Erasmus University Rotterdam

MSc in Maritime Economics and Logistics

2011/2012

Assessment of the TEN-T policies on the hinterland flows and modal splits of European Seaports

by

Joey van Elswijk

Acknowledgements

Up front, this thesis project looked like a challenge. Now, I can only acknowledge that it was a challenge indeed. Still, I have enjoyed (almost) every single moment of it and I have to thank some special persons for making this thesis possible.

Many thanks to my supervisor Koen Berden for all his enthusiasm, dedication, help and recommendations regarding this thesis. It is way easier to write a thesis when the supervisor is just as enthusiastic as the student is!

Many thanks to Olga Ivanova for helping me out with the GAMS software every moment I asked for.

Many thanks to the people at ECORYS for their suggestions and willingness to help, as well as for the distraction the Brazil-project gave me.

Last but certainly not least, many thanks to my family; who supported me as always and to my friends; for not blaming me the Sorry-I-have-to-work-on-my-thesis-excuse too much.

All in all, this thesis finalises an incredibly valuable year of MEL. Thinking back, I am thankful for all the knowledge, experiences and friends I have gained in this exhausting but fruitful year. It was a year to never forget, but also one to end now.

Abstract

The infrastructural network of the European Union is of crucial importance for the functioning of its internal market, for the cohesion of the more peripheral countries and for the competitiveness for Europe as a whole. However, the expected increase of cargo volumes as well as the need for sustainability has created pressure on the existing network. The revised structure for the Trans-European Network for Transport aims therefore at increasing the capacity of the network and facilitating a shift towards usage of sustainable modes as rail and inland waterway transportation.

At the same time, a spread of cargo is envisaged as well by the EU as they included 83 ports into their proposed Core Network. It is however questioned whether this spread enables at the same time the desired effect of TEN-T on the use of sustainable modes. Therefore, this thesis tries to assess the effect of the implementation of a new TEN-T structure on the modal splits of European ports, as well as on their supported hinterland volumes.

The Global Simulation Model (GSIM) is used to make this assessment. The initial status of the European infrastructure is analysed and quantified into tariff equivalents. These are part of a total trade barrier tariff equivalent that is established as well. Infrastructural projects carried out under two time periods of TEN-T form two scenario's of infrastructure improvements which both contribute to lower trade tariff equivalents. The two scenarios are assessed on their impact on port hinterland volumes towards EU27 countries for various modes of transport, calculated trough GSIM.

Both scenarios showed little impact on modal splits and port volumes of European ports. However, changes between ports, clusters and importing countries were identified. The Priority Project scenario showed a polarization among European ports in hinterland volume changes. On the other hand, the Core Network showed a wider spread of increased volumes due to infrastructure improvements.

The Priority Projects have proven themselves to be influential on all three inland modes. In terms of shares on a European level, rail benefited 0.02% and IWW 0.01%. The focus of the Core Network projects was predominantly on rail improvements, leading to an estimated shift in modal shares of 0.02% for rail and no shift for the share of inland waterway usage. For the effectiveness in achieving a change in the usage of sustainable modes, it is expected that the Core Network Scenario contributes less to this objective than the previous TEN-T structure of Priority Projects.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

CEF	Connecting Europe Facility
DG MOVE	Directorate-General of Mobility and Transport
DG TREN	Directorate-General Transport and Energy
ECMT	European Conference of Transport Ministers
ERDF	European Regional Development Fund
ESPO	European Seaports Organisation
EU	European Union
EU27	27 Member States of the European Union since 2007
GSIM	Global Simulation Model
GVA	Gross Value Added
IWW	Inland Waterways
JRC	Joint Research Centre
Km	Kilometres
Km/h	Kilometres per hour
MoS	Motorways of the Sea
Pkm	Passenger-kilometres
PP	Priority Project
RA	Rail
RO	Road
ROW	Rest of the World
SEALS	Statistical coverage and economic analysis of the logistics sector in the EU
TEN-T EA	TEN-T Executive Agency
TEN-T	Trans-European Network for Transport
Tkm	Tonne-kilometres
UK	United Kingdom
UNECE	United Nations, Economic Commission

1. Introduction

Transport is seen as a vital element for the economy and society as a whole. Transportation connects regions, people and companies, facilitating the movement of people and goods. In this way, transport adds value and enables the creation of jobs.

In the European Union, transport and its facilities have accounted for €520 billion of gross value added (GVA), 4.6% of total GVA for the EU27 countries in 2008. (European Commission, 2011) Some other economic indicators of transport are indicated in Table 1.1. These figures support the importance of the transport sector in the EU.

Table 1.1. Economic indicators for transport in the EU

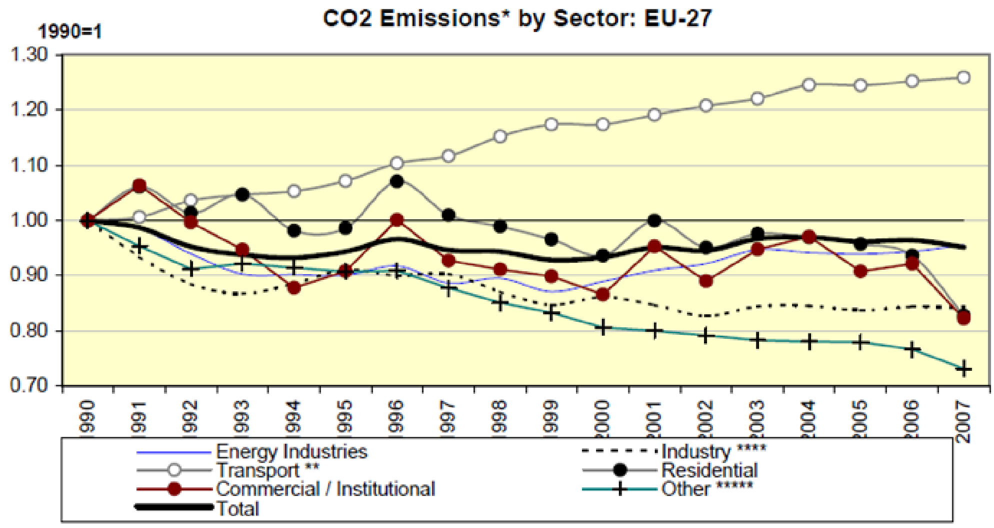
Indicator	*Absolute figure*	*% of total*
Gross Value Added	€520 billion	4.60%
Employment	9.1 million	4.50%
Household expenditure	€890 billion	13.20%
Transportation of goods	3632 billion tkm	
Transportation of passengers	6503 billion pkm	

Source: European Commission, 2011

The European Commission acknowledges the importance of transport by giving it a crucial role in its funding and policies. As the European Union has transformed the past years by the inclusion of more (Central-European) countries, the inequality between the member states in terms of welfare and economic development has increased. The development of infrastructure therefore is – in the view of the European Commission – an enabler of the cohesion and development of the European Union as a whole. Without sufficient infrastructure, the free movement of goods and people across the Union may suffer.

On the other hand, transport needs to become more sustainable to limit its effect on climate change. (European Commission, 2011) In the Kyoto-protocol, it is agreed by the international community that the European Union has to reduce emissions by 80-95% below 1990 levels in 2050. In this picture, the transport sector is responsible for around the 23% of total EU-emissions (DG TREN, 2010). The development of CO2 per sector in the EU is shown in Figure 1.1.

Figure 1.1. The development of CO2 emissions per sector in the EU



Source: (DG TREN, 2010)

The figure shows the importance of reducing the CO2 emission in the transport sector. Although measures have been taken and the industry is already adapting in an energy-efficient way, the growth of transport and trade over the last years has resulted in an increase in emissions in the transport sector. Therefore, it is estimated that the transport sector needs to reduce their emissions with 60% in 2050 to meet the Kyoto-standards for the EU.(European Commission, 2011)

To provide the necessary sustainable network that assures the required connections between the EU-countries themselves and the rest of the world by integrating with multiple modes of transport, the Trans European Network for Transport (TEN-T) has been established in 1996. To achieve realisation of this network, the European Commission funds infrastructural projects, helps removing bottlenecks, attracts sustainable modes of transport and upgrades the infrastructure. Thirty 'Priority Projects' show the focus of funding key projects which have major importance for the pan-European integration and development.

More recently, the TEN-T policy has been revised and a new approach has been developed. An identified Core Network consisting of ten multimodal corridors across Europe will have the focus for funding in the new funding period of 2014-2020. An amount of €31.7 billion is planned to be awarded for projects concerning the Core Network.[1]

A first part of the Core Network are the 83 seaports that are identified as relevant and important given their size of throughput or location. These ports have to be connected by the Core Network and infrastructure improvements should provide

[1] More information on the TEN-T policy is provided in chapter two.

these connections, assuring a spread of cargo flows over Europe. However, it is questioned whether this scattered approach of ‘focussing’ on 83 ports and their connections really can attribute to the necessary change towards sustainable modes of transport, as supported by the following quotes. Quoting the Port of Rotterdam Authority (2011) from their public statement:

“*In order to transport more cargo to and from the hinterland via short sea, rail and inland shipping as the Commission proposes, a concentration of volume streams is necessary. The European Commission’s idea to distribute maritime streams from outside the EU to many ports closer to the final destination is at odds with this and could lead to even more transport by road to the hinterland because the volume needed to make economically responsible intermodal transport possible would not be reached.”* (Port of Rotterdam, 2011)

Moreover, the European Seaports Organisation (ESPO) has also addressed the importance of concentration of cargo flows in their public statement concerning the new TEN-T approach in 2011. Quoting:

“There needs to be a good spread of core network ports around Europe but on the other hand, a degree of consolidation is necessary to collect positive economies of scale, also in terms of sustainability. The key challenge in the design of the core network is to find an appropriate balance between these two principles.” (ESPO, 2011)

These statements show the relevance of the question whether the proposed TEN-T policy truly influences a modal shift towards the use of the more sustainable modes of transport; rail and inland waterway transport. The spread or concentration of cargo flows across European ports is an essential underlying point as well. This is because, a wider spread of cargo flows across Europe might affect the necessary volume of throughput in ports to accommodate the use of barges and trains. These modes of transport need large volumes in order to benefit from the economies of scale that make them beneficial above trucks in economic and sustainable terms.

Therefore, this thesis assesses the impact of the proposed TEN-T policy on both the volumes and modal splits of the 83 European Core Ports. The results will show whether the TEN-T approach really contributes to a wider use of the sustainable modes of transport; by rail and inland waterway, and indicates a concentration or spread of cargo flows across Europe. The research question is therefore identified as:

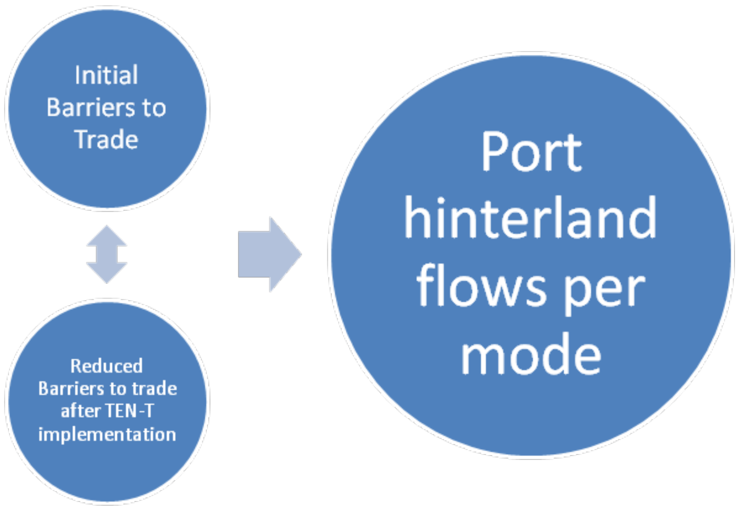
“*What is the impact of creating a Core Network as TEN-T policy on the volumes and modal splits of European Seaports?”*

The outcome of the assessment will prove a significant or non-significant shift of cargo flows over the sustainable modes of transport, as well as an overview of the change in freight transport patterns in Europe. In this way, the TEN-T policy is reflected along one of its targets; stimulating sustainable modes of transport and intermodality. It should be noted that the TEN-T does also aim to improve the transport capacity of Europe as well as the cohesion and development of Europe as a whole. These aims are not questioned by this thesis. The thesis focuses at the impact on the modes of transport used for transportation of goods, not on other economic or social factors which might be influenced by the TEN-T policy. An increase in transport capacity is also not questioned by the thesis, as this is likely to increase if infrastructure is constructed and bottlenecks removed.

The research question will be answered by using the Global Simulation Model (GSIM), developed by J.F. Francois and H.K Hall. GSIM is built to model global trade policy changes in partial equilibrium. The policy changes are translated in tariff equivalents and changes in the tariff equivalents result in a change in the trade flows across countries. In this thesis, the method is applied at a larger scale than initially built by the developers. Namely, the original model is applied at a country scale of 25x25 countries. However, the thesis assesses a total of 83 ports with the three modes of transport road rail and inland waterway transportation, which equals 249 points of origin (or supply). The points of destination (or demand) will amount to 28, equal to the 27 member states of the European Union, plus Rest of the World. Therefore, a GSIM model of 249x28 is applied in this thesis, requiring a high capacity Excel Solver and the scaling up of the available GSIM model.

