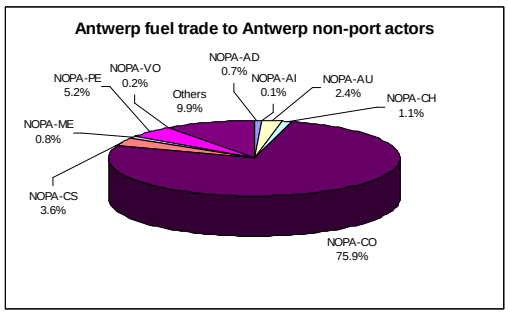

Suppliers of the Antwerp fuel trade
21.7%
30.9%
13.6%
33.7%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

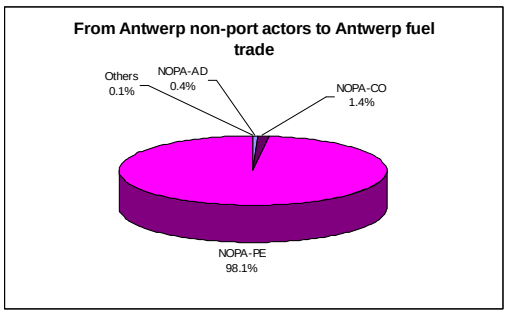

Antwerp fuel trade to Antwerp port actors
OMS-SUP 0.1%
TOC 0.1%
AGEN 0.4%
FORW 0.1%
HTC 0.4%
SHIP 0.4%
OMS-COFU 97.7%

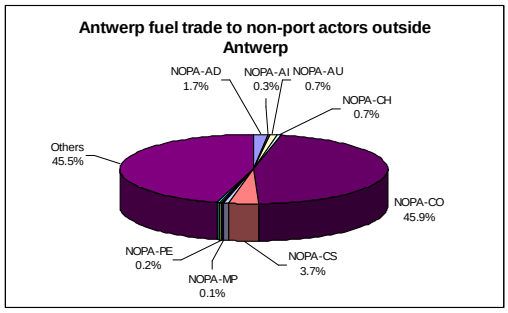

From Antwerp port actors to Antwerp fuel trade
TOC 1.7%
OMS-SUP 4.2%
FORW 2.2%
HTC 9.8%
OMS-COFU 81.0%

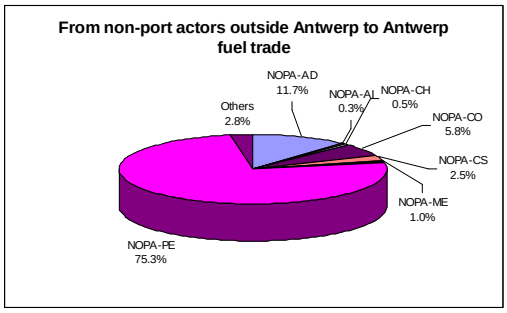

Antwerp fuel trade to port actors outside Antwerp
OMS-SUP 0.4%
HTC 9.8%
OMS-CO 0.3%
OMS-COFU 89.2%


From port actors outside Antwerp to Antwerp fuel trade
CUST 0.1%
HTC 4.4%
OMS-COFU 82.6%

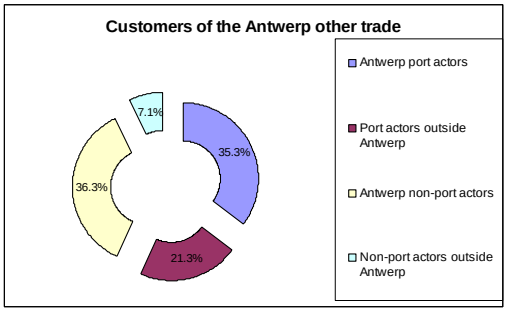

Antwerp fuel trade to Antwerp non-port actors
NOPA-AD 0.7%
NOPA-PE 5.2%
NOPA-VO 0.2%
NOPA-AI 0.1%
NOPA-AU 2.4%
Others 9.9%
NOPA-CH 1.1%
NOPA-ME 0.8%
NOPA-CS 3.6%
NOPA-CO 75.9%

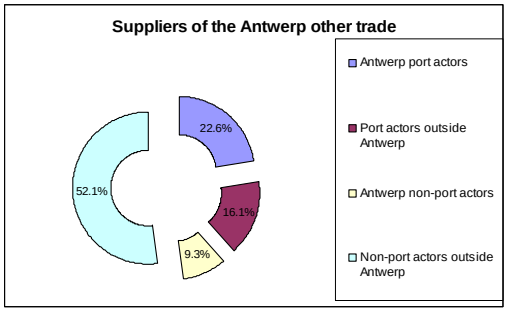

From Antwerp non-port actors to Antwerp fuel trade
Others 0.1%
NOPA-AD 0.4%
NOPA-CO 1.4%
NOPA-PE 98.1%

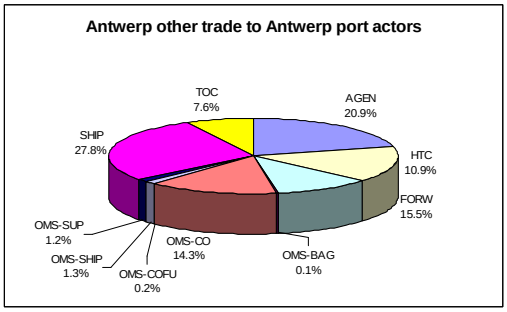

Antwerp fuel trade to non-port actors outside Antwerp
NOPA-AD 1.7%
NOPA-AI 0.3%
NOPA-AU 0.7%
NOPA-CH 0.7%
Others 45.5%
NOPA-CO 45.9%
NOPA-PE 0.2%
NOPA-CS 3.7%
NOPA-MP 0.1%

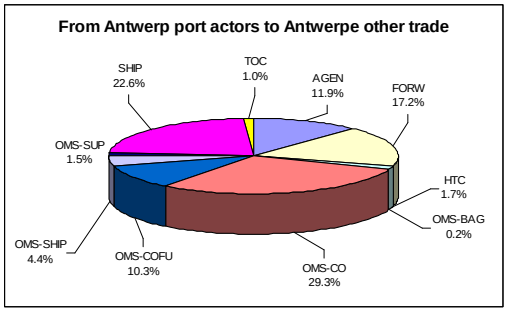

From non-port actors outside Antwerp to Antwerp fuel trade
NOPA-AD 11.7%
Others 2.8%
NOPA-AI 0.3%
NOPA-CH 0.5%
NOPA-CO 5.8%
NOPA-CS 2.5%
NOPA-ME 1.0%
NOPA-PE 75.3%

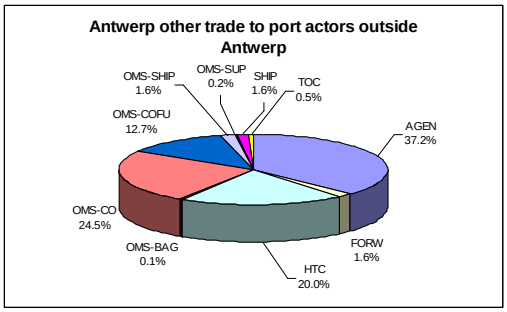
- Other trade

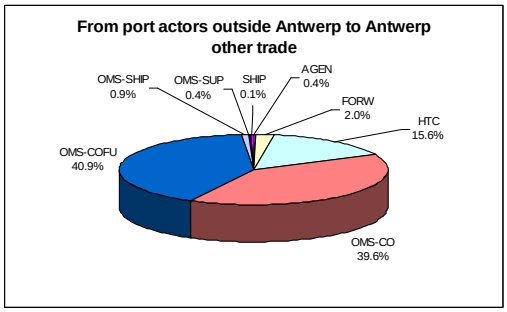

Customers of the Antwerp other trade
7.1%
35.3%
36.3%
21.3%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

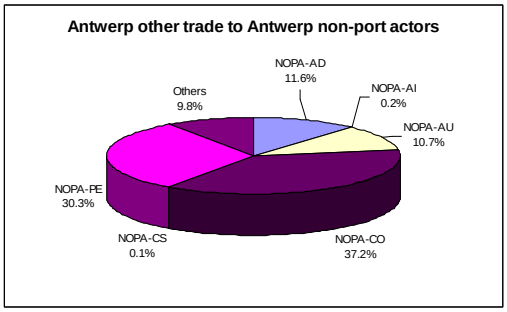

Suppliers of the Antwerp other trade
22.6%
52.1%
16.1%
9.3%
Antwerp port actors
Port actors outside Antwerp
Antwerp non-port actors
Non-port actors outside Antwerp

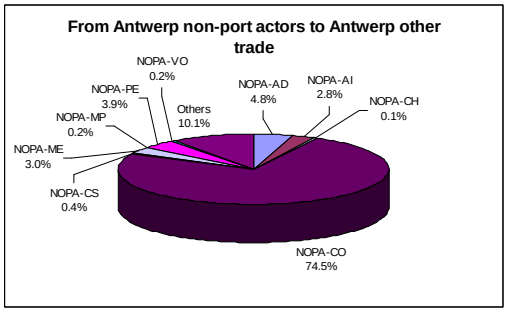

Antwerp other trade to Antwerp port actors
TOC 7.6%
AGEN 20.9%
SHIP 27.8%
HTC 10.9%
FORW 15.5%
OMS-SUP 1.2%
OMS-SHIP 1.3%
OMS-COFU 0.2%
OMS-CO 14.3%
OMS-BAG 0.1%

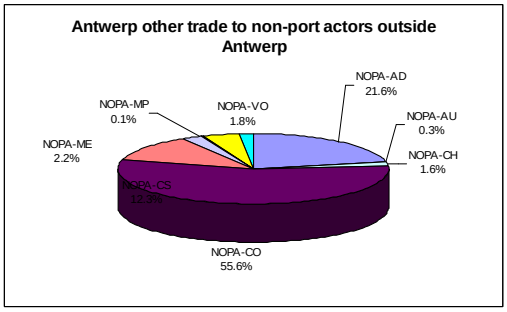

From Antwerp port actors to Antwerpe other trade
SHIP 22.6%
TOC 1.0%
AGEN 11.9%
FORW 17.2%
OMS-SUP 1.5%
HTC 1.7%
OMS-BAG 0.2%
OMS-SHIP 4.4%
OMS-COFU 10.3%
OMS-CO 29.3%