Where the original model is based on the three layers: value of trade flows, initial import tariff equivalents and final import tariff equivalents, the TEN-T policy assessment will be applied as follows: port hinterland value of cargo flows per mode, initial barriers to trade and final barriers to trade after TEN-T project implementation. In these steps, the status of the infrastructure is part of the barrier to trade. Other barriers are as well identified, but it is the change in status of the infrastructure that will enable a change in the total trade barrier. The final process is visualised in Figure 1.2.

Figure 1.2. The GSIM process applied for TEN-T assessment



The three main layers of GSIM form therefore the three key steps to take in order to get to the results of the analysis. Together with other important tasks to perform in the thesis, this implies the following sub-questions to answer in the thesis:

1. *“What is TEN-T, its structure, its background and its future plans?”*
2. *“Which relevant academic literature and consultancy reports are available concerning the topics of sustainable modes of transport, concentration of cargo flows, stimulating infrastructure policy and TEN-T?”*
3. *“How can we quantitatively estimate the impact of TEN-T in terms of trade flow changes and ports modal splits?”*
4. *“What is the hinterland freight flow value per flow from the 83 European ports towards the EU-member states, per mode of transport?”*
5. *“What is the initial barrier to trade between the 83 European ports and the EU-member states, per mode of transport?”*
6. *“What is the barrier to trade between the 83 European ports and the EU-member states, per mode of transport, after considering the TEN-T projects to be finalized?”*

Following these steps, the results will take the form of the absolute and relative changes in freight flows per mode and per combination of a port and a member state. Further, an application of two scenarios for infrastructure improvements is used to apply in sub-question seven. The first scenario takes into consideration the already granted funds for the priority projects of the TEN-T financial framework of 2007-2013. The second scenario does also consider the proposed improvements of the new funding framework of the Core Network up to 2020. This will lead to two results of the model; one given the funded investments of 2007-2013 and one including proposed investments up to 2020. The framework period is therefore the cut between the two scenarios; 2007-2013 and 2014-2020. The change of the scope between the two scenario’s (Priority projects against more spread Core Network) makes this interesting to investigate.

Because of the scope and size of the research, the assessment of the freight flows and infrastructure status throughout Europe will be based on as many as existing studies and data as possible. Because of time-limitations, it was impossible to derive all data through own research.

Given the above mentioned steps, the thesis will hold the following structure.

First, we provide thebackground of TEN-T and its policy components in chapter two, focusing on its specific structure, funding and history Chapter 3 contains a concise literature review of TEN-T.. Both academic literature and commissioned reports relevant for this thesis are discussed. The fourth chapter provides the used Global Simulation (GSIM) methodology and it further contains the methods and data applied to establish the initial trade tariff equivalents. A separate fifth chapter presents the TEN-T projects carried out and ‘translates’ them into reductions in tariff equivalents. Chapter four and five follow a stepwise approach to illustrate the various building blocks of the GSIM analysis. The sixth chapter presents the results of the analysis in various ways and highlights the most important findings. Chapter seven concludes by structurally covering the research question and its sub-questions. This chapter also provides policy recommendations and research limitations.

As the vast excel matrices with data that underlie the research were too large to be included in the Appendix, these can be made available by the author upon request. After each section, the corresponding excel file is mentioned.

2. Background of the TEN-T Policy

In order to become familiar with the concepts and policies of TEN-T dealt with in this thesis, a necessary background of TEN-T and its current policies in place are provided in this chapter. This chapter therefore answers the sub-question: *“What is TEN-T, its structure, its background and its future plans?”*

2.1 The structure of TEN-T, up to 2012

For multiple reasons, the Trans European Network of Transport (TEN-T) has been developed by the European Community in the 1980’s. The Network had to provide the necessary infrastructure to ensure a good functioning of the Community’s internal market, enable social, economic and territorial cohesion and upgrading the internal and external accessibility of Europe. In 1992, the TEN-T was inserted in the Maastricht Treaty, making it part of the European Commission’s policy of the European Union. In that time, 14 major infrastructural projects were adopted. By 1996, the first official Guidelines for TEN-T policy were set up as well as a framework for infrastructure planning in the EU.

Since the revision of the Guidelines in 2004, the Priority Projects were identified and extended to 30 (of which a map and list is published in the Appendix, section 9.1 and 9.2). This was because of the extension of the EU and because of changes in the volumes and directions of transport flows. Infrastructural improvements along these projects had to ensure the future accessibility of the more peripheral countries, as well as a provision of sufficient capacity for transport across the EU. Further, the amended guidelines did also provide the funding of country specific projects of common interest, not directly linked to the Priority Projects.

The Directorate General of Mobility and Transport (DG MOVE) is the responsible department of the European Commission for policy making related to mobility and transport issues and thus for the TEN-T as well. However, the TEN-T Executive Agency (TEN-T EA) is responsible for the actual implementation of the TEN-T programme. They assist project managers and ensure the technical and financial management of these projects.

The Member States themselves have to submit detailed proposals regarding the Priority Projects. On this basis, grants will be allocated per project. The TEN-T EA advises and prepares the allocation, DG MOVE takes the final decisions.

There are multiple financial instruments which enables the European Commission to award funds for the Priority Projects. The TEN-T has its own financial programme, which is a predetermined budget. Moreover, the Cohesion Fund, Structural Fund, and European Regional Development Fund (ERDF) do also support funding for the

Priority Projects. However, the awarded funds are mostly only grants that are at maximum 20% of the total investment costs related the specific project. The other share of investment has to come from the Member States themselves or regional authorities. To illustrate the working of a priority project and its underlying specific projects, an example of provided in the following box.

Priority Project 5: The Betuwe Line

The Priority Project of the Betuwe Line involved the construction of a 160 km double track rail line from the port of Rotterdam towards the German border. The line was put into service in June 2007. The rail track is dedicated to freight transport and has increased the hinterland connectivity of the port of Rotterdam, especially into the direction of the important German industrial Ruhr-Area. Currently, around the 70 freight trains use the track on a daily basis.

Figure 2.3. The Betuwe Line. (Source: (ANP, 2010))

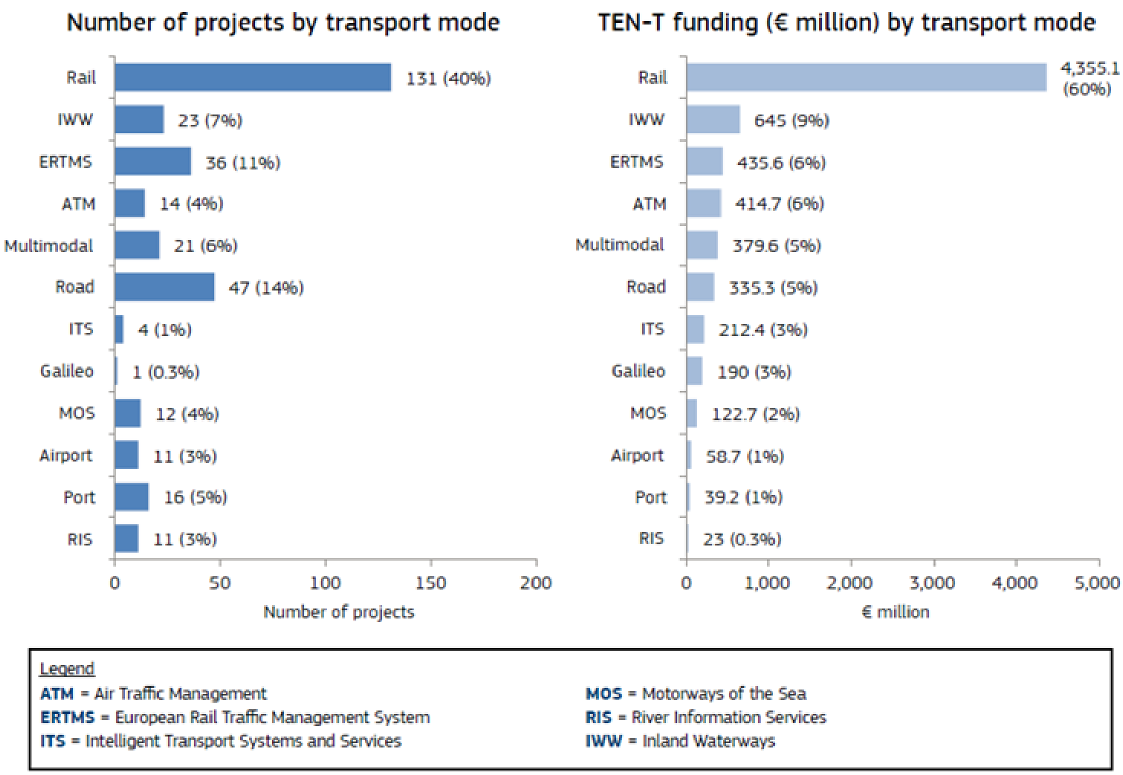
An example of a concrete project that falls within this Priority Project, the *2007-NL-05020-P* project is taken. This project will provide the necessary power supply of 15/25 kVAC on two parts (Kijfhoek and Zevenaar) of the Betuwe Line track. This electrification system serves as the standardized European system, leading to less changes of electrification along the route and thus implies time-savings. The total costs of the project amounted €99,400,000. The TEN-T funding contribution is 20%, implying a grant of €19,880,000. The other 80% is paid by the Dutch government.

Figure 2.4. The two sections of *2007-NL-05020-P* project. (Source:(TEN-T EA))

The TEN-T projects are carried out and financed under so called ‘Multi-annual Financial Frameworks’. This is the period for which a specific budget is pre-determined to co-finance the projects. Under the first financial framework of the TEN-T from 2000-2006, 254 transport projects were co-financed by the fund in place at that time; the Cohesion Fund. These projects were divided up to 99 road projects, 112 rail, 34 port-related, 6 regarding airports and 3 for urban transport issues.

The second Financial Framework covers the period of 2007-2013. Since this period, the TEN-T EA was set up to manage the projects. Under this framework, a total of €7.21 billion is granted to projects. A division of the number of projects and the funds per mode is shown in the following figure.

Figure 2.3. Number of projects and TEN-T funding per mode



Source: (TEN-T EA, 2012)

It is shown in this figure that the concentration of the TEN-T funding lays in rail transport improvements. 60% of the funds are determined for this mode of transport. The second largest mode of transport by funds is inland waterways, a mode that did not receive any attention during the 2000-2006 Framework but which is more and more seen as a valuable alternative for rail and road transport. This thesis will assess whether this focus on these modes really contributes to a shift of the actual usage of these modes and leads *de facto* to a more 'sustainable' transport infrastructure in the European Union.

2.2 The 2011 Guideline revision and future plans of TEN-T

A second revision of the TEN-T Guidelines was carried out in 2011. This revision was necessary to align the TEN-T Guidelines with the new policy objectives for transport and mobility in the EU as determined in the 'White Paper for Transport

2011'[2]. The European transport network had to be developed into a competitive, sustainable and resource-efficient network. The current infrastructure in place is considered as too fragmented between countries, too fragmented between modes with missing multi-modal infrastructure and with lacking compatibility among operational systems and regulations.

- The revision has led to a new structure regarding the TEN-T projects. This new structure will be the basis for the financing proposals for the new Financial Framework of 2014-2020. The structure around the Priority Projects has been abandoned, and the new structure entails the so called 'Core Network' and 'Comprehensive Network'. The Core Network should, when completed in 2030, function as the backbone of the European transport network. It takes the form of 10 identified multimodal corridors that cross Europe and connects: 83 main European ports with rail and road links, 37 key airports with rail connections into major cities, 15,000 km of railway line upgraded to high speed, and 35 cross border projects to reduce bottlenecks.

The corridors cover at least 3 modes of transport, 3 Member States and 2 cross-border sections. By using the corridor-approach, co-ordination between the Member States and relevant stakeholders should become easier. A governance structure called 'Corridor Platforms' should help this co-ordination being executed. An overview of the 10 corridors and a description of the planned work are included in the Appendix, section 9.3.

Besides the Core Network, a 'Comprehensive Network' should be ready in 2050. This secondary network of infrastructure should feed the traffic towards the Core Network. The aim is that by 2050, the greater majority of European businesses and citizens should be connected with the Comprehensive Network within 30 minutes. The funding of this second network is mostly the responsibility of the Member States themselves.

Finally, a new financing instrument has been put in place for the 2014-2020 period as well. The 'Connecting Europe Facility' (CEF) of €31.7 billion has to co-finance in the infrastructure projects and motivates other parties to invest as well. The aim is that the relative investment scale per project is set as 1/5/20 for CEF/Member State contribution/private sector investments respectively. 80% of the CEF budget will serve the Core Network, the remainder will fund other stand-alone projects and the Comprehensive Network.

[2] In full: White Paper 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.

2.3 TEN-T assessment of this thesis

This thesis assesses the impact of the scattered 2014-2020 TEN-T approach of connecting 83 ports with the Core Network on the multimodal volumes of ports. To do so, a comparison is made between this new approach and the previous Priority Projects approach. The two scenarios of TEN-T infrastructure investments that are part of sub-question three are thus set as:

1. 2007-2013 Framework investments regarding Priority Projects.
2. 2014-2020 CEF planned project investments along the Core Network.