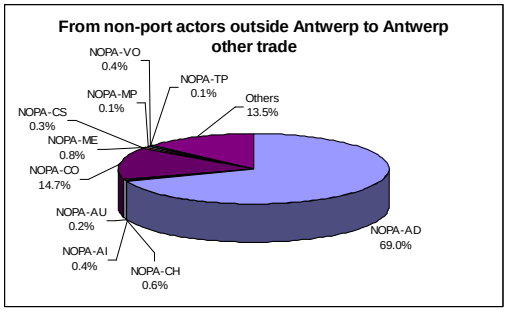

Antwerp other trade to port actors outside Antwerp
OMS-SHIP 1.6%
OMS-SUP 0.2%
SHIP 1.6%
TOC 0.5%
OMS-COFU 12.7%
AGEN 37.2%
OMS-CO 24.5%
OMS-BAG 0.1%
FORW 1.6%
HTC 20.0%


From port actors outside Antwerp to Antwerp other trade
OMS-SHIP 0.9%
OMS-SUP 0.4%
SHIP 0.1%
AGEN 0.4%
FORW 2.0%
HTC 15.6%
OMS-COFU 40.9%
OMS-CO 39.6%

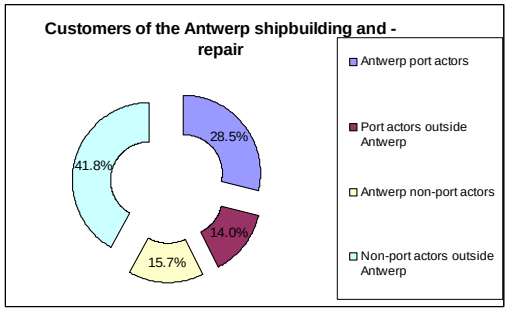

Antwerp other trade to Antwerp non-port actors
NOPA-AD 11.6%
Others 9.8%
NOPA-AI 0.2%
NOPA-AU 10.7%
NOPA-PE 30.3%
NOPA-CS 0.1%
NOPA-CO 37.2%

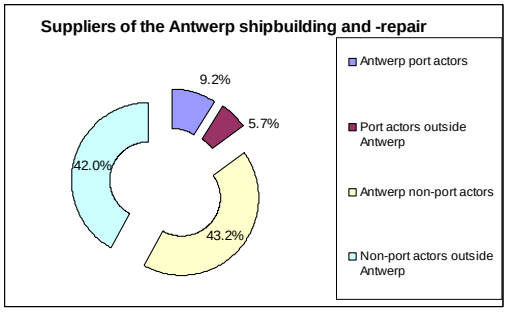

From Antwerp non-port actors to Antwerp other trade
NOPA-VO 0.2%
NOPA-PE 3.9%
NOPA-AD 4.8%
NOPA-AI 2.8%
Others 10.1%
NOPA-CH 0.1%
NOPA-MP 0.2%
NOPA-ME 3.0%
NOPA-CS 0.4%
NOPA-CO 74.5%

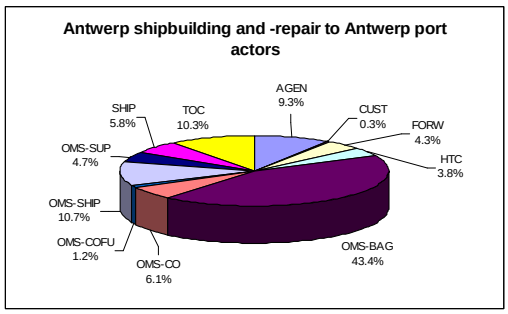

Antwerp other trade to non-port actors outside Antwerp
NOPA-AD 21.6%
NOPA-MP 0.1%
NOPA-VO 1.8%
NOPA-AU 0.3%
NOPA-ME 2.2%
NOPA-CH 1.6%
NOPA-CS 12.3%
NOPA-CO 55.6%

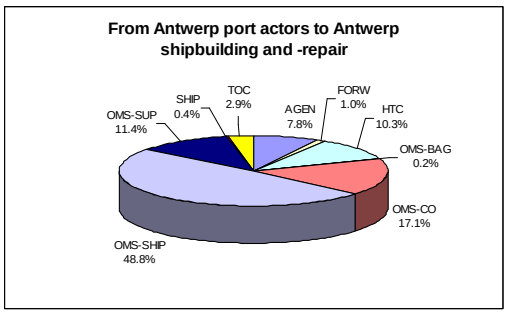

From non-port actors outside Antwerp to Antwerp other trade
NOPA-VO 0.4%
NOPA-TP 0.1%
NOPA-MP 0.1%
Others 13.5%
NOPA-CS 0.3%
NOPA-ME 0.8%
NOPA-CO 14.7%
NOPA-AU 0.2%
NOPA-AD 69.0%
NOPA-AI 0.4%
NOPA-CH 0.6%