Regarding the first scenario, all specific projects are known, including the amount of contributed TEN-T funds. This adds up to €5,7 billion divided over 153 sub-projects covering the Priority Projects.

The assessment of the second scenario involves an extra assumption to be made since there is not yet decided upon the exact grants per project. It is known that a budget of 80% of €31.7 billion will be allocated over the envisaged projects summed up in Appendix section 9.3, but not the exact amount per project.

The usage of the different trade tariff equivalents, initial and final over the two periods of time is illustrated in Figure 2.4.

Figure 2.4. The two GSIM scenarios and usage of initial and final tariff equivalents

Source: Compiled by Author

The first scenario considers an initial status of the infrastructure at the beginning of the financial framework 2007-2013 as part of the total trade barrier. The relevant projects of the Priority Projects will then influence this tariff equivalent.

The second scenario of infrastructure improvements starts with the status of the infrastructure after the 2007-2013 framework consideration. This tariff equivalent was used as final tariff equivalent in GSIM for the first scenario but is used as initial tariff equivalent in the second scenario, because the status of infrastructure has become initial for the new framework of 2014-2020. The final trade barrier of the second scenario incorporates the new time barriers established by considering the rough descriptions of the Core Network projects.

3. Compilation of most relevant sources

This chapter aims to provide the academic basis for the several topics this thesis relates to. It also provides an overview of consultancy reports with a similar scope of research as this thesis. Further, the reports were essential in providing data sources relevant for the analysis of this thesis. They have also proven to be useful data sources themselves. As such, this section answers the second sub-question:

"Which relevant academic literature and consultancy reports are available concerning the topics of sustainable modes of transport, concentration of cargo flows, stimulating infrastructure policy and TEN-T?"

3.*1 Academic basis*

Apart from the fact that the EU's transport policy is more and more focussing on multi-modality and intermodal transport[3], there is also some academic foundation for the usage of the more sustainable modes of transport, the role ports play and the importance of a stimulating policy in this respect.

To come up with advices to cope with the current trends[4] that will change the logistical world, PriceWaterhouseCoopers and the EBS Business School have identified seven essentials for the future logistic industry(PriceWaterhouseCoopers & EBS Business School, 2009). These follow from a worldwide consultation of hundreds of policy and strategy experts. The seven essentials are described as follows.

First, it is expected that alternative energy usage will increase, but a global energy turnaround will not be achieved by 2030. Experts from the International Energy Agency anticipate that the current energy mix can continue to meet the needs of energy up to 2030. Fossil fuels will be able to deliver 85% of these needs. In relation to this point, the second essential states that reducing transport emissions will be a greater challenge for transport companies than the supply of energy. This is partially due to the stronger regulations to focus on sustainable modes of transport.

The third essential says that costs related to the carbon footprint of logistics processes will be allocated to the user. The costs of mitigating climate change are partially paid by governments but the private sector is expected to contribute the

[3] Concepts should not to be used as substitutes. Multi modal is the high degree of availability of multiple transport modes, inter modal is the usage of multiple modes to transport the same load of cargo from origin to destination.
[4] Such as globalization, environmental awareness, alternative energy usage and technology changes.

most. The costs will inevitably be passed through on the user, thinking of emission trading schemes and toll systems.

In supply chain design, the minimization of energy consumption will become a crucial criterion next to total costs minimization. As both also influence each other positively (less energy usage-less costs), a sustainable supply chain will be desirable.

Due to the increasing possibilities in ICT, integration and digitisation will take transport infrastructure to the next level. Sharing information will become key for logistic service providers, transport companies, governments and consumers.
A closer collaboration between industry, academia, and governments in logistics clusters is expected to raise new potential in transport infrastructure development. Spill-over effects are expected to create an innovative environment for development.

The last essential mentions the difficulty of the transport sector to attract high qualified human capital. As products and services in the industry are becoming more and more knowledge-intensive, it demands new skills of employees. The sector has shown however in past years not to be a very popular one for higher educated people. This is a key challenge for the industry.

Keeping these essentials in mind, the usage of inland waterways and rail would perfect fit in the image of a sustainable, energy-efficient, innovative and cost-cutting transport industry. Especially, the energy consumption advantage of rail over road (1 to 5 ratio) and inland waterways over road (1 to 30), makes them beneficial (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011).

The advantages of combined transport over road transport are present in terms of costs, prices for shippers, showing interest in society as a company and offering a reliable transport chain dealing with only one bill of lading. However, stimulation through policy is still necessary. (Frémont & Franc, 2010)

In light of the stimulation of multi-modality by policy, it is shown in an inventory-theoretic framework that certain policy measures (road tax, eliminating time bottlenecks and reducing rail costs) do have a significant effect on the shift from road to other modes and intermodal transport. (Blauwens, Vandaele, Van de Voorde, Vernimmen, & Witlox, 2006)

The crucial point for intermodal transport to take over the road haulage lies in the volume. The generalised costs of intermodal transport can only be lower than the costs for road transport if there is the ability to carry large volumes over long distances. When the infrastructure and organization of it are present, this can be done. (Van Klink & Van den Berg, 1998) Efficient multimodal terminals as transhipment points are key infrastructure that is necessary. There needs to be as less time lost as possible by transhipment in order to compete with road transport. (Priemus, 1999)

The hinterland infrastructure of ports should also facilitate multi-modal and intermodal transport. As an example, a study by Parola and Sciomachen apply the improved rail hinterland connection of an Italian port on a simulation model. The improvement reduced the congestion in the port and roads across the port. It is an example of how improved hinterland connections can contribute to modal shifts. (Parola & Sciomachen, 2009)

3.2 Consultancy reports and studies

Apart from academic literature, many consultancy reports and extensive studies are written, of which some are commissioned by the European Commission, that are highly relevant for this thesis. The most relevant ones were the TENCONNECT study, the study called ‘Ports and their connections within the TEN-T’ and the SEALS study. All three studies are summarised on their main findings as well as on their contributions to this thesis.

TENCONNECT (Petersen M.S., 2009) served as input for the TEN-T review of 2011. It carried out a traffic flow forecast up to 2020 and 2030 and identified crucial bottlenecks in place for European transport. Their traffic flow analysis for EU27 indicated an overall 43% increase in truck tonne km, an 78% increase in railway tonne km and an 39% increase for IWW tonne km compared to the initial situation in 2005. The total tonne km increase is estimated at 49%. They have included estimations on the internalisation of external costs, changing oil prices and a prediction on technological development.

Apart from their traffic flows analysis, a study has been carried out as well regarding the bottlenecks in place for road, rail and IWW transport in Europe. Full maps and tables are provided with this analysis. These have helped the identification of bottlenecks in this thesis considerably. The study highlighted the types of bottlenecks for the three modes as well as their locations in Europe.

This thesis builds further on the identification of the bottlenecks. Moreover, the indication of traffic flow increases for the three modes in tonne km due to macro-economic trends and policy proposals also reflects the need for a change in the modal splits of ports, as analysed in this thesis.

The study ‘Ports and their connections within the TEN-T’ (S. Newton, 2010) also carried out a traffic flow analysis. Their estimated increase of total hinterland transport volumes is 94% in 2030, almost twice as much as the TENCONNECT study, but this estimate only considers port related flows. As such, the volume growth for ports that is expected to develop over the coming years is indicated as the most prominent development identified by the study. Especially the volume of containerized cargo will grow. It is expected to double in the coming twenty years. Another conclusion made by this study is the statement that the distribution of port traffic along the European coastline will not change a lot. The main established patterns of port choice remains. Further, policy initiatives to redistribute cargo can be effective at national level, but not so much considering the European level.

In light of this thesis, the scope of research is similar considering the hinterland flows of ports and TEN-T. However, where the study carried out a port traffic flow analysis without TEN-T project consideration, this thesis essentially makes an impact analysis of TEN-T projects on port volumes. This is a crucial difference. However, there were some useful data sources of this study that served as input for the used GSIM model in the thesis. For example, the ETISplus database was used for the estimation of the transport flow analysis on a national level for the three modes of transport.

The SEALS project (Meyer-Ruhle, et al., 2008) had a different research dimension than the two earlier described studies. It did not carry out a traffic flow analysis but it had to deliver a better understanding into the logistical sector by providing characteristics, developments and needs of the sector. Extensive macro and micro-economic analyses were carried out in preparation for the European Commission, DG TREN.

In that respect, it is also of less similarity to the research of this thesis. However, the micro-economic analysis from a shippers perspective provided useful data and characteristics of road, rail and inland waterway transport, including cost comparisons per mode for different routes. This information contributed to the establishment of the freight cost tariff equivalent and the estimation of the trip durations in time for the three modes of transport between the ports and their hinterlands.

4. Methodology and Data; GSIM, Transport flows and initial trade barrier estimation.

This chapter provides a description of the methodology used for the assessment of the TEN-T policy on European ports volumes and their modal splits. It starts with a description of the modelling approaches available for this thesis. The choice of the model is explained as well. Further, it provides the mathematical description of GSIM, the explanation of the TEN-T application in GSIM, as well as the methodology and explanations behind the trade flow analysis and the initial trade barriers.

4.1 Available methods to model transport flows and mode choices

In order to get to the desired analysis of TEN-T influence on transport flows across Europe and its impact on modal splits of ports, a method has to be found which is able to do so. Therefore, the following sub-question is stated in this thesis:

"How can we quantitatively estimate the impact of TEN-T in terms of trade flow changes and ports modal splits?"

The model has to be able to present results on transport flows for road, rail and inland waterway transport and it has to be able to incorporate the status of European infrastructure as one of the influencing factors.

The model widely used for modelling transport mode choices is the logit mode choice model. This model is used to determine the choice of transport mode or choice of port considered by for instance shippers or logistic service providers. The model assumes a utility maximization by the shippers, taking into account several variables as costs, transit times, service regularity, reliability of the service, and possibly more. State of the hinterland infrastructure can also act as a criterion.

Applications of this type of modelling are the World Container Model of TNO/University of Leuven and the Western-European Container model by ECORYS (Veldman & Buckmann, 2003). The first application describes yearly container flows over the world's major shipping routes, taking into account more than 400 ports. The model has served as an input to assess future port related container flows on TEN-T networks, described by the NEA report in section 3.2 (S. Newton, 2010). The second application by ECORYS can estimate the market shares for Western-European hub-ports. (Veldman & Buckmann, 2003)

However, the already present application on TEN-T of this type of model and the necessary input of data that is considered as a vast amount, made the decision to make use of an alternative model that has not yet been used in TEN-T context; the

GSIM model. GSIM can be carried out relatively easy on the European scope of this thesis. The already established World Container Model and ECORYS model were designed for a different scope. If the logit model has to be carried out, a complete new model had to be defined on the scope of this thesis. Moreover, the GSIM model does not need that many different sorts of input but still produces a transparent insight in transport flows which makes it an excellent model for a thesis project. The answer of the sub-question is therefore already given, the GSIM model is able to carry out such an analysis. However, the exact mathematical structure of GSIM is provided in the next section.

This chapter continues with the general description of the GSIM-model, which is the core method for this thesis. Because the GSIM model takes another form and size in this thesis, an explanation of the 'TEN-T' model is provided as well. Then, each step necessary to construct the model is discussed to show the choices and assumptions that forms the basis of the trade barrier construction. Because these methodological steps are also involved with some data gathering, the description of data and its sources are included in this chapter as well. The full databases comprising the model can be made available upon request.

4.2 Global Simulation Model (GSIM) Methodology

The Global Simulation Model (GSIM) (Francois & Hall, 2003), was developed as a model to analyse the impact of global, regional or unilateral trade policy on trade flows. Their approach of a partial equilibrium at industry level with a global scope makes it possible to derive changes in trade flows based on changes in import tariff equivalents.

The GSIM model is built on three sources of input, represented by matrices. The size of the matrices depends on the number of origin and destination regions which may be countries of supply and countries of demand. The first matrix illustrates the initial trade flows between the countries. The second represents the initial import tariff equivalent that is present between the country of supply and the country of demand. The third matrix is the final import tariff equivalent which might contain higher or lower equivalents than in the initial situation. The output contains the estimated trade flows between the set of countries, due to the change in tariff equivalents.

The mathematical structure remains the same in the approach that is taken in this thesis. The dimensions are the only difference in that respect. Regarding the interpretation of the model, countries of supply are replaced by the European ports and their hinterland transport modes, resulting in 249 points of supply; 83 ports with 3 modes each. Countries of import are represented by the 27 EU Member States, plus a Rest of World column. Further, trade flows are by interpretation replaced by transport flows per road, rail and inland waterway. The initial and final import tariff equivalents used in the model are the total barriers to trade between the ports and their hinterlands, per the mode of transport.

The mathematical notation of the model is provided in table 4.1.