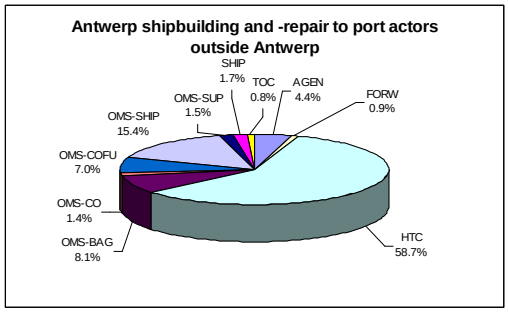
- Shipbuilding and -repair

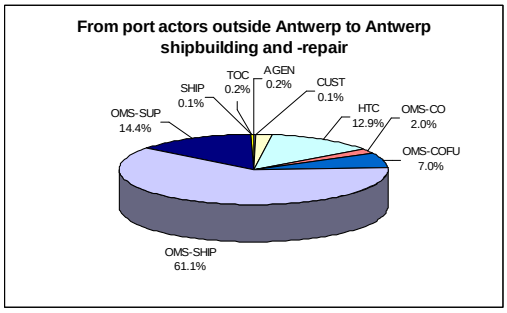


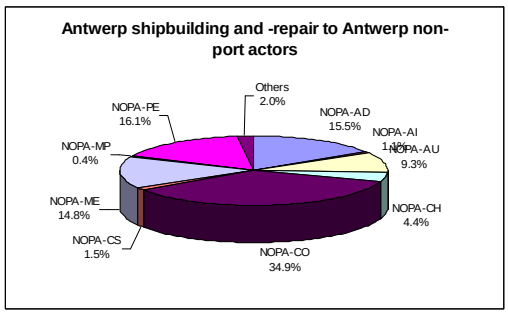


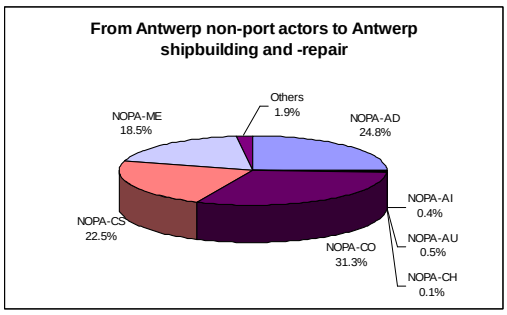


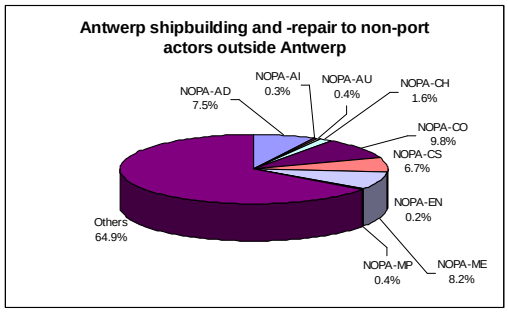


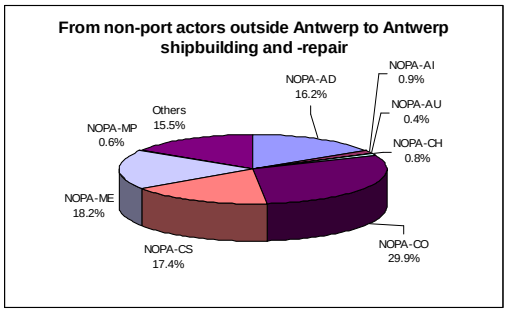




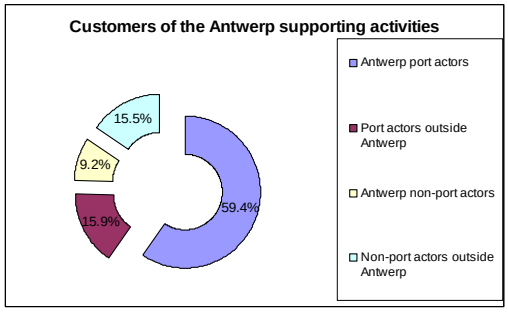


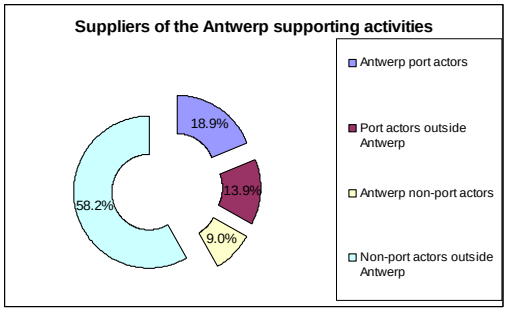


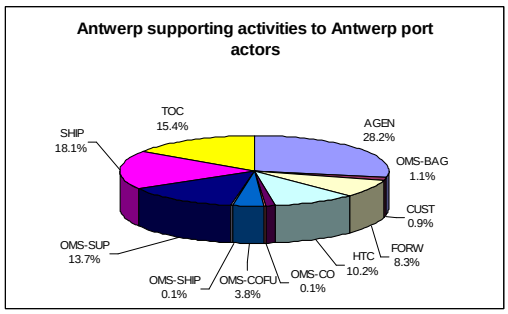


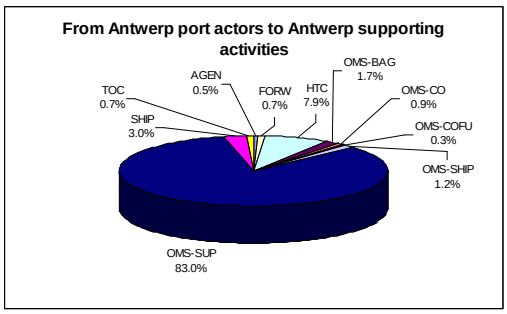


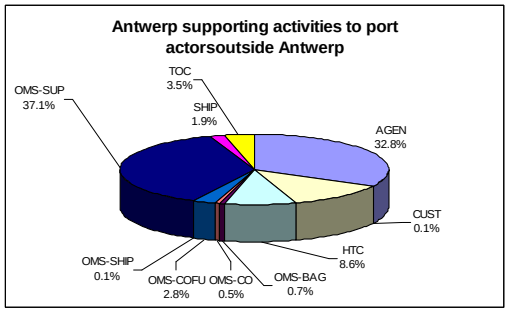
- Supporting activities

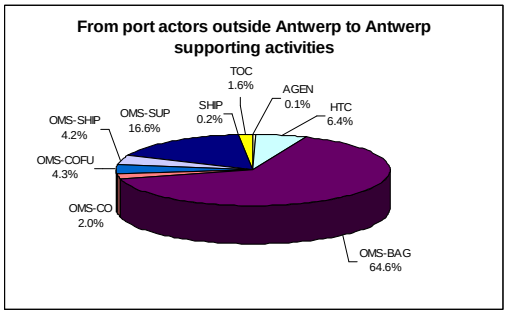


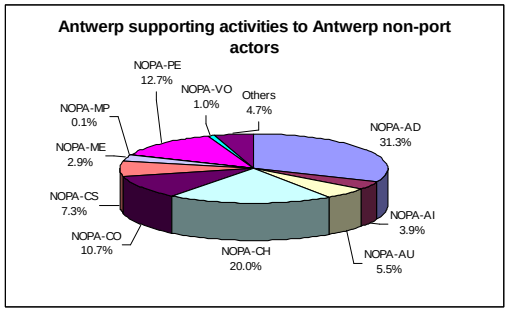


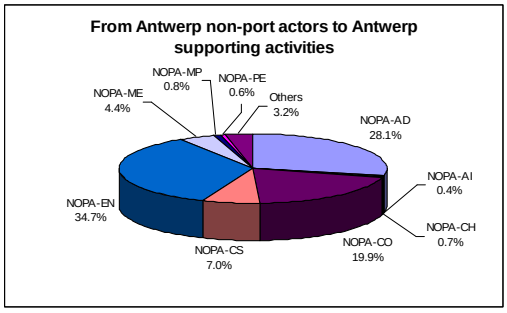


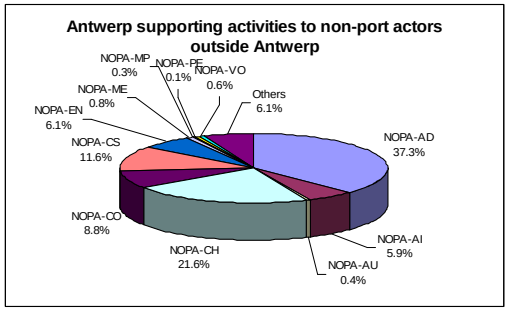


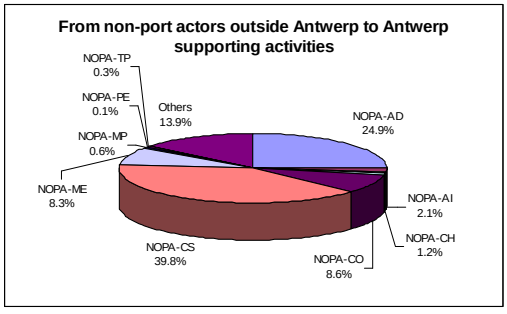




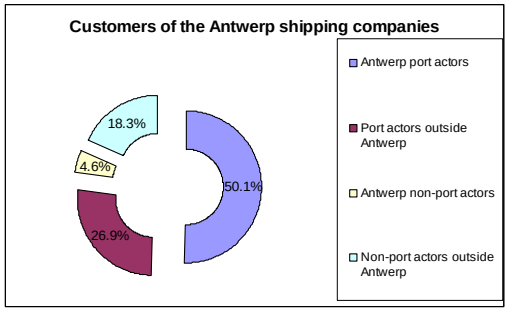


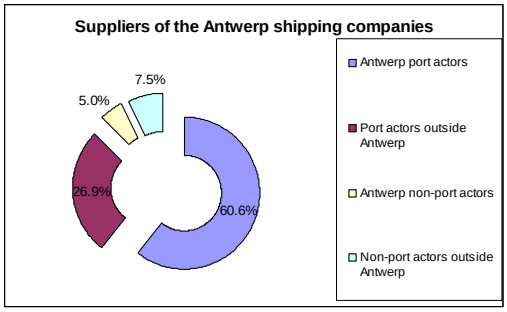


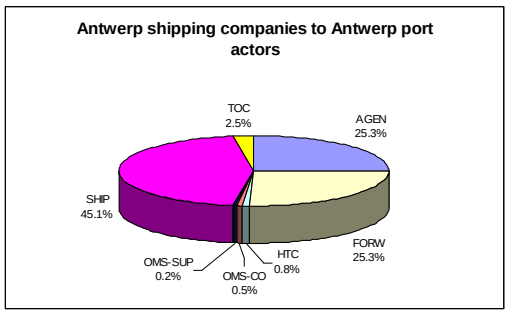


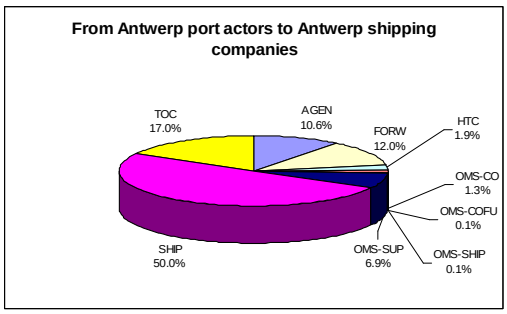


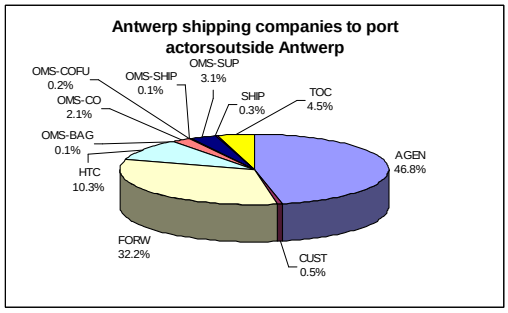
g) Shipping companies

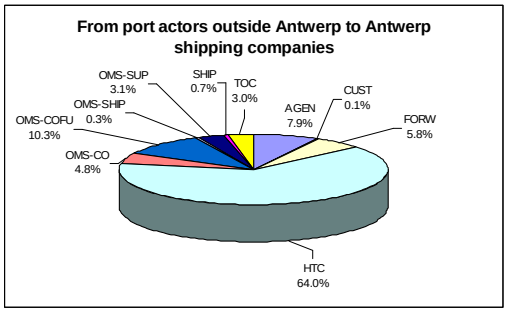


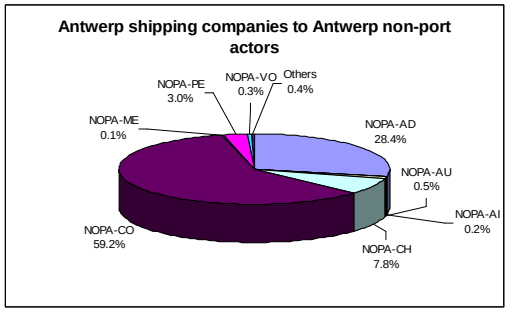


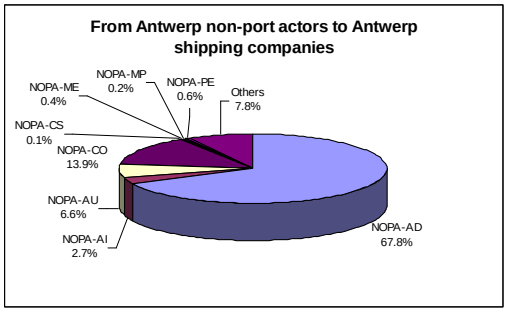


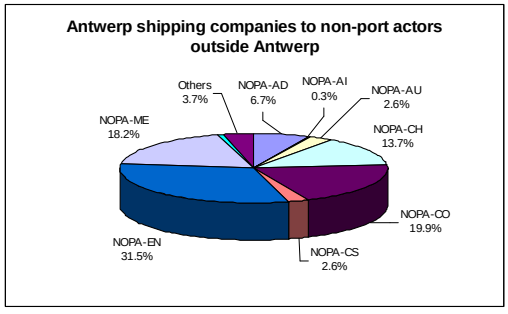


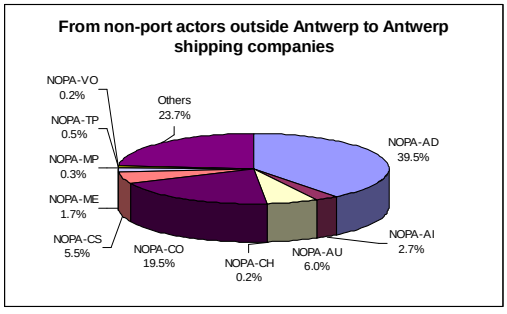




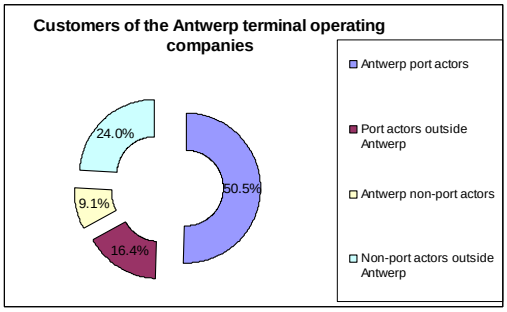


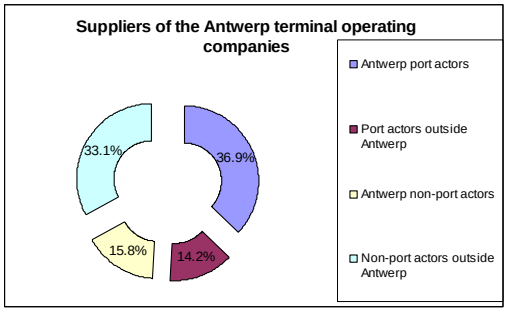


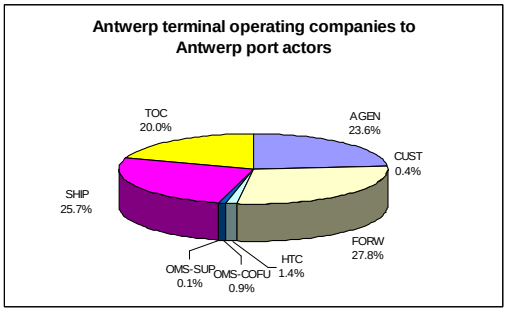