Table 4.1. Notation of the GSIM model applied to TEN-T assessment

Indexes	
$\boldsymbol{r,s}$	*Ports of supply*
$\boldsymbol{v,w}$	*Demanding EU27 Member States*
$\boldsymbol{i}$	*Designation of industry/type of goods*
Parameters	
$\boldsymbol{Es}$	*Elasticity of substitution*
$\boldsymbol{Em(i,v)}$	*Aggregate import demand elasticity*
$\boldsymbol{Ex(i,r)}$	*Elasticity of export supply*
Calibrated coefficients	
$\boldsymbol{N(i,v)(r,r)}$	*Own price demand elasticity*
$\boldsymbol{N(i,v)(r,s)}$	*Cross-price elasticity*
$\boldsymbol{T(i,v),r}$	*The power of the trade barrier, T=(1+t)*
$\boldsymbol{\theta(i,v),r}$	*Demand expenditure share*
$\boldsymbol{\varphi(i,v),r}$	*Export quantity share*
Variables	
$\boldsymbol{M}$	*Imports (quantity) by demanding countries*
$\boldsymbol{X}$	*Flow of goods from ports to European hinterland (quantity)*
$\boldsymbol{P}$	*Composite domestic price*
$\boldsymbol{P^*(i,r)}$	*World price for goods leaving port r destined Europe*
$\boldsymbol{P(I,r),v}$	*Internal prices for goods from port r destined for country v*
$\boldsymbol{t(i,r),v}$	*Barrier to trade (tariff equivalent) for goods from port r destined for country v.*

Source: compiled by author

The indexes and parameters are input from the user of the model. The industry designation is of less relevance in this case, the model is applied to all sorts of goods that flow from European ports to the European hinterland. The parameters are also exogenous. However, port and mode specific elasticities will be assessed as well and incorporated in the tariff equivalents because of the asymmetric (249x28) application. Those specific elasticities will serve as input for the aggregate demand elasticity. This derivation of elasticities is accounted for later on in this chapter.

As shown in the table, some coefficients are calibrated in the model. These are the demand expenditure share, calibrated according to formula (1):

(1) $$\boldsymbol{\theta}(i,v),r = {\boldsymbol{M}(i,v),r\,\boldsymbol{T}(i,v),r}\Big/{\sum_s \boldsymbol{M}(i,v),s\,\boldsymbol{T}(i,v),s}$$

and the export quantity share from the ports in formula (2):

(2) $$\boldsymbol{\varphi}(i,v),r = {\boldsymbol{M}(i,v),r}\Big/{\sum_w \boldsymbol{M}(i,w),r}$$

Then, the cross price elasticity can be calibrated (3), followed by the own-price demand elasticity (4), per combination of port and hinterland destination:

(3) $$\boldsymbol{N(i,v)(r,s)} = \boldsymbol{\theta(i,v)},s\ (\boldsymbol{Em}+\boldsymbol{Es})$$

(4) $$N(\boldsymbol{i},\boldsymbol{v})(\boldsymbol{r},\boldsymbol{r}) = \boldsymbol{\theta}(i,v),r\,\boldsymbol{Em} - \sum_{\boldsymbol{sr}} \boldsymbol{\theta(i,v)},s\,\boldsymbol{Es} = \boldsymbol{\theta}(i,v),r\,\boldsymbol{Em} - (1-\boldsymbol{\theta}(i,v),r)\boldsymbol{Es}$$

To achieve market-clearing, the change in demand $\widehat{\boldsymbol{M}}i,r$ should equal the change in supply $\widehat{\boldsymbol{X}}i,r$ of the goods, by changing the world prices $\boldsymbol{P}^*(\boldsymbol{i},\boldsymbol{r})$.

The market clearing condition $\widehat{\boldsymbol{X}}i,r = \widehat{\boldsymbol{M}}i,r$ is then set as:

(5) $$E_{X(i,r)}\hat{P}_{i,r}{}^* = \sum_v N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_v\sum_{s\,r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$
$$= \sum_v N_{(i,v),(r,r)}[P_r{}^* + \hat{T}_{(i,v),r}] + \sum_v\sum_{s\,r} N_{(i,v),(r,s)}[\hat{P}_s{}^* + \hat{T}_{(i,v),s}]$$

4.3 The GSIM TEN-T application explained

As described earlier, the two assessments of TEN-T frameworks 2007-2013 and 2014-2020 consider the impact of these frameworks on the freight flows between European seaports and the EU-countries. As main European ports, the 83 ports which were included as Core Ports in the Core Network proposal for 2014-2020 are considered in this assessment. The full list of these ports is included in the Appendix, section 9.4

Further, the three main modes of hinterland transportation in Europe are incorporated as well to assess the impact of changes in freight flows per mode. The three modes considered are: Road, Rail and Inland Waterway transportation (IWW). Combining the 83 ports and these three modes, the total number of origin points is 83*3=249.

The points of destination are the 27 European Union Member States. Because the TEN-T is an EU project, the assessment is therefore also on EU-level, incorporating these countries. Further, one point of destination is called 'Rest of World'(ROW), to capture all land freight flows from European ports towards non-EU27 countries such as Norway, Switzerland or Russia. There is no ROW as origin point because it is assumed that also these flows towards Europe are handled by the 83 ports.

The GSIM modelling involves three layers of data. The first is an origin-destination table comprising the initial value of freight flows from the 83 ports towards the EU27 countries. Because a distinction between modes is made to assess the impact on the modal splits per port, the freight flows will be divided over the three modes of hinterland transport. The fourth sub- research question involves this first layer; *"What is the hinterland freight flow value per flow from the 83 European ports towards the EU-member states, per mode of transport?"*

The second layer consists of the matrix that contains the barriers to trade, in terms of an ad-valorem tariff equivalent between the 83 ports and the hinterland of EU27 countries. This total trade barrier consists of multiple components, such as; freight costs, time-costs, policy barriers, a language barrier and more. Again, this barrier analysis is also made per mode of transport. The fifth sub-question is answered to get to this layer; *"What is the initial barrier to trade between the 83 European ports and the EU-member states, per mode of transport?"*

The third layer has the same structure as the second, but the changes in infrastructure status because of TEN-T works are incorporated. These improvements in infrastructure decrease a part of the total barrier to move goods from ports towards the hinterland. It is this change in trade barriers that results in a change of transport flows and modal splits per port. The construction of the third layer involves answering the sixth sub-question, in chapter five; *"What is the barrier to trade between the 83 European ports and the EU-member states, per mode of transport, after considering the TEN-T projects to be finalized?"*

To give an indication of the Core ports and their location, the following maps are presented. The red dots resemble the capital cities of the EU Member States.

Figure 4.1. Ports around the North Sea

Figure 4.2.Ports around the Baltic Sea

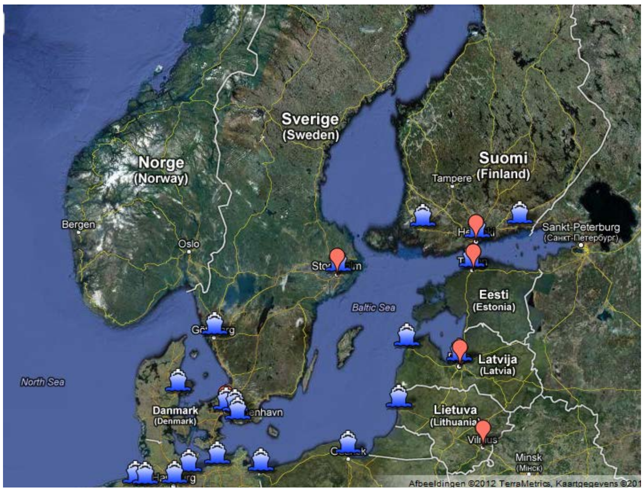


Figure 4.3. Ports around the Iberian Peninsula

Figure 4.4. Ports near Italy

Source: (Google Maps, 2012)

Figure 4.5. Ports around Greece and Black Sea

The only ports missing on the maps are the distant ports Valetta, Las Palmas and Lulea. So, for all combinations of these mapped ports and the EU Member States, the value of freight flows and trade barriers have to be derived, divided over three modes of transport. The methods supporting this analysis are described stepwise in the next sections.

4.4 Value of hinterland flows per mode and ports to the EU27 Member States

The first essential step for GSIM modelling in this case involves answering the sub question:

"What is the hinterland freight flow value per flow from the 83 European ports towards the EU-member states, per mode of transport?"

This is a challenging task. Only the bigger and more modern ports in the EU have publically available information on the origins and destinations of the cargo flows they handle. Moreover, this information is not divided per mode of transport and is unitized in tonnes, not in Euros.

However, combining several sets of data available through Eurostat[5] made it possible to estimate the transport flows per mode of transport, from ports to EU27 countries. The main sets of annual data used are listed in Table 4.2.

Table 4.2. Overview of Data sets used to determine port related freight flows across the EU

Type of data	Year	Source	Appendix/Excel file
Outgoing freight per port in tonnes	2010	mar_go_aa (Eurostat, 2012)	Table A3
Modal Splits per country	2010	tran_hv_frmod (Eurostat, 2012)	Table A2
Modal Splits per port	2010	(Bureau Voorlichting Binnenvaart) (Port of Rotterdam, 2010) (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011)	Table A1
International annual road transport	2010	road_go_ia_tc (Eurostat, 2012)	O_D_Value.xlsx
National annual road transport	2010	road_go_na_tgtt (Eurostat, 2012)	O_D_Value.xlsx
International annual rail transport	2010	rail_go_intgong, rail_go_intcmgn, (Eurostat, 2012)	O_D_Value.xlsx
National rail freight per country	2010	(ETISPLUS, 2010)	O_D_Value.xlsx
International IWW transport by goods	2010	iww_go_atygofl (Eurostat, 2012)	O_D_Value.xlsx

Source: Compiled by Author

The table indicates that all data is from the year 2010, as this was in most cases the most recent data available. It is possible to review the used data in the Appendix and trough the Excel file mentioned.

Given the tonnes of outgoing freight per port, the assumption is made that the largest part of this outgoing freight has its destination in Europe. Therefore, the freight flow reported is larger than actually should, the shipment of goods outside Europe should actually have been removed from this number. A lack of data made this impossible to execute.

[5] The provider of European Union's statistics.

This flow of freight is then assumed to be transported into Europe along the three modes of transport road, rail and inland waterway. Short sea shipping is ignored in this respect because no data was available on the exact amount of short sea shipping per port. The considered freight flows per land mode contains therefore also a small part of actual short sea traffic. However, the aim of the assessment is not to produce the exact size of the freight flows, which is overestimated due to the data used. The main aim is to have an indicative relative figure on the change of the freight flows, per mode, due to TEN-T.

By multiplying the modal splits per port[6] by the tonnes of outgoing freight per port, an estimation of the freight transported per mode per port is achieved. A large part of the European ports does not produce statistics on their modal splits, therefore the modal splits of that country were used instead. The modal split figures are provided in the Tables A1 and A2 of section 9.5 of the Appendix. The outgoing freight statistics are available under Table A3, Appendix.

As an example, the hinterland freight for the port of Antwerp is derived as in Table 4.3:

Table 4.3. Example of estimating hinterland freight for port of Antwerp

Core Port	Outgoing freight per port	Modal split%	Hinterland freight per mode
	thousand tonnes	*%*	*thousand tonnes*
Antwerp RO	76.151	57%	43.406,07
Antwerp RA	76.151	11%	8.376,61
Antwerp IWW	76.151	32%	24.368,32

Source: Compiled by author

Then the flow of freight per port per mode needs to be divided per destination, consisting of EU27 countries. The international transport figures which are available by Eurostat per mode (Table 4.2) made it possible to derive the percentage of total freight loaded in country A and unloaded in country B with the following formula:

(6) $$\% \; of \; goods \; transported \; from \; A \; with \; destination \; B = {Tons \; Transported \; from \; A \; to \; B}\Big/{Total \; Tons \; transported \; from \; A \; to \; EU27}$$

This percentage is then used to divide the outgoing hinterland freight per port and mode over the EU27 countries. It is thus assumed that the international transport figures between country A and B do also hold for the international transport figures of the ports inside country A.

A small example of the derivation of hinterland transport per port towards hinterland countries is given for road, rail and IWW transport from Antwerp to France.

[6] Available for Antwerp, Oostende, Bremerhaven, Lubeck, Hamburg, Barcelona, Calais, Le Havre, Marseille, Amsterdam, Rotterdam, Constanta.

Table 4.4. Percentage of transport from Belgium to France, per mode

Mode	Type of variable	Total freight per mode to France, tonne and %	Total from Belgium to EU 27, tonne and %
Road	tonnes*1000	31.177	324.361
	%	**9,61%**	100%
Rail	Reported by A, tonnes*1000	3.052	
	Reported by B, tonnes*1000[7]	1.707	
	Average	2.38	34.518
	%	**6,89%**	100%
IWW	tonnes*1000	15.126	161.525
	%	**9,35%**	100%

Source: Compiled by Author

Table 4.5. Distribution of freight from Antwerp to France

Port of origin	*Mode*	Hinterland freight Thousand Tonnes (Table 4.3)	% destination France (Table 4.4)	Freight per mode Thousand tonnes (column 1*column 2)
Antwerp	Road	43.406,07	9,61%	4180,8
	Rail	8.376,61	6,89%	595,0
	IWW	24.368,32	9,35%	2278,8

Source: Compiled by Author

In Table 4.4, the percentage of transport from Belgium to France, per mode is estimated according to formula (6). This percentage is indicated in red. Then, the percentage is applied to the estimated hinterland flow throughout Antwerp per mode (Table 4.3). The result is the annual amount of freight in tonnes departing from Antwerp and arriving in France, as indicated in Table 4.5. This procedure is repeated for all ports and EU27 combinations.

Having all transport flows per port, EU27 country and mode in tonnage, the valuation of these flows is still necessary. Ideally, the average value per tonne for every combination of port and hinterland country had to be derived. However, since no such data is available, aggregate values for the entire EU are taken and applied on the tonnages. The calculation of the value of thousand tonnes traded inside the EU is shown in Table 4.6.

[7] Because a distinction in this dataset was made between loading reporting country and unloading reporting country, the sum of these two reports were divided by 2 to avoid double counting of the same freight.

Table 4.6. Value of trade tonnages

	Intra EU Imports	Intra EU Exports
Time frame	Jan.-Dec. 2010	Jan.-Dec. 2010
Value €	2.468.833.887.689	2.540.738.786.212
Thousand Tonnes	1.625.886	1.618.520
Value per Thousand Tonnes €	1.518.454	1.569.791
Average of imports and exports €	1.544.123	

Source: (Eurostat, 2012), EU27 Trade since 1988 by CN8 [DS-016890]

The average value of imports and exports of €1.554.123 per thousand tonnes is applied on all transport flows between the European ports and the hinterland of EU 27 countries.

Besides the EU27 destinations, the ROW column is also derived as point of destination for transport flows from the 83 ports. There is thus also a percentage of the goods that flows out of the ports trough road, rail and IWW that has a different destination than a EU27 country. This percentage is derived by subtracting the total EU27 flows from the total flows from port-countries to the whole world. There is a special data selection of total world transport flows per mode in Eurostat available for this analysis. The procedure is applied on all road and rail flows. However, the ROW countries such as Norway, Russia, Switzerland, Ukraine and others are not possible to reach by inland navigation. Therefore, the flows to ROW only involve the modes rail and road.

From the full data file, it is shown that especially the Baltic States and Eastern European countries involve in quite some transport to ROW, especially to Russia, Ukraine and Turkey in case of Greece.

This explanation of methodology and data therefore answers the question:

"What is the hinterland freight flow value per flow from the 83 European ports towards the EU-member states, per mode of transport?"

The full answer is only provided by the entire spread sheet called O_D_Value.xlsx, available upon request. This spreadsheet does also contain the intermediate steps done.

4.5 Trade barriers between the Core ports and EU-Member States

Instead of using an import tariff equivalent as in the regular GSIM application, in this thesis a total trade barrier is established with the status of the hinterland infrastructure of ports as part of this barrier. First the initial barrier is set, as defined in the sub question:

“What is the initial barrier to trade between the 83 European ports and the EU-member states, per mode of transport?”

The term initial refers to the current stage of the barrier, especially to the current situation of the infrastructure. As the considered TEN-T works started in 2007 (for the 2007-2013 framework), the barrier is mostly based on data just around this period. However, we are depending on the data available.

The barrier to trade can be broadly defined as all costs incurred of getting a specific good to the final consumer apart from the marginal costs of producing the good itself. According to a paper by Anderson and Van Wincoop, in which they take together several studies done towards various parts of trade costs, the costs of trade are build up with the following components (Anderson & Van Wincoop, 2004).

Transportation costs, divided in; freight costs and time costs. Border related barriers, comprising; policy barriers, language differences, currency differences, information costs and transaction costs. Retail and wholesale distribution costs.

Regarding freight costs, these are the freight charges and insurance costs of getting the goods transported. Time costs are associated with the time value of the goods in transit. The longer the transportation takes, the longer the goods are carried in inventory.

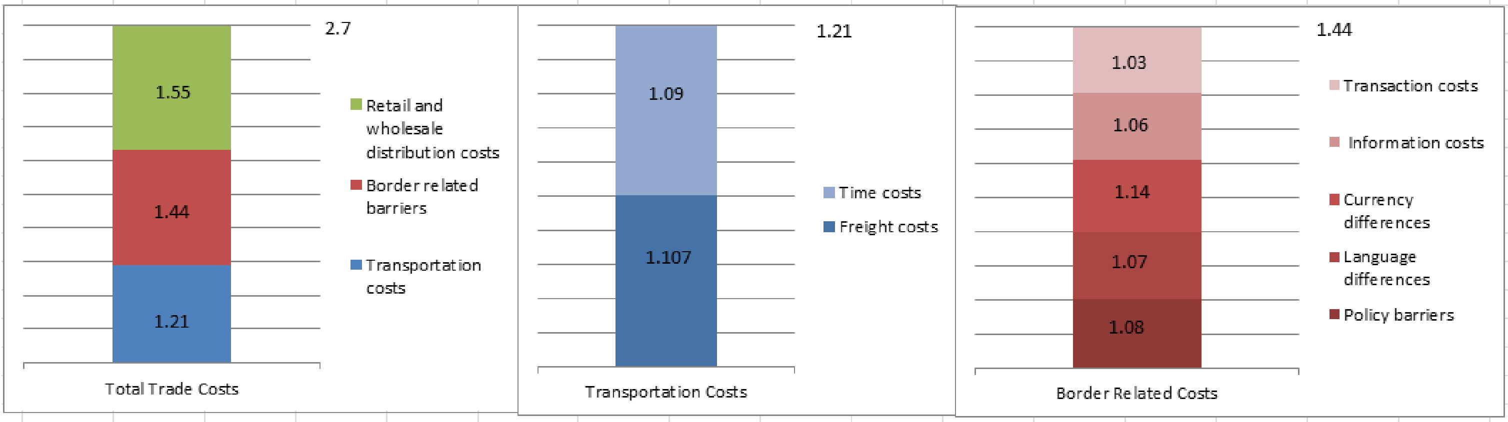
Multiple costs are related to border costs. Tariffs and non-tariff barriers (quantity and quality control measures and antidumping regulations) consists between countries and more evidently, differences in language and currency makes it harder to trade. Further, costs are present due to a lack of available information about possible trading partners; information costs. Also, the presence of uncertainty between trading partners and the resulting costs to sign contracts (transaction costs) are identified.

Finally, retail and wholesale distribution costs are present when selling the product on a local market level.

Reported in terms of an ad-valorem tax[8], the above described components have the sizes as illustrated in figure 4.6, building up to an average ad valorem tax of 170% for industrialized countries.

[8] Tax on the value of the good

Figure 4.6. Overview of tariff equivalents per type of trade costs



Source: Compiled by Author, based on Anderson & Van Wincoop, 2004.

Based on gravity estimations, the total tax of 170% consists of a 21% transport barrier, a 44% border barrier and a 55% retail and wholesale barrier.[9] The transport barrier of 21% can be further broken down to a freight costs barrier of 10.7% and an estimated 9% time costs barrier. For the border related costs, these a divided into 3% transaction costs, 6% information costs, 14% currency costs, 7% language costs and an 8% policy barrier equivalent.

This division of barriers is used in the analysis as the average tariff equivalent structure for a 'trade' between the Core ports and the EU hinterland. To achieve a credible division of total trade costs per port and country combination, the transport barrier is set for every combination of port, mode and hinterland country. The retail and border related costs are set constant (1.55 and 1.44) for each combination since this is not related to the scope of infrastructure analysis.

The freight costs tariff equivalent is set for each combination based on the distance between the ports and countries, and on the relative attractiveness of the modes per distance class. The time costs barrier is set based on the distance, speed of the modes and the status of the infrastructure of each mode. The latter serves as the main and crucial part of the analysis because the TEN-T policy scenario' s influences this time-costs part of the total barrier.

4.5.1 The freight costs tariff equivalent

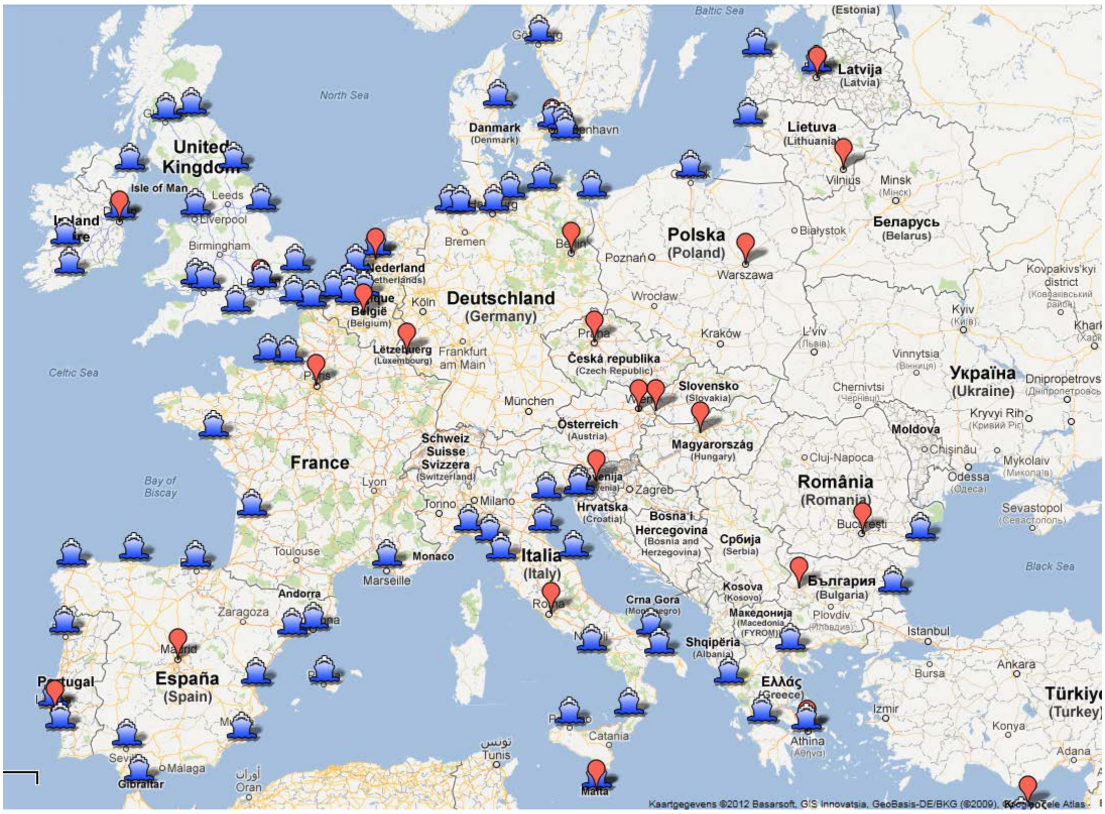
The freight cost tariff equivalent of transporting goods from the 83 Core ports towards the European hinterland is assumed to be based on the distance to be covered. The basic interpretation is the longer the distance, the higher the equivalent. Of course, in reality this does not always have to make sense. Due to

[9] 1.21*1.44*1.55=2.7=170%

possibly the type of cargo, return haul freight and the type of route, shorter distances can be more expensive to cover by transport than the longer routes. These exceptions are too complex to incorporate in this assessment. Therefore, we assume that on average, the longer distances face higher transport costs.

Not yet taking the mode into consideration, the first step to get to a freight costs tariff equivalent is to make a distance table that covers the distance between the 83 ports and the 27 hinterland countries. It is assumed that the capital city of the countries attracts the main volume of freight and therefore the distance between ports and the capital cities are taken. For smaller EU Member States this assumption is small, but the larger the EU Member State the larger this assumption turns out to be (e.g. for Luxemburg indeed all is close to Luxemburg city, but for Germany, Munich, Frankfurt, Ruhrgebiet are also important destinations next to Berlin). The total distance table constructed contains 2241 distances (83*27). The following map gives an indication of the distances that had to be derived.

Figure 4.7. Overview of the ports (blue) and capital cities (red) of which the distances in between are retrieved



Source: (Google Maps, 2012)

Concerning the distances, there is no distinction made between modes. It is assumed that the road, rail and IWW transport all have to cover the same distances. Regarding the ports that are also capital cities, an average distance into the country is taken instead.

As an example, the part of the spreadsheet resembling the distances between the port of Antwerp and the capitals Brussels, Sofia, Prague and Copenhagen are showed in Table 4.7.

Table 4.7. Distances in km between Antwerp and four capitals

		Destinations, EU27			
Origins		Brussels	Sofia	Prague	Copenhagen
Country	**TEN-T Core Ports**	Belgium	Bulgaria	Czech Republic	Denmark
Belgium	**Antwerp RO**	41,0	1715,0	712,0	738,0
	Antwerp RA	41,0	1715,0	712,0	738,0
	Antwerp IWW	41,0	1715,0	712,0	738,0

Source: Compiled by Author

After having derived the distances, the average tariff equivalent of 10.7% regarding freight costs is applied to all distances according to the following formula:

(7) $Freight\ costs\ tariff\ equivalent = \left({}^{Distance}/_{1330.49}\right) \times 0.107 + 1$

The 1330,49 is the average distance derived from all combinations of ports and capitals. This distance is therefore set at the average 1,107 equivalent. Regarding the example, this meant the following.

Table 4.8. Freight costs tariff equivalent for Antwerp and four destinations.

		Destinations,EU27			
Origins		Brussels	Sofia	Prague	Copenhagen
Country	**TEN-T Core Ports**	Belgium	Bulgaria	Czech Republic	Denmark
Belgium	**Antwerp RO**	1,003	1,138	1,057	1,059
	Antwerp RA	1,003	1,138	1,057	1,059
	Antwerp IWW	1,003	1,138	1,057	1,000

Source: Compiled by Author

It is shown in the table that in this way, the more distant locations in the hinterland get a higher tariff equivalent. The freight costs of transporting an average type of good with an average tonnage from the port of Antwerp towards Sofia would costs with this method 13.8% of the value of the transported goods.