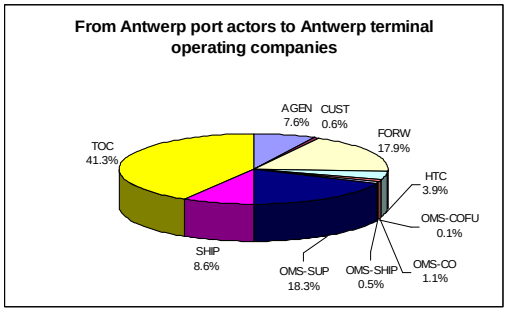


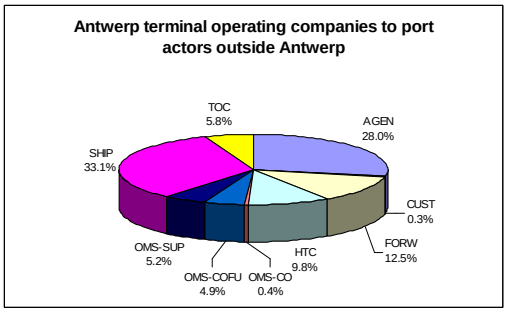
h) Terminal operating companies

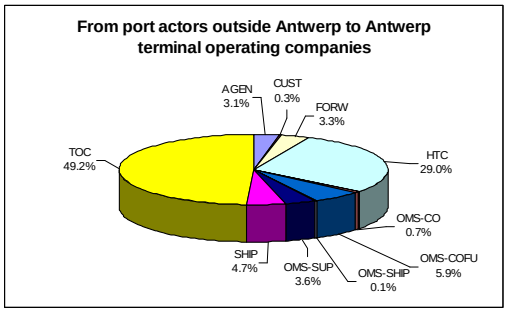


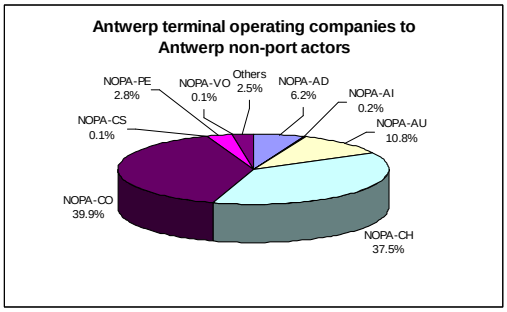


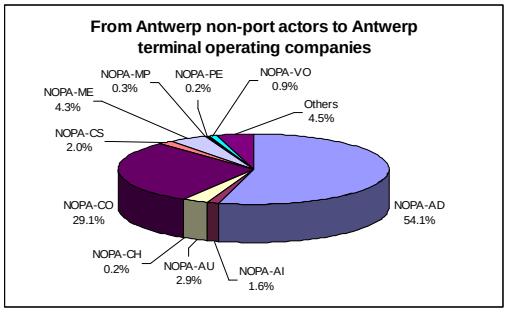


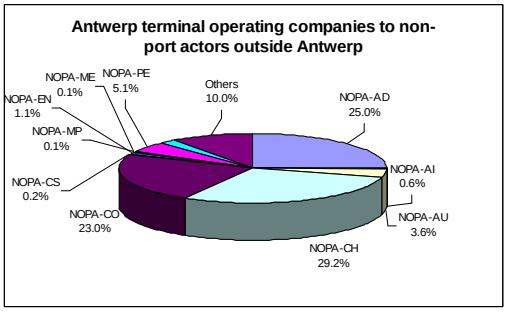


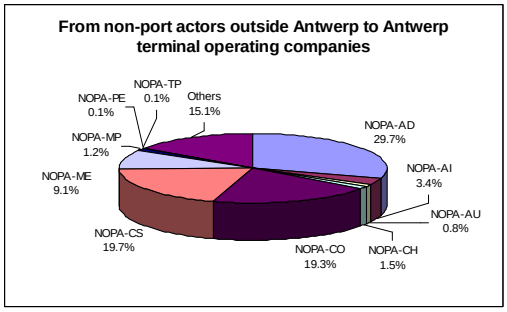










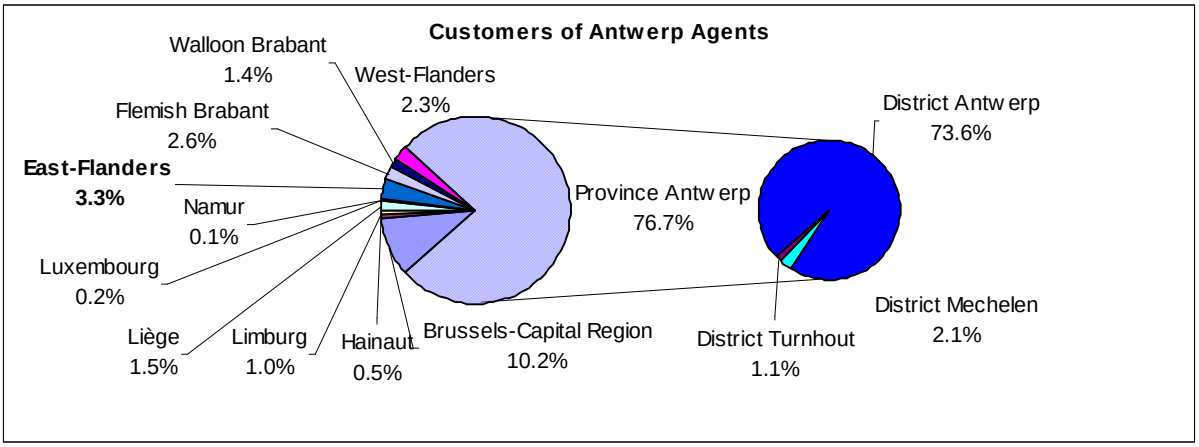


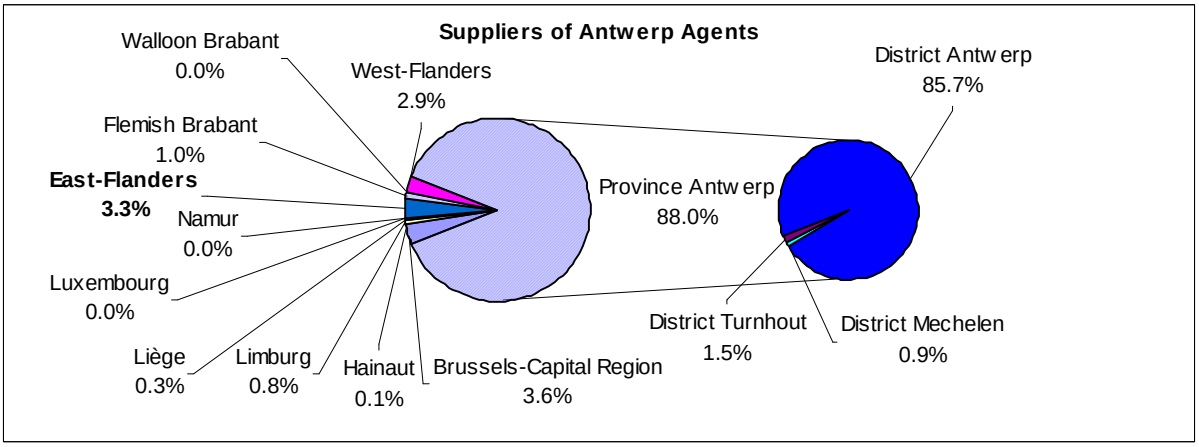
Legend:

AGEN	Agents
CUST	Customs brokers
FORW	Forwarders
HTC	Hinterland transport companies
NOPA-AD	Non-port actor - Other services
NOPA-AI	Non-port actor - Other industries
NOPA-AU	Non-port actor - Car manufacturing
NOPA-CH	Non-port actor - Chemical industry
NOPA-CO	Non-port actor - Trade
NOPA-CS	Non-port actor - Construction
NOPA-EN	Non-port actor - Energy
NOPA-ME	Non-port actor - Metallurgy
NOPA-MP	Non-port actor - Electronics
NOPA-PE	Non-port actor - Oil industry
NOPA-PU	Non-port actor - Public services
NOPA-TP	Non-port actor - Land transport
NOPA-VO	Non-port actor - Food industry
OMS-BAG	Other maritime services - Dredging
OMS-CO	Other maritime services - Other trade
OMS-COFU	Other maritime services - Fuel trade
OMS-SHIP	Other maritime services - Shipbuilding and repair
OMS-SUP	Other maritime services - Supporting activities
Others	Other sectors
SHIP	Shipping companies
TOC	Terminal operating companies

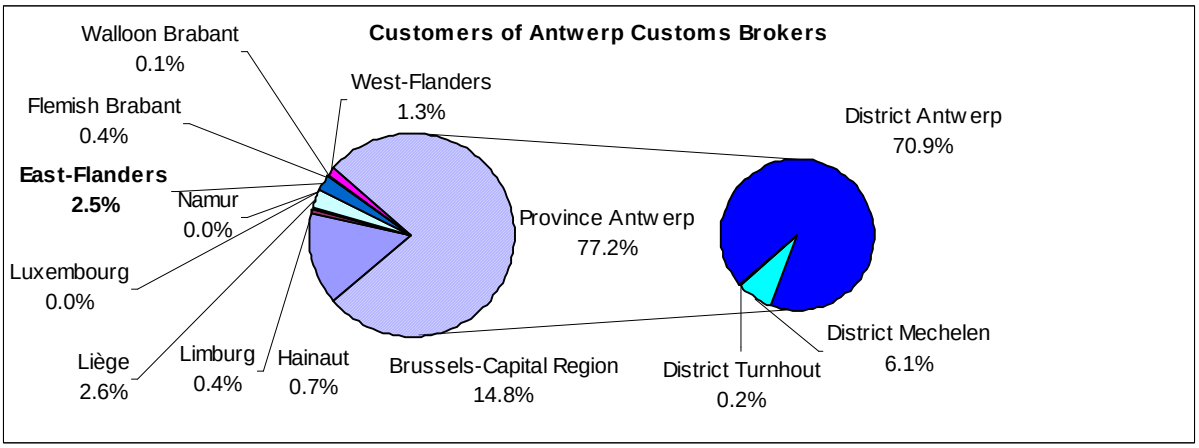
APPENDIX 6: Charts geographical analysis per port actor in 2000