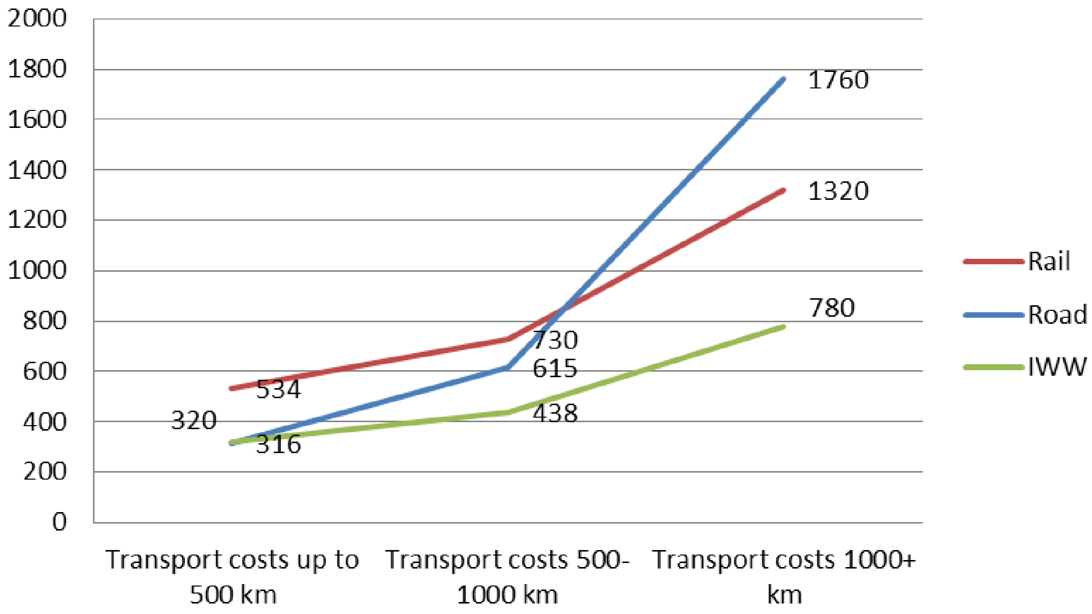
Because there is no possibility to transport by pure barge from Antwerp to Copenhagen (this would mean Short sea shipping), the barrier is set as 1. This is done for all impossible routes and is shown in the full spread sheet.

The ROW-destination also needs to have a distance tariff equivalent. However, there are multiple countries forming the ROW-destination. An average distance from country-ports to the main non-EU countries is therefore taken. The most relevant non-EU countries and the related distances are summed up in the Appendix, Table A4. Formula 7 is also applied here to derive the freight cost tariff equivalent.

The last step is to set the relative difference in freight costs between the modes of road, rail and IWW. Because the relative attractiveness of the modes depends also on distance, an analysis of the transport costs of the three transport modes per distance is used, provided by the SEALS study. (Meyer-Ruhle, et al., 2008)

The exact cost-distribution per several routes are included in the Tables A5 to A7 of the Appendix, but the average costs led to the following cost-distribution per distance class, illustrated by Figure 4.8.

Figure 4.8. The distribution of average freight costs in Euro's per distance and mode.



Source: Compiled by author, based on (Meyer-Ruhle, et al., 2008)

As shown, for every distance class the relative costs between modes differ. For the shorter legs, the truck remains the cheapest mode of transport (€316) although IWW can already be seen as very competitive on these shorter hauls (€320). On the medium distance class, IWW is indeed cheaper to transport the same type and quantity of goods which also holds for the longest distances. Especially road transport has a steep increase in costs when surpassing the 1000 km and rail is never the cheapest, on average. It must be the attractive transit times for rail transport that makes it attractive as a cargo mode.

To correct the equivalents for the relative cost-attractiveness per mode, the cheapest mode per distance class has been set to an additional barrier of 0. The other modes get an additional tariff equivalent on the basis of their costs. The tariffs are only corrected inside the same distance class because the distance tariff already incorporates the different distances. Table 4.9 illustrates the additional tariff equivalents per mode and distance class.

Table 4.9. Tariff equivalent adjustments per mode

Corrections:	Distance		
Mode	<500km	500-1000km	1000+km
Road	1,000	1,404	2,256
Rail	1,690[10]	1,667	1,692
IWW	1,013	1,000	1,000

Source: Compiled by author

In case of the Antwerp example, the final tariff equivalent is therefore set as in Table 4.10. The green cells resemble the distance class up to 500 km, the yellow the middle class and the neutral the largest distance class. Red is used to highlight the impossible routes.

Table 4.10. Final freight costs tariff equivalent adjusted for relative costs per mode.

	Destinations, EU27				
Origins		Brussels	Sofia	Prague	Copenhagen
Country	**TEN-T Core Ports**	Belgium	Bulgaria	Czech Republic	Denmark
Belgium	**Antwerp RO**	1,003	1,311	1,080	1,083
	Antwerp RA	1,006[11]	1,233	1,095	1,099
	Antwerp IWW	1,003	1,138	1,057	1,000

Source: Compiled by author

After correcting, a difference in tariff equivalents between the modes is also shown. This procedure is repeated for all port, mode and hinterland country combinations as well as for ROW, leading to the spread sheet called Distance_tarriff_adjusted.xlsx, available upon request.

4.5.2 The time costs tariff equivalent

The second type of transport costs as part of total trade costs are time costs. According to Anderson and Van Wincoop (2004), the average time costs of transport lies around the 9% of the value of the goods transported. However, this thesis will make a thorough analysis of the time costs per port, mode and hinterland country combination.

It is assumed that the state of the infrastructure of the three modes has a considerable impact on the transit times. The worse the situation of the infrastructure is, the more delays occur in transporting the goods. It is therefore this

[10] For example, this additional tariff is gained by applying the cost of rail/cheapest mode; 534/316=1.69
[11] Reached by: (1.003 (Table 4.7)-1)*1,690+1

part of the total trade barrier that is influenced by the TEN-T policies in the end. But first the initial status of Europe’ s infrastructure is assessed.

The analysis focuses on the presence of bottlenecks and the degree of available infrastructure. The simple interpretation holds that if there are no bottlenecks present along the route of transporting the goods from port to the specific hinterland country and there is an average degree of infrastructure available, then this route can be completed within the average amount of time. If however bottlenecks are present (too shallow water, road congestion, differences in rail electrification systems for example), or there is an under average degree of infrastructure available, additional time is needed to complete the route.

For every mode of transportation considered in this thesis, an assessment is thus made on the availability of hard infrastructure per country as well as an assessment of the types and presence of bottlenecks. The following bottlenecks for road transport are identified; lack of infrastructure available per country, congestion on country level, specific road capacity bottlenecks and specific road condition bottlenecks. The TENCONNECT study (Petersen M.S., 2009) served as the basis for the bottleneck identification of road capacity and road condition.

For transportation by road, the availability of infrastructure is assessed on the basis of the available kilometres of highways, corrected for the surface of the country. The average kilometres of highways per square kilometre of land surface in the EU are then set as threshold. Countries that have less km of highways per square kilometre get a time bottleneck based on the degree. An overview of the availability of highways per country and the related time barrier is given in Table 4.11.

The basic rule concerning the time barrier is that per 0,01 highway km/km2 surface under the average of the EU, a time barrier of 0,5 hour is applied. If the country has a better degree of highway km per km2 of land surface than the average, there is no bottleneck concerning the availability of infrastructure.

The table shows that especially the Central-European countries and the Baltic States face an available road infrastructure that is under EU average. A time barrier ranging from zero to almost an hour is applied. The Netherlands, Belgium and Luxembourg have the highest degree of motorways per country surface. Their little surface helps in this respect.

Table 4.11. Highway availability determining a time barrier per country in minutes

Country	Km of highways (Eurostat, 2010)	Country surface (World Factbook)	highways/km2	Under average	Barrier	Time Barrier
Belgium	1.763	30.278	0,058227	-0,037648	0	**0,0**
Bulgaria	437	108.489	0,004028	0,0165509	0,016551	**49,7**
Czech Republic	734	77.247	0,009502	0,0110769	0,011077	**33,2**
Denmark	1.128	42.434	0,026582	-0,006004	0	**0,0**
Germany	12.819	348.672	0,036765	-0,016186	0	**0,0**
Estonia	115	42.388	0,002713	0,0178659	0,017866	**53,6**
Ireland	663	68.883	0,009625	0,0109539	0,010954	**32,9**
Greece	948	130.647	0,007256	0,0133227	0,013323	**40,0**
Spain	14.262	498.980	0,028582	-0,008003	0	**0,0**
France	11.163	549.970	0,020297	0,0002814	0,000281	**0,8**
Italy	6.668	294.140	0,022669	-0,002091	0	**0,0**
Cyprus	257	9.241	0,027811	-0,007232	0	**0,0**
Latvia	250	62249	0,004016	0,0165628	0,016563	**49,7**
Lithuania	309	62.680	0,00493	0,0156491	0,015649	**46,9**
Luxembourg	152	2.586	0,058778	-0,038199	0	**0,0**
Hungary	1.273	89.608	0,014206	0,0063726	0,006373	**19,1**
Malta	1	316	0,003165	0,0174144	0,017414	**52,2**
Netherlands	2.631	33.893	0,077627	-0,057048	0	**0,0**
Austria	1.719	82.445	0,02085	-0,000271	0	**0,0**
Poland	857	304.255	0,002817	0,0177622	0,017762	**53,3**
Portugal	2.737	91.470	0,029922	-0,009343	0	**0,0**
Romania	332	229.891	0,001444	0,0191347	0,019135	**57,4**
Slovenia	771	20.151	0,038261	-0,017682	0	**0,0**
Slovakia	415	48.105	0,008627	0,0119519	0,011952	**35,9**
Finland	779	303.815	0,002564	0,0180148	0,018015	**54,0**
Sweden	1.891	410.335	0,004608	0,0159705	0,01597	**47,9**
United Kingdom	3.673	241.930	0,015182	0,0053968	0,005397	**16,2**
Suisse[12]	1.406	39.997	0,03515	-0,01457	0	**0,0**
Average		**threshold:**	**0,020579**			

Source: Compiled by author. Based on (Eurostat, 2012) Road_if_motorwa and (Central Intelligence Agency (CIA), 2012)

The most obvious bottleneck concerning road transport is road congestion. On the basis of a study done by the Joint Research Centre of the EU, a time barrier have been constructed for the degree of congestion per country. Table 4.12 shows the

[12] Switzerland is not an EU- member but the large amount of freight transport crossing the country made it necessary to consider.

congestion figures in terms of ratios for free flow and related time barrier per country.

Table 4.12. The ratio of free flow speed per country and calculation of time barrier

Ratio of free flow speed for highways (100+kmph)					Barrier
Country	**%**	**average speed**	**average distance**	**Extra time**	**Minutes**
Belgium	89%	71.12	174	0.149848	**9.0**
Bulgaria	92%[13]	73.456	329	0.136367	**8.2**
Czech Republic	92.50%	74	278	0.087253	**5.2**
Denmark	92.40%	73.92	206	0.067682	**4.1**
Germany	89.90%	71.92	590	0.41615	**25.0**
Estonia	93.50%	74.8	206	0.034878	**2.1**
Ireland	94.70%	75.76	262	0	**0.0**
Greece	92%	73.456	361	0.149646	**9.0**
Spain	92%	73.6	706	0.273639	**16.4**
France	92.70%	74.16	742	0.211193	**12.7**
Italy	93.80%	75.04	542	0.068687	**4.1**
Cyprus	92%	73.456	96	0.039799	**2.4**
Latvia	92%	73.456	249	0.103296	**6.2**
Lithuania	93.40%	74.72	250	0.045996	**2.8**
Luxembourg	84.40%	67.52	51	0.081916	**4.9**
Hungary	91%	72.8	299	0.160655	**9.6**
Malta	92%	73.456	18	0.00736	**0.4**
Netherlands	86.60%	69.28	184	0.227291	**13.6**
Austria	93.90%	75.12	287	0.03229	**1.9**
Poland	93.20%	74.56	552	0.11718	**7.0**
Portugal	93.30%	74.64	302	0.059903	**3.6**
Romania	92%	73.456	479	0.198507	**11.9**
Slovenia	92%	73.456	142	0.058771	**3.5**
Slovakia	91.30%	73.04	219	0.107811	**6.5**
Finland	94.40%	75.52	551	0.023121	**1.4**
Sweden	94.30%	75.44	641	0.035866	**2.2**
United Kingdom	90.20%	72.16	492	0.3239	**19.4**
Suisse	91.82%	73.456	200	0.0828	**5.0**

Source: Compiled by author based on ratio figures (Christidis & Ibanez Rivas, 2012)

The ratio tells what the ratio is of the average speed and the allowed speed. Therefore, it was possible to calculate the average speed driven given an assumed allowed speed for trucks of 80 km/h. The average distance to cover per country is

[13] The red percentages resemble the countries with no corresponding data. Therefore, the average ratio was taken.

calculated by taking the square root of the country's surface. The time barrier is then calculated by the following formula:

(8) $$Time\ barrier\ in\ minutes = \left(\left(\frac{average\ distance}{average\ speed}\right) - \left(\frac{average\ distance}{75.76}\right)\right) * 60$$

Table 4.13. Sum of the time barriers per country

Country	SUM barrier minutes	hours
Belgium	9.0	0.15
Bulgaria	57.8	0.96
Czech Republic	38.5	0.64
Denmark	4.1	0.07
Germany	25.0	0.42
Estonia	55.7	0.93
Ireland	32.9	0.55
Greece	48.9	0.82
Spain	16.4	0.27
France	13.5	0.23
Italy	4.1	0.07
Cyprus	2.4	0.04
Latvia	55.9	0.93
Lithuania	49.7	0.83
Luxembourg	4.9	0.08
Hungary	28.8	0.48
Malta	52.7	0.88
Netherlands	13.6	0.23
Austria	1.9	0.03
Poland	60.3	1.01
Portugal	3.6	0.06
Romania	69.3	1.16
Slovenia	3.5	0.06
Slovakia	42.3	0.71
Finland	55.4	0.92
Sweden	50.1	0.83
United Kingdom	35.6	0.59
Switzerland	5.0	0.08

The highest EU number on average speed including congestion is taken as reference (Ireland, 75.76 km/h) instead of the maximum average speed of 80 km/h. This speed is more realistic to achieve as average.