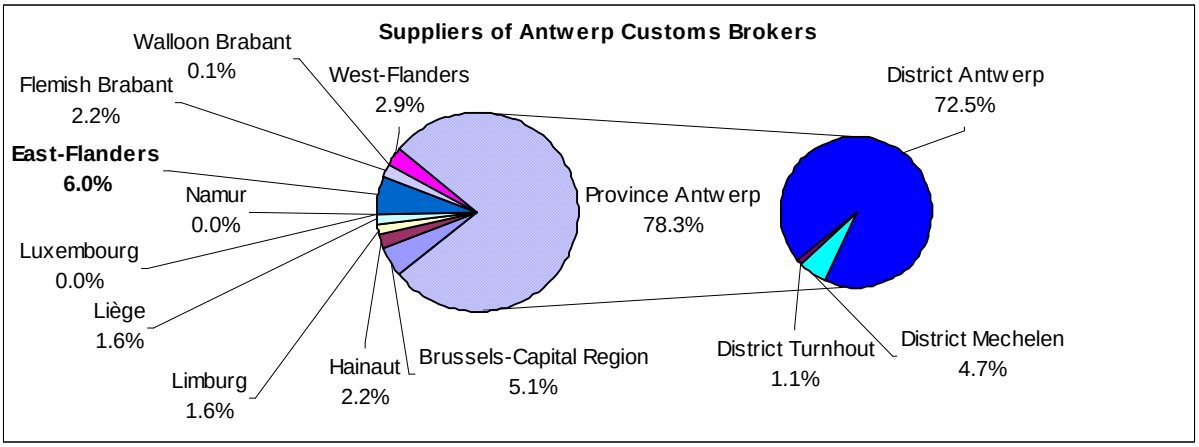
a) Agents



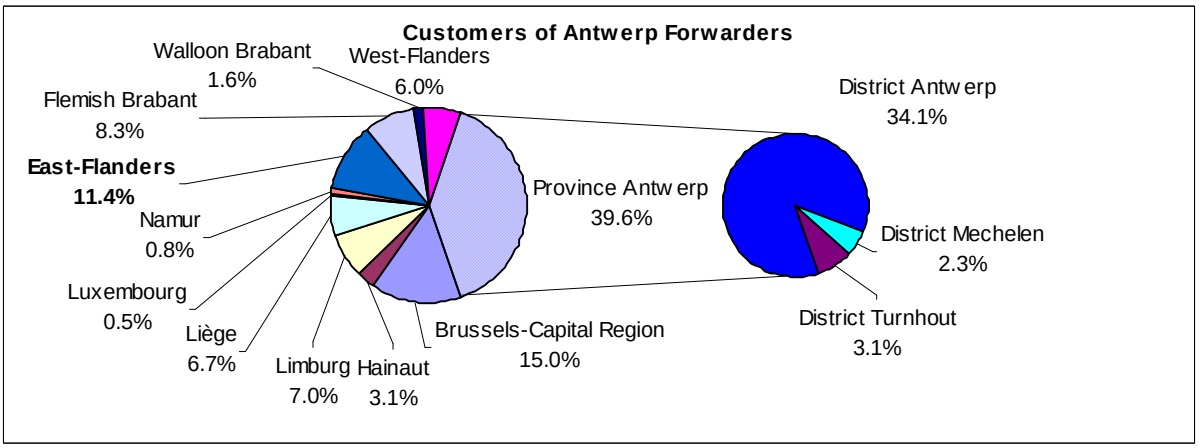


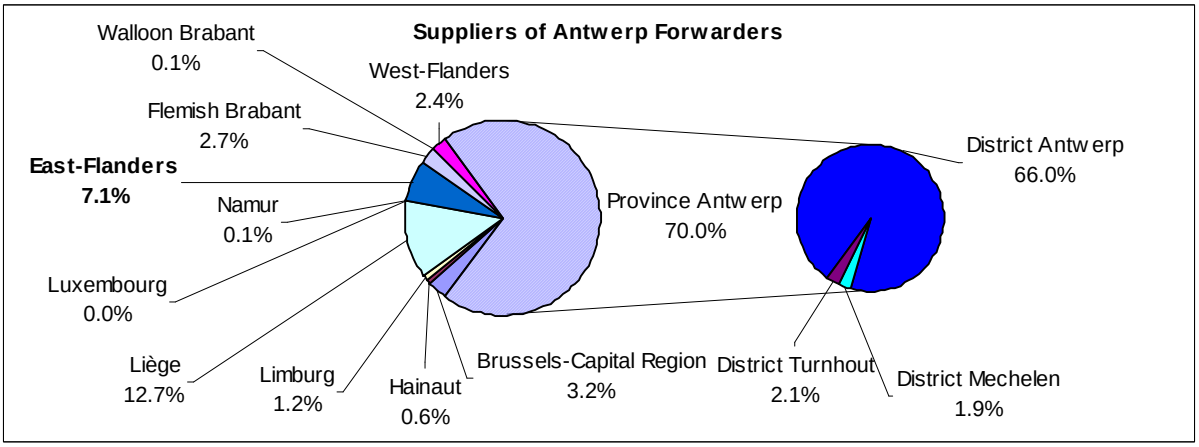
b) Customs brokers



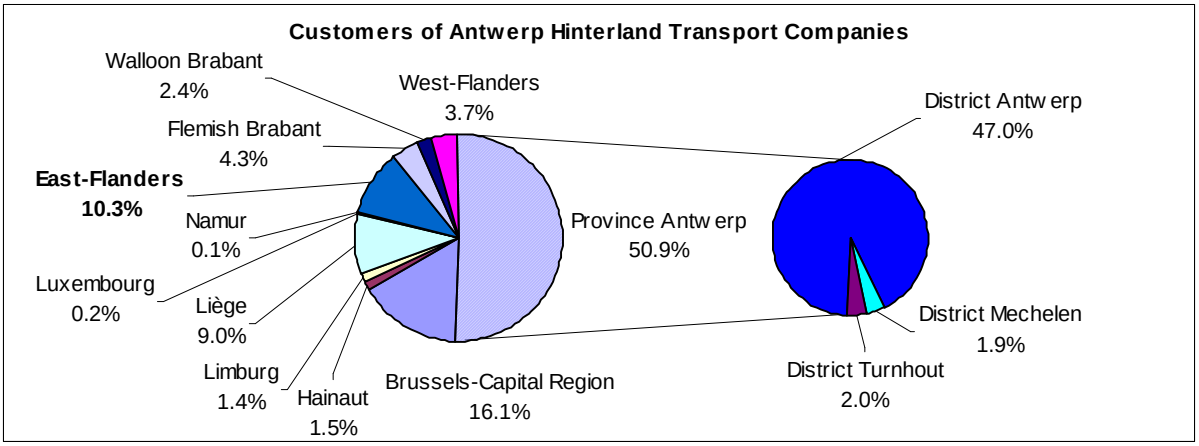


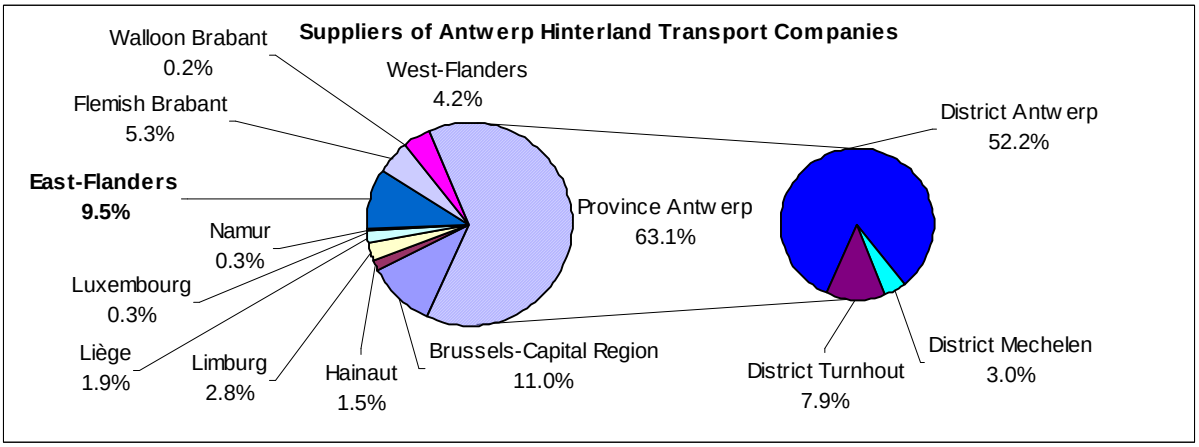
c) Forwarders





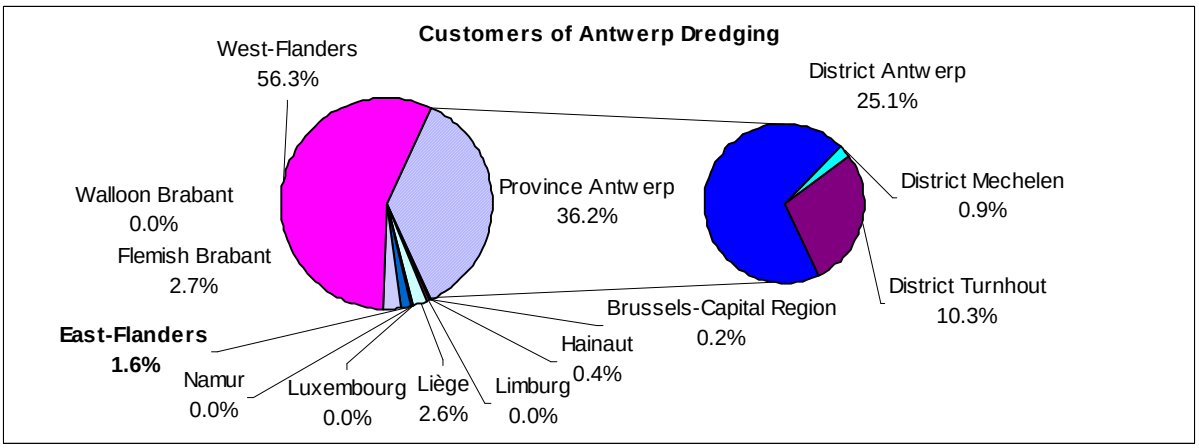
d) Hinterland transport companies

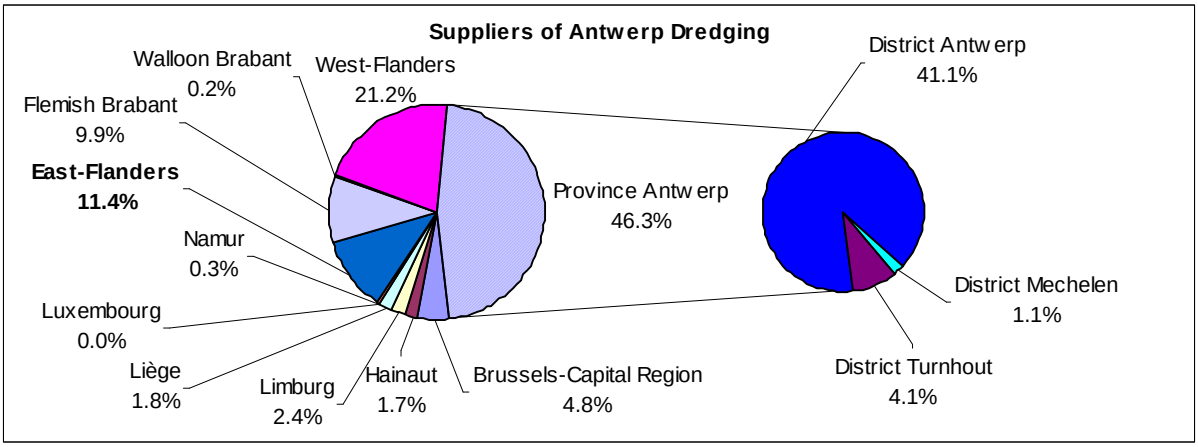




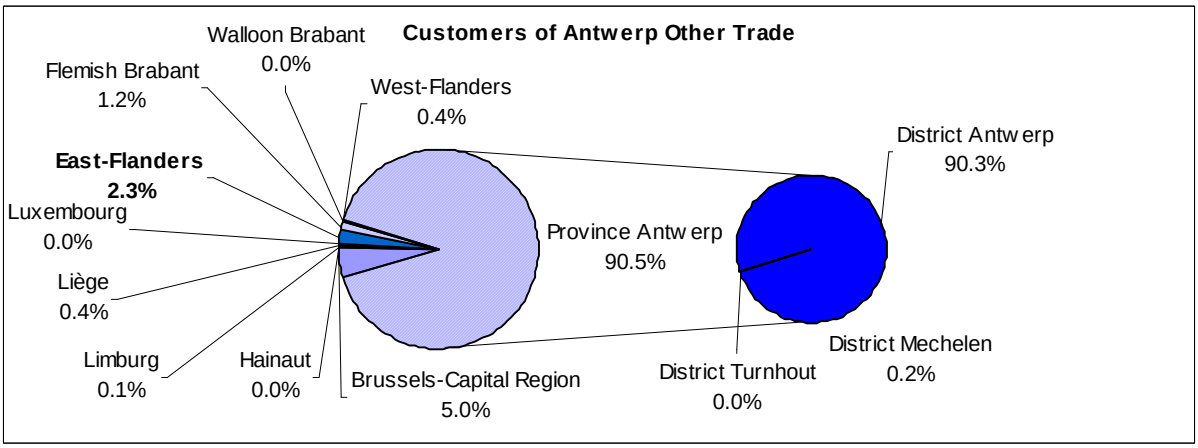
e) Other maritime service

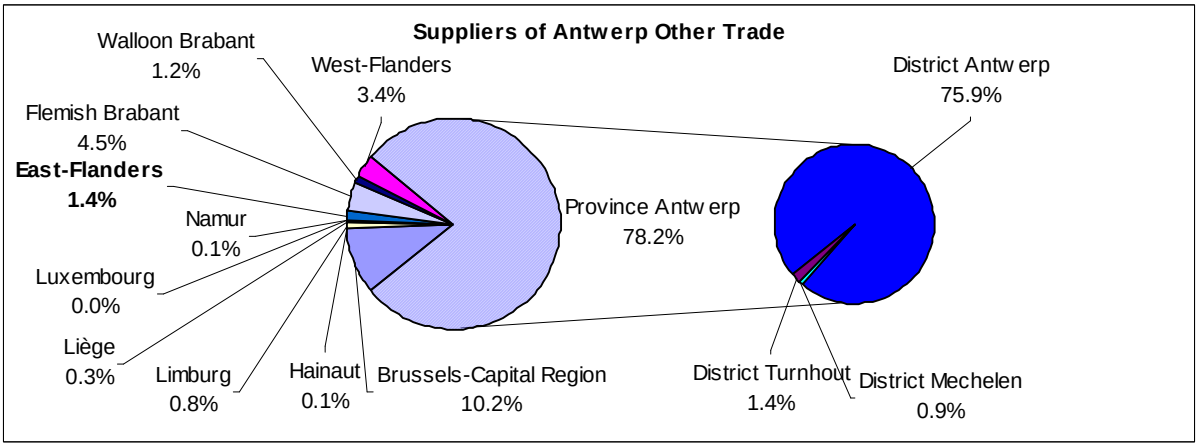
- Dredging



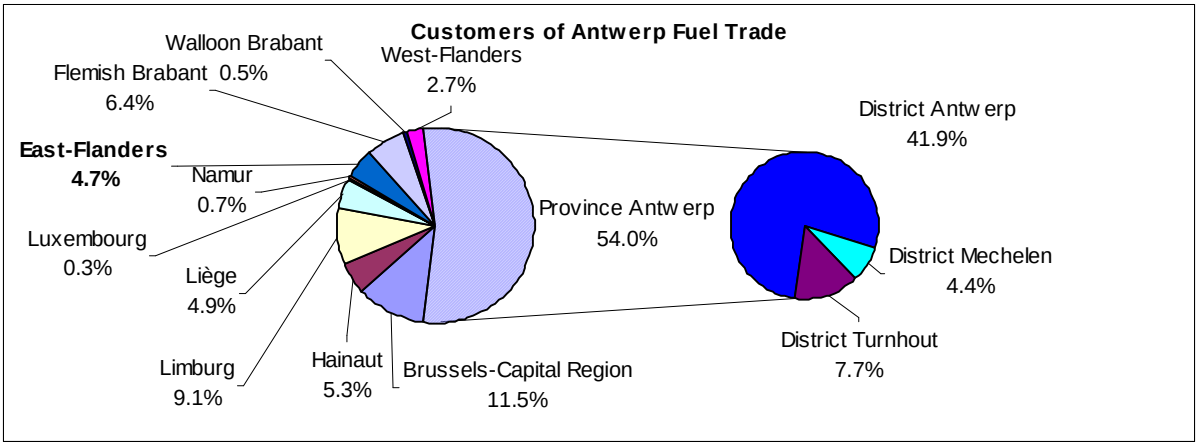

Suppliers of Antwerp Dredging
Walloon Brabant 0.2%
West-Flanders 21.2%
Flemish Brabant 9.9%
East-Flanders 11.4%
Namur 0.3%
Luxembourg 0.0%
Liège 1.8%
Limburg 2.4%
Hainaut 1.7%
Brussels-Capital Region 4.8%
Province Antwerp 46.3%
District Antwerp 41.1%
District Mechelen 1.1%
District Turnhout 4.1%

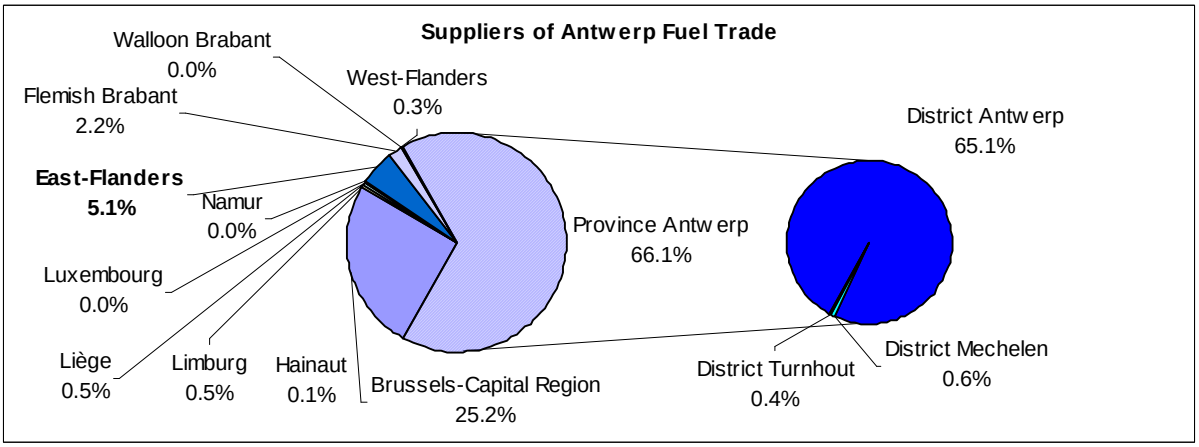
- Other trade


Customers of Antwerp Other Trade
Walloon Brabant 0.0%
Flemish Brabant 1.2%
West-Flanders 0.4%
East-Flanders 2.3%
Luxembourg 0.0%
Liège 0.4%
Limburg 0.1%
Hainaut 0.0%
Brussels-Capital Region 5.0%
Province Antwerp 90.5%
District Antwerp 90.3%
District Mechelen 0.2%
District Turnhout 0.0%

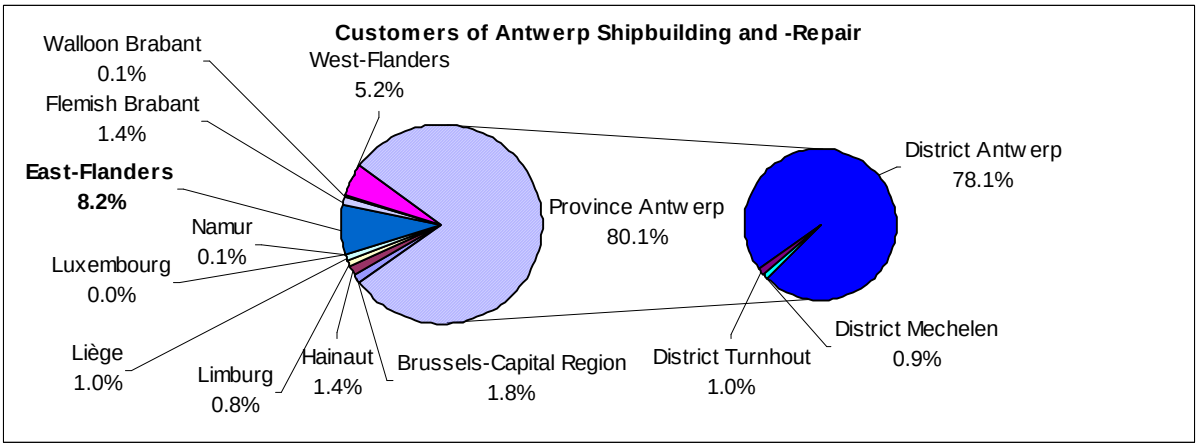

Suppliers of Antwerp Other Trade
Walloon Brabant 1.2%
West-Flanders 3.4%
Flemish Brabant 4.5%
East-Flanders 1.4%
Namur 0.1%
Luxembourg 0.0%
Liège 0.3%
Limburg 0.8%
Hainaut 0.1%
Brussels-Capital Region 10.2%
Province Antwerp 78.2%
District Antwerp 75.9%
District Turnhout 1.4%
District Mechelen 0.9%