Now, the picture of barriers is quite different related to the availability of infrastructure. The Western-European countries have the highest congestion rates and therefore higher time barriers in this respect.

The sum of the two time barriers results in the following total time barrier per country, in minutes and hours. (Table 4.13)

The highest time barrier is present if road transport had to be carried out in Romania with an estimated barrier of 1.16 hours. Also Poland, Bulgaria and the Baltic States face high barriers. Low barriers are present for the smaller countries Denmark, Slovenia and Switzerland.

Apart from the country-level barriers, there are also very specific bottlenecks present around a certain congested city or area and concerning the status of the roads. This thesis bases the location and size of these specific bottlenecks on the studies from TENCONNECT and JRC. The maps that show these capacity and road condition bottlenecks are presented in the Appendix section 9.7. However, an overview of both capacity and condition bottlenecks is made in Google Maps for illustration. (Figure 4.9)

Figure 4.9. Overview of road capacity bottlenecks(red) and bad road conditions (yellow)

Source: Compiled by author, map: (Google Maps, 2012)

The capacity bottlenecks are quite spread out across Europe with the larger cities as area's that attracts the most congestion. Road condition bottlenecks are only present in some Eastern-European countries, notably in Romania, Poland and the Baltic States. An overview of these specific bottlenecks is given in table 4.14.

The table further provides the degree of the bottlenecks. For capacity bottlenecks, there is a distinction made between small, moderate and severe bottlenecks, leading to a respective time barrier of 10, 20 and 30 minutes extra to cross the bottleneck. For condition bottlenecks, the distinction is made on moderate and severe, with an additional time barrier of 30 minutes and 1 hour.

Eastern-Poland has a very wide and spread out difficulty in providing a good condition of roads, therefore this bottleneck is determined at 1 hour additional time for crossing the area. The most severe capacity bottlenecks are present around Essen, Paris, and St-Petersburg. The latter is taken into analysis because it serves as crossing for road transport between Finland and the Baltic States.

Table 4.14. Overview of the specific congestion and condition road bottlenecks

Congestion and Condition Bottlenecks						
Country	**Bottleneck**					
Belgium	Kortrijk	Antwerp	Brussels			
Bulgaria	Sofia					
Czech Republic	Prague					
Denmark	Copenhagen/Helsingborg					
Germany	Hamburg	Essen/Dusseldorf	Frankfurt	Stuttgart		
Estonia	Narva	Parnu				
Ireland	Dublin	Cork				
Greece	Athens	Thessaloniki				
Spain	Madrid	Barcelona	Valencia	Santander	Malaga	
France	Paris	Lyon	Marseille	Nancy	Toulouse	Bordeaux
Italy	Milan	Rome	Napoli	Verona/Venetia		
Cyprus	-					
Latvia	Riga	Riga				
Lithuania	Vilnius	Kaunas				
Luxembourg	Luxembourg					
Hungary	Budapest					
Malta	Valetta					
Netherlands	Amsterdam	The Hague	Rotterdam	Utrecht	Arnhem	
Austria	Wien					
Poland	Warsaw	Katowice	Gdansk	Wroclaw	East-Poland	
Portugal	Lisbon	Porto				
Romania	Bucharest	Bucharest	Bacau	Cluj-Napoca	Sibiu	
Slovenia	-					
Slovakia	Bratislava					
Finland	Helsinki					
Sweden	Stockholm	Goteborg				
United Kingdom	London	Reading	Portsmouth	Liverpool	Birmingham	
	Middlesbrough	Glasgow	Belfast			
Switzerland	Zurich					
Russia	St-Petersburg					

Legenda:	**Capacity:**		**Condition:**		
Small:	0.166	(10 min)	Moderate:	0.5	(30 min)
Moderate:	0.333	(20 min)	Severe:	1	(60 min)
Severe:	0.5	(30 min)			

Source: Compiled by Author on the basis of (Christidis & Ibanez Rivas, 2012) (Petersen M.S., 2009)

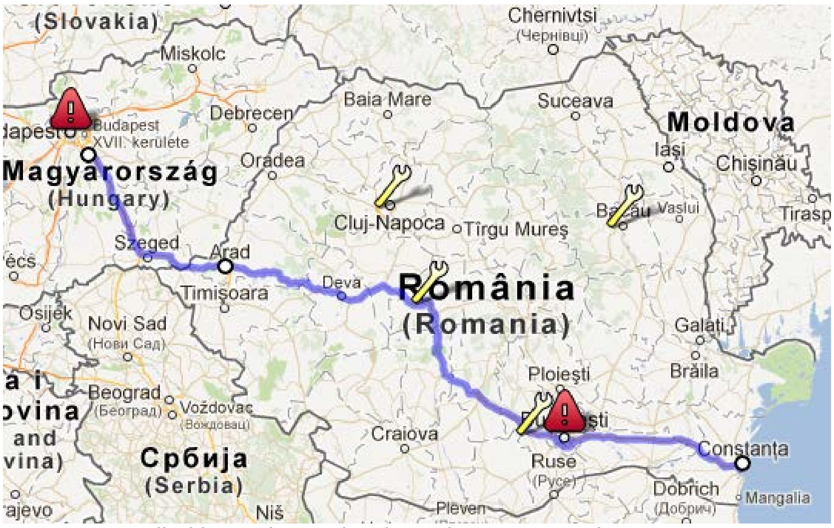
Making use of the different determined road bottlenecks per country and per specific area, the total additional time barrier is established trough summing up the bottlenecks that are crossed on the route from the specific port to the specific country. Therefore, for every combination of port and hinterland country, the most logical route a truck has to follow had to be found. Following these routes, 2241 in total, the total barrier per route is then determined by the formula:

(9) $$Total\ road\ time\ barrier = \sum country\ barriers + \sum condition\ barriers + \sum capacity\ barriers$$

As an example we take the route from the port of Constanta, Romania towards Hungary, as showed in Figure 4.10. The total time barrier for the route taken is then:

$$Total\ road\ time\ barrier\ Constanta - Hungary$$
$$= Country\ barrier\ Romania + country\ barrier\ Hungary$$
$$+ condition\ barrier\ Bucharest + condition\ barrier\ Sibiu$$
$$+ capacity\ barrier\ Bucharest = 1.16 + 0.48 + 0.5 + 0.5 + 0.166$$
$$= 2.81\ hours$$

Figure 4.10. Route from Constanta to Hungary with the crossed bottlenecks



Source: Compiled by Author, using (Google Maps, 2012)

Because of the identified available road infrastructure, the countries average congestion rates and bottlenecks on the route, it is estimated that the journey by truck from Constanta towards Hungary takes 2.81 hours longer than without these bottlenecks. This type of analysis is carried out for all 2241 routes between the ports and the hinterland countries.

Considering the time barrier for rail transport, other barriers and bottlenecks have been identified, including; a lack of infrastructure available per country, slot restrictions (capacity), electrification bottlenecks, single rail tracks, border stop bottlenecks and necessary gauge changes. Again, the TENCONNECT study provided this division of bottlenecks for rail transport. Further, its maps helped in the identification of the specific locations of the bottlenecks.

Similar to the estimation of a time barrier for road transport, the available infrastructure on a country level is again assessed. The same approach is taken, using the total length of available rail track kilometres per country and the surface of the country, as shown in Table 4.15.

Table 4.15. Rail track availability per country and determined time barrier in minutes.

Country	Total Rail km Eurostat, 2010	Country surface (World factbook)	Rail/m2	Under average	Barrier	Time Barrier
Belgium	3578	30278	0.118172	-0.050893	0	**0.00**
Bulgaria	4098	108489	0.037773	0.029505	0.029505	**44.26**
Czech Republic	9568	77247	0.123862	-0.056584	0	**0.00**
Denmark	3181	42434	0.074963	-0.007685	0	**0.00**
Germany	37679	348672	0.108064	-0.040785	0	**0.00**
Estonia	1196	42388	0.028216	0.039063	0.039063	**58.59**
Ireland	1889	68883	0.027423	0.039856	0.039856	**59.78**
Greece	2552	130647	0.019534	0.047745	0.047745	**71.62**
Spain	13853	498980	0.027763	0.039516	0.039516	**59.27**
France	29466	549970	0.053577	0.013701	0.013701	**20.55**
Italy	16704	294140	0.056789	0.010490	0.01049	**15.73**
Cyprus		9241	-	-	-	**-**
Latvia	1897	62249	0.030474	0.036804	0.036804	**55.21**
Lithuania	1767.6	62680	0.0282	0.039078	0.039078	**58.62**
Luxembourg	657	2586	0.25406	-0.186781	0	**0.00**
Hungary	7390	89608	0.08247	-0.015191	0	**0.00**
Malta		316	-	-	-	**-**
Netherlands	2888	33893	0.085209	-0.017931	0	**0.00**
Austria	5828	82445	0.07069	-0.003411	0	**0.00**
Poland	20228	304255	0.066484	0.000795	0.000795	**1.19**
Portugal	2843	91470	0.031081	0.036198	0.036198	**54.30**
Romania	10785	229891	0.046914	0.020365	0.020365	**30.55**
Slovenia	1228.07	20151	0.060943	0.006335	0.006335	**9.50**
Slovakia	3622	48105	0.075294	-0.008015	0	**0.00**
Finland	5919	303815	0.019482	0.047797	0.047797	**71.69**
Sweden	11149	410335	0.02717	0.040108	0.040108	**60.16**
United Kingdom	15884	241930	0.065655	0.001623	0.001623	**2.44**
Suisse	5159	39997	0.128985	-0.061706	0	**0.00**
Average		**threshold:**	**0.067279**			

Source: Compiled by author based on (Eurostat, 2012) [rail_if_line_ga], (Central Intelligence Agency (CIA), 2012)

Because of a wider difference from the European average on rail track density than with road track density, a time barrier of 0,25 hour per 0,01 less track coverage/km2 from the mean is taken, resulting in a barrier ranging from 1 up to 71 minutes. The countries which perform better than average in rail coverage per km2 are considered to have no bottleneck on infrastructure availability.

Further, slot restrictions, type of electrification, number of tracks, border stops and gauge system changes are also identified as bottlenecks based on the TENCONNECT study. Slot restrictions are present if the certain track is estimated as too densely occupied by traffic. Different types of electrified systems are present over Europe, which makes it necessary to change locomotives or change the voltage of the locomotive. This is time consuming and takes on average 45 minutes to complete. (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011). Further, when a rail section only has one track to accommodate locomotives coming from both sides, this immediately creates a bottleneck in terms of capacity. There are also some border crossings that require more than average time to pass and the existence of multiple gauge widths also creates bottlenecks. The standard European gauge is 1435 mm wide, but wider gauges are also used in for instance Finland and Spain. This requires the change of the locomotive's axle which takes on average 20 minutes. (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011)

The TENCONNECT map that served as basis to identify these different bottlenecks is the following Figure 4.11.

Figure 4.11. Map of European rail bottlenecks. (Petersen M.S., 2009)

From the map, the different bottlenecks are derived and displayed together with the time barrier in the Appendix, section 9.8. The justification of the specific time barrier per bottleneck is given in table 4.16.

Table 4.16. Time barrier per rail bottleneck and justification

Bottleneck	Distance	Time barrier (hours)	Based on
Slot restrictions	long distance	0.5	own reasoning
	city or short distance	0.25	own reasoning
Electrification	uniform	0.75	(Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011)
Single track	long distance	1	own reasoning
	medium distance	0.5	own reasoning
	short distance	0.25	own reasoning
Border stop	uniform	0.33	(Petersen M.S., 2009)
Gauge change	uniform	0.33	(Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011)

Source: Compiled by author.