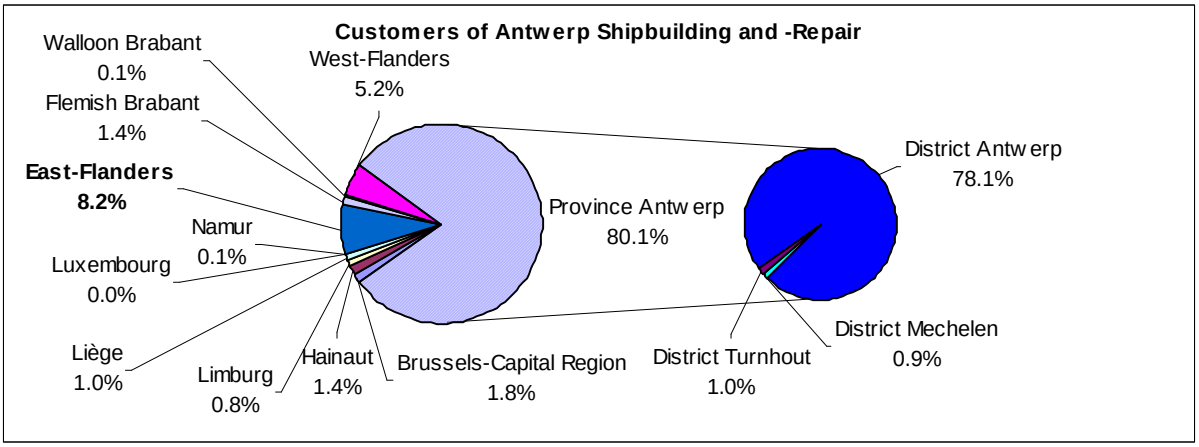
- Fuel trade



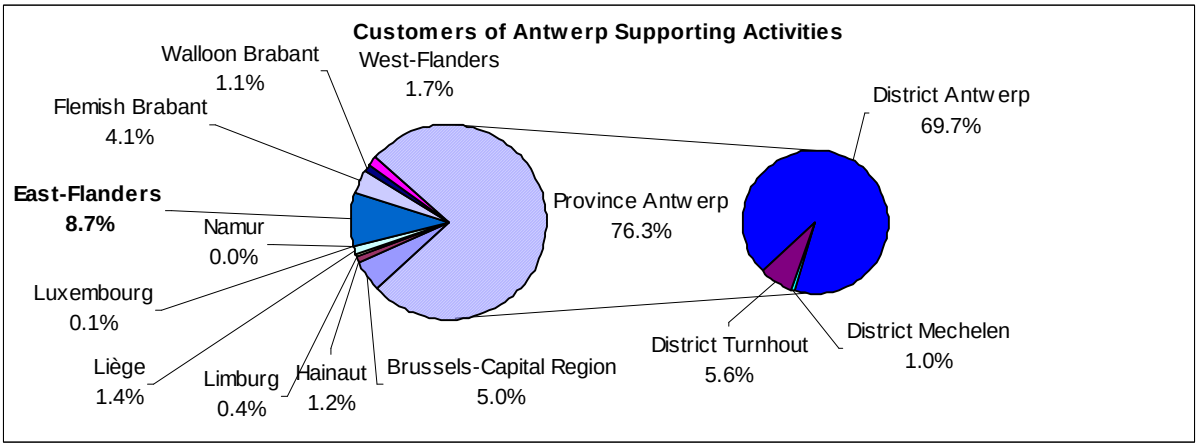


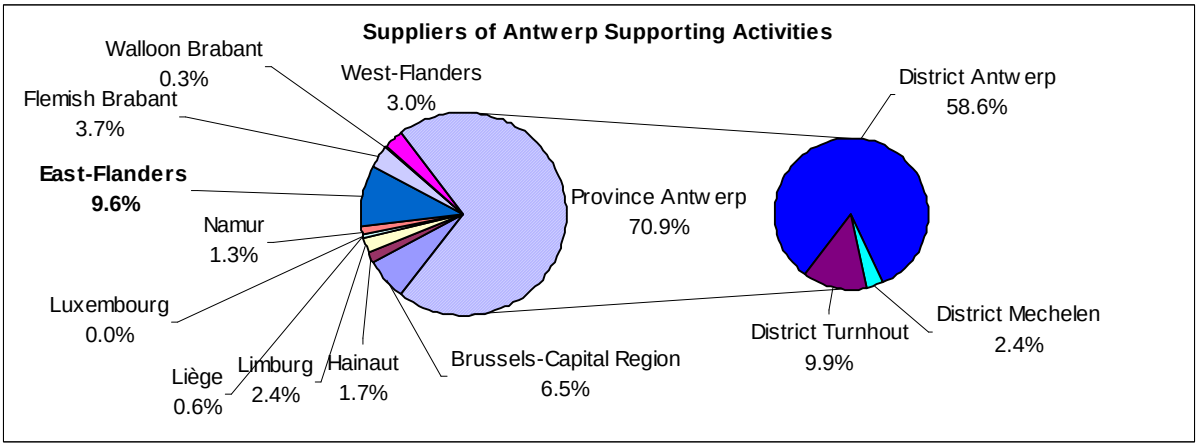
- Shipbuilding and -repair



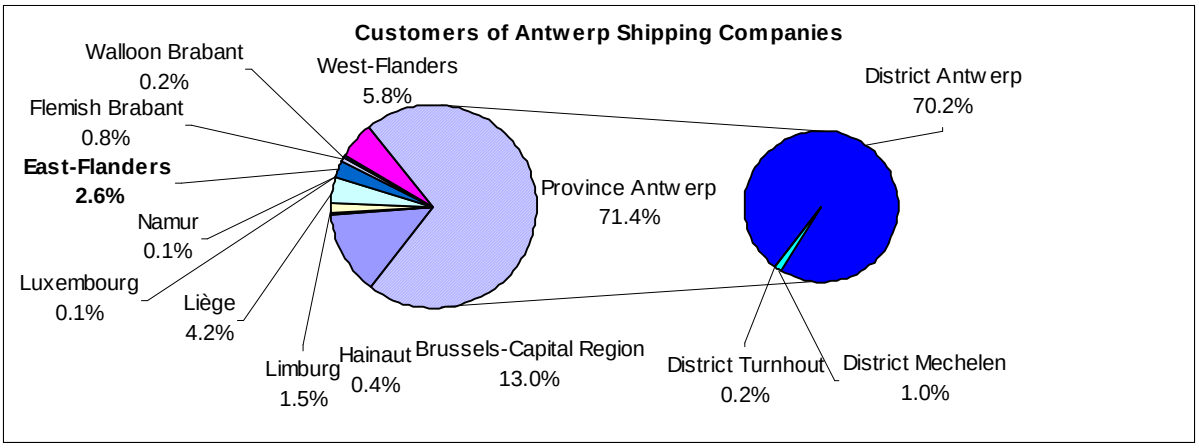


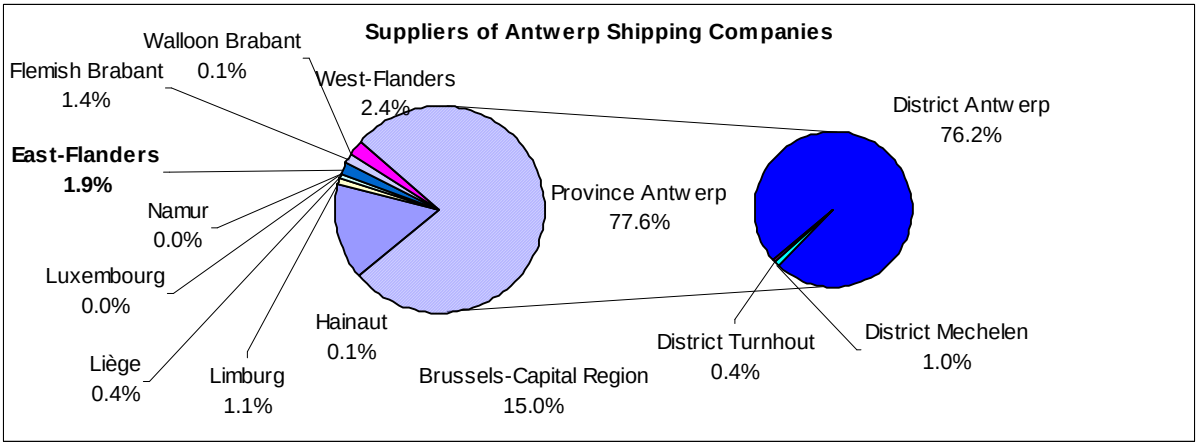
- Supporting activities



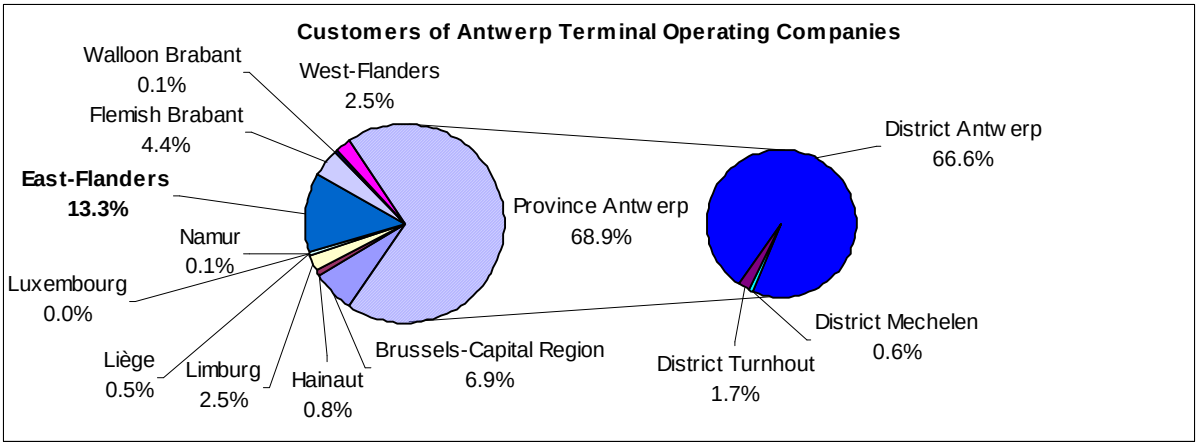


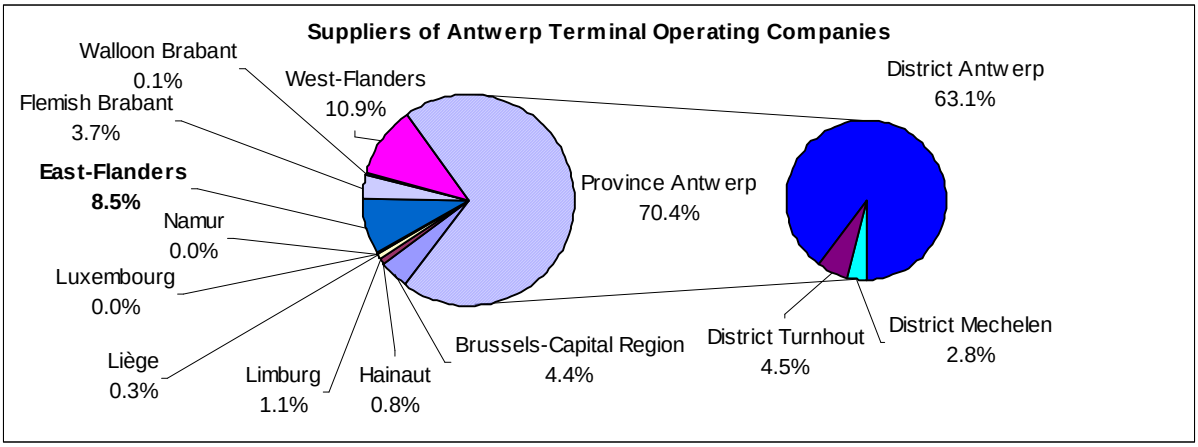
f) Shipping companies





g) Terminal operating companies




Suppliers of Antwerp Terminal Operating Companies
Walloon Brabant
0.1%
West-Flanders
10.9%
District Antwerp
63.1%
Flemish Brabant
3.7%
East-Flanders
8.5%
Province Antwerp
70.4%
Namur
0.0%
Luxembourg
0.0%
Liège
0.3%
Limburg
1.1%
Hainaut
0.8%
Brussels-Capital Region
4.4%
District Turnhout
4.5%
District Mechelen
2.8%

APPENDIX 7: Principal component analysis

PCA is a statistical technique applied to a single set of variables to discover which variables in the set form coherent subsets that are relatively independent of one another. Variables that are correlated with one another but largely independent of other subsets of variables are combined into components (Tabachnick and Fidell, 2001, p. 582).

Kaiser's measure of sampling adequacy gives an indication concerning the suitability of the data for PCA. Values of 0.6 are required for good PCA. In our case the value is 0.86 for the customers and 0.94 for the suppliers (see table 1).

Table 1: KMO and Bartlett's Test for customers' and suppliers' PCA

		Customers	Suppliers
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.86	.94
Bartlett's Test of Sphericity	Approx. Chi-Square	18259.25	17702.70
	df	55	55
	Sig.	.00	.00

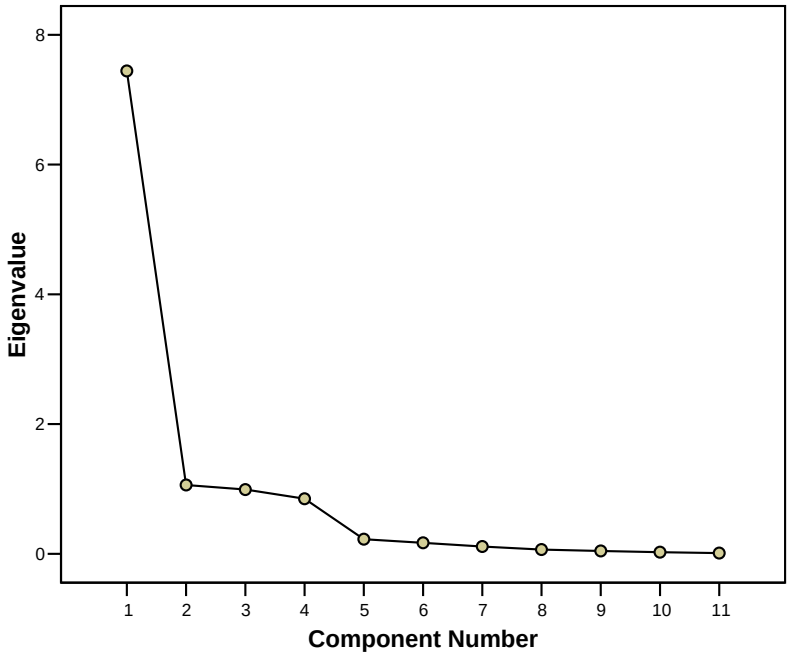
To determine the number of components to keep, two methods are used (Tabachnick and Fidell, 2001, p. 620-622). The first one looks at the sizes of the eigenvalues, which represent variance. Because the variance that each variable contributes to a principal components extraction is 1, eigenvalues less than 1 reveal components which are not as important as an observed variable. Therefore the components that are kept have eigenvalues exceeding 1. In our analysis only two components are withdrawn (see table 2). A second method to find the number of components, unfortunately less exact, makes use of a scree plot, with on the vertical axis the eigenvalues and on the horizontal the component number. To find the number of components to keep, one draws a line through the points until the point where the line changes slope. In our case a line with the same slope can be drawn through the points of components 1 and 2 (see figure 1).

Table 2: Total Variance Explained for customers' and suppliers' PCA

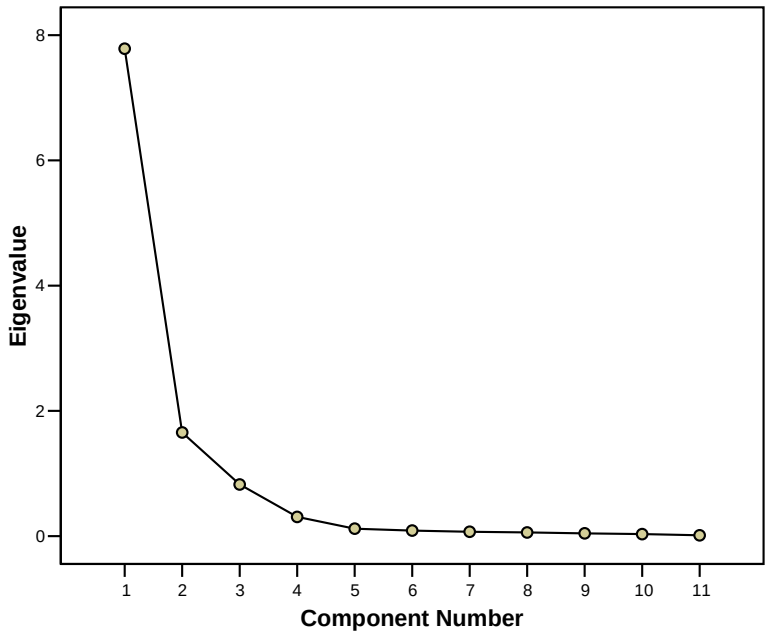
Component	Customers Initial Eigenvalues			Suppliers Initial Eigenvalues		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.44	67.66	67.66	7.78	70.76	70.76
2	1.06	9.65	77.31	1.66	15.05	85.80
3	.99	9.01	86.32	.82	7.50	93.31
4	.85	7.72	94.04	.31	2.80	96.10
5	.22	2.05	96.09	.12	1.09	97.19
6	.17	1.54	97.63	.09	.81	97.10
7	.11	1.03	98.66	.07	.63	98.63
8	.07	.60	99.26	.06	.54	99.167
9	.04	.40	99.66	.04	.41	99.58
10	.03	.23	99.89	.03	.30	99.88
11	.01	.11	100.00	.01	.12	100.00

Figure 1: Scree plots for customers' (a) and suppliers' (b) PCA

(a) Scree Plot: Customers



(b) Scree Plot: Suppliers



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