It is relatively hard to determine the time it takes extra when there is not enough capacity of slots on a certain track. This depends on the precise shortage of capacity. This information is however not available and the reasoning therefore follows that for congested tracks, other routes are taken which has an impact of around 0,5 or 0,25 hours extra time, depending on the length of the track at which there are too less slots. The electrification and gauge change bottlenecks require 0,75 and 0,333 extra hours based on the Intermodal Yearbook. (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011). Further, the presence of only a single track is assumed to have an hour, half and quarter of an hour additional time. The border stop has an average delay of 20 minutes according to the TENCONNECT study. (Petersen M.S., 2009)

The different identified bottlenecks and time barriers that are associated with these bottlenecks are then used to determine the total time barrier for rail transport between the ports and hinterland countries, assuming the most logical route in between them. For all 2241 routes, the formula (10) holds.

(10) $$Total\ Rail\ time\ barrier = \sum country\ time\ barriers + \sum slot\ restriction\ barriers + \sum electrification\ barrier + \sum single\ track\ barrier + \sum border\ stop\ barrier + \sum gauge\ change\ barrier$$

Again, an example is provided to illustrate the methodology. The route from the port of Bordeaux to Portugal involves several bottlenecks like a gauge change, border stop difficulties and single track restrictions. This is shown in the map of Figure 4.12.

Figure 4.12. The route (white dots) between Bordeaux and Portugal

Source: Compiled by author with map of TENCONNECT. (Petersen M.S., 2009)

The implied total time barrier is then estimated according to formula (10):

$$
\begin{aligned}
&Total\ Rail\ time\ barrier \\
&\quad = country\ time\ barrier\ France + Spain + Portugal \\
&\quad + gauge\ change\ barrier\ between\ France\ and\ Spain \\
&\quad + border\ stop\ barrier\ Spain\ and\ Portugal \\
&\quad + single\ track\ restriction\ between\ Madrid\ and\ Portugal \\
&\quad + single\ track\ restruction\ in\ Portugal \\
&\quad = 0{,}34 + 0{,}99 + 0{,}9 + 0{,}333 + 0{,}5 + 0{,}25 = 3{,}32\ hours
\end{aligned}
$$

So, due to bottlenecks present at the borders, single tracks and a not so dense rail infrastructure network, it takes as estimated 3,32 hours additional to transport goods by rail from Bordeaux to Portugal. Again, this procedure is repeated for all rail combinations between the 83 ports and the 27 EU Member States.

Regarding inland waterway transport, the time barriers are also established according to the method used for rail and road transport. The following bottlenecks are used to determine time barriers; a lack of infrastructure per country, a low ECMT classification, water depth restrictions, low bridges and missing links.

First, the average coverage of waterway km per km2 of country surface is used to determine a country specific barrier for the availability of the infrastructure. Table 4.17 is used in this respect.

Table 4.17. Availability of navigable waters per country and respective time barrier in minutes

IWW availability per country						
Country	Km of waterways (Eurostat, 2010)	Country surface (World factbook)	Waterway km/km2	Under average	Barrier	Minute barrier
Belgium	1.516	30.278	0,050069357	-0,02721	0	**0,00**
Bulgaria	470	108.489	0,004332236	0,0185276	0,018528	**55,58**
Czech Republic	676	77.247	0,008751149	0,0141087	0,014109	**42,33**
Germany	7.728	348.672	0,022164097	0,0006957	0,000696	**2,09**
France	5.132	549.970	0,009331418	0,0135284	0,013528	**40,59**
Italy	1.562	294.140	0,005310396	0,0175494	0,017549	**52,65**
Luxembourg	37	2.586	0,014307811	0,008552	0,008552	**25,66**
Hungary	1.587	89.608	0,017710472	0,0051493	0,005149	**15,45**
Netherlands	6.102	33.893	0,180037176	-0,157177	0	**0,00**
Austria	351	82.445	0,004257384	0,0186024	0,018602	**55,81**
Poland	3.659,3	304.255	0,012027083	0,0108327	0,010833	**32,50**
Romania	1.779	229.891	0,00773845	0,0151214	0,015121	**45,36**
Slovakia	172	48.105	0,003575512	0,0192843	0,019284	**57,85**
United Kingdom	1.050	241.930	0,004340098	0,0185197	0,01852	**55,56**
Croatia	805,2	56.594	0,014227657	0,0086322	0,008632	**25,90**
Serbia	587	77.474	0,007576735	0,0152831	0,015283	**45,85**
Average		Threshold:	0,022859814			

Source: Compiled by author with usage of (Eurostat, 2012) and (Central Intelligence Agency (CIA), 2012)

Only Belgium and The Netherlands have waterway coverage above EU average. All other countries are in respect of these countries under-covered and therefore attributed with a time barrier of 0,5 hours per 0,01 of coverage under EU-average. The barriers are spread from 2 up to 56 minutes.

Further, the Inland Waterways of Europe are classified according to their capabilities to accommodate certain vessels based on length, beam, draught and tonnage; ECMT[14]- classification. Since not all waterways are needed to accommodate the largest pushed convoys or barges, the waterways which only have no ECMT class are considered as bottlenecks, if they are also reasonably used for the transport between the European ports and hinterland countries. The map with ECMT classification is shown in Figure 4.13. A larger version is available in section 9.9 of the Appendix.

[14] European Conference of Ministers of Transport.

Figure 4.13. ECMT Classification and considered bottlenecks

Source: (Inland Navigation Europe, 2005), amendments by Author. Red= weak ECMT, Yellow= depth restriction, Orange= missing links, Black= low bridges.

Also shown in the map are the other considered bottlenecks related to waterway depth, low bridges and missing links. These are based on a study of TENCONNECT, an inventory of bottlenecks carried out by the Inland Transport Committee of the Economic Commission for Europe of the United Nations. (Economic Commission for Europe Inland Transport Committee, 2005), and a more recent map of bottleneck locations published by the same UNECE Commission.

The bottlenecks presented in the map are as well summed up in Table 4.18. This table also shows the related time barrier. It is assumed that the bottlenecks have a restrictive impact on the navigation speed of the vessels, thereby resulting in a time barrier. The time delay is then calculated as according formula (11), assuming an average speed for inland navigation of 12 km/h. (Meyer-Ruhle, et al., 2008)

(11) $$Time\ barrier\ in\ hours = \frac{Length\ of\ section}{12 + speed\ implication} - \frac{Length\ of\ section}{12}$$

The implication for the sailing speed is based on Table 4.18. The higher the bottleneck, the higher the decrease in km/h. For draught restrictions, the implication for the speed is more severe than for bridges.

Table 4.18. Degrees of bottlenecks

Type of Bottleneck	Thresholds	km/h decrease
Draught restriction	<1m	4
	<1,5m	3
	<2,5m	2
Bridge	<6m	1
	<7.5m	0.5
Missing link		2
No ECMT Class		3

Source: Compiled by Author

Table 4.19. Overview of Navigation Bottlenecks and time barriers

Type of Bottleneck	Country	Respective section	Length of section km	Depth/Bridge height	Speed implication km/h	Time Barrier, hours
ECMT Classification	Czech Republic	Morava-Danube	200		-3	**5,56**
		Oder-Morava	200		-3	**5,56**
	France	Nantes-Loire	100		-3	**2,78**
	Poland	Oder-Wisla	50		-3	**1,39**
	UK	Bristol-London	100		-3	**2,78**
		Felixstowe	50		-3	**1,39**
		Forth-Glasgow	50		-3	**1,39**
		Liverpool-inland	50		-3	**1,39**
		London-North	50		-3	**1,39**
Missing Link	Belgium/France	Seine-Scheldt	100		-2	**1,67**
		Danube-Oder-Elbe	200		-2	**3,33**
Draught restriction	Germany	Main: Bamberg	20	1,9m	-2	**0,33**
		Elbe: Lauenberg	150	1,4m	-3	**6,94**
	France	Nancy	20	2,5m	-2	**0,33**
	Hungary	Gabcikovo-Budapest	100	1,7m	-2	**1,67**
	Austria	Wachau-Slovak	50	2,2m	-2	**0,83**
	Poland	Oder	100	1,1m	-3	**2,78**
		Warta	50	1,3m	-3	**1,39**
		Wisla:Gdansk-Warschau	100	0,8m	-4	**4,17**
Low Bridges	Germany	Rhine: Mainz	20	5,4m	-1	**0,15**
		Danube: Straubing	75	4,6m	-1	**0,57**
	Austria	Linz	20	7,1m	-0,5	**0,07**

Source: Compiled by Author

It is estimated that the most delays occur along the Elbe, Morava and the Wisla, also because of the length of these sections at which the bottleneck is in place. The time barriers vary from 5 minutes up to almost seven hours for the entire Elbe section.

Again, all combinations of Core ports and the hinterland countries in which navigation in between them is possible are examined on country and route specific time barriers. Formula (12) is used to determine the total barrier per combination.

(12) $$Total\ IWW\ time\ barrier = \sum country\ time\ barriers + \sum missing\ link\ barriers + \sum low\ water\ barriers + \sum No\ ECMT\ class\ barriers + \sum low\ bridges\ barriers$$

For example, if waterway transportation takes place from the Port of Rotterdam towards Austria, it follows the route as illustrated in Figure 4.14. Along the route, several identified bottlenecks are crossed resulting in the following time barrier according to formula (12):

$$\begin{aligned} Total\ IWW\ time\ barrier\ from\ Rotterdam\ to\ Austria \\ &= country\ barrier\ Netherlands + country\ barrier\ Germany \\ &+ country\ barrier\ Austria + bridge\ barrier\ Mainz \\ &+ bridge\ barrier\ Straubing + bridge\ barrier\ Linz \\ &+ depth\ barrier\ Bamberg + depth\ barrier\ Wachau \\ &= 0 + 0{,}0348 + 0{,}903 + 0{,}152 + 0{,}57 + 0{,}072 + 0{,}333 + 0{,}83 \\ &= 2{,}92\ hours \end{aligned}$$

Figure 4.14. The route from Rotterdam to Austria and crossed bottlenecks for IWW

Compiled by Author, making use of map (Inland Navigation Europe, 2005)

This procedure is followed for all combinations of the 83 European ports and the hinterland countries in which inland navigation is possible in between. Given the fact that this is the third and last mode to consider time barriers for, the estimation of time barriers is done.

Based on the distances between the Core Ports and the EU Member States, the average time to complete the route depends on the average speed of the modes. Provided by the SEALS study, the average speeds are 80 km/h, 100 km/h and 12 km/h for the modes Road, Rail and Inland Waterway. (Meyer-Ruhle, et al., 2008)

With these speeds, the average time to transport goods by road, rail and inland waterway for all port and hinterland combinations are calculated. By adding the specific time barriers for all combinations on the average time to complete the route, the total time is calculated.

Given the 9% time costs barrier derived from Anderson and Van Wincoop as average barrier, the time costs tariff equivalent is calculated by formula (13):

(13) $$Time\ cost\ tariff\ equivalent = \frac{Total\ time}{22{,}717} \times 0{,}09 + 1$$

22,71 is the average number of hours of all mode, port and hinterland country combinations, excluding the infeasible routes. All infeasible routes are set at a total time of 0, leading to a tariff equivalent of 1. As an example, the distances, average time required to complete the route, time barriers, total time including the barriers and time cost tariff equivalent tables for a small part of the dataset are shown in Table 4.20.

Table 4.20. Distances, Time, Time barrier, Total Time and tariff equivalents for Marseille and four countries

Distances, km	Destination			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	854	1461	1016	1461
Marseille RA	854	1461	1016	1461
Marseille IWW	854	1461	1016	-
Time, hours	**Destination**			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	10,68	18,26	12,70	18,26
Marseille RA	8,54	14,61	10,16	14,61
Marseille IWW	71,17	121,75	84,67	-
Time barrier, hours	**Destination**			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	1,21	4,28	1,95	1,54
Marseille RA	3,09	4,59	2,09	3,34
Marseille IWW	2,34	8,46	5,04	0,00
Total Time, hours	**Destination**			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	11,88	22,54	14,65	19,80
Marseille RA	11,63	19,20	12,25	17,95
Marseille IWW	73,51	130,21	89,71	0,00
Time cost Tariff equivalent	**Destination**			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	1,05	1,09	1,06	1,08
Marseille RA	1,05	1,08	1,05	1,07
Marseille IWW	1,29	1,52	1,36	1,00

Source: Compiled by author

From the table, it is shown that IWW receives the highest tariff equivalent in terms of time, because it is also the slowest mode. In a later stage of the research, the part of the Time Barrier will be influenced in a positive way because of the TEN-T projects, resulting in a lower total time and a lower time cost tariff equivalent for the respective combinations where barriers are removed.

For the ROW column, a time cost tariff equivalent has to be determined as well. Because transporting goods from the European ports towards these non-EU countries by road and rail also involve the surpassing of bottlenecks inside the EU, the established bottlenecks are also applied to ROW. However, as the ROW column involves multiple countries, an average is again taken do determine the single time costs tariff equivalents from ports to the Rest of the World.

To derive the average time barrier, a nearby EU-country is selected for the seven main non-EU countries. The reasoning follows that the non-EU countries are reached trough the EU-countries and the time cost tariff equivalent of the closest country should therefore apply for the non-EU country. The average time barrier from the relevant port towards the seven EU 'substitutes' is then taken as ROW barrier. The EU countries that play as substitute for the non-EU countries Norway, Switzerland, Russia, Turkey, West-Balkan, Ukraine and Belarus are respectively; Sweden, Italy, Latvia, Bulgaria, Hungary, Slovakia and Lithuania.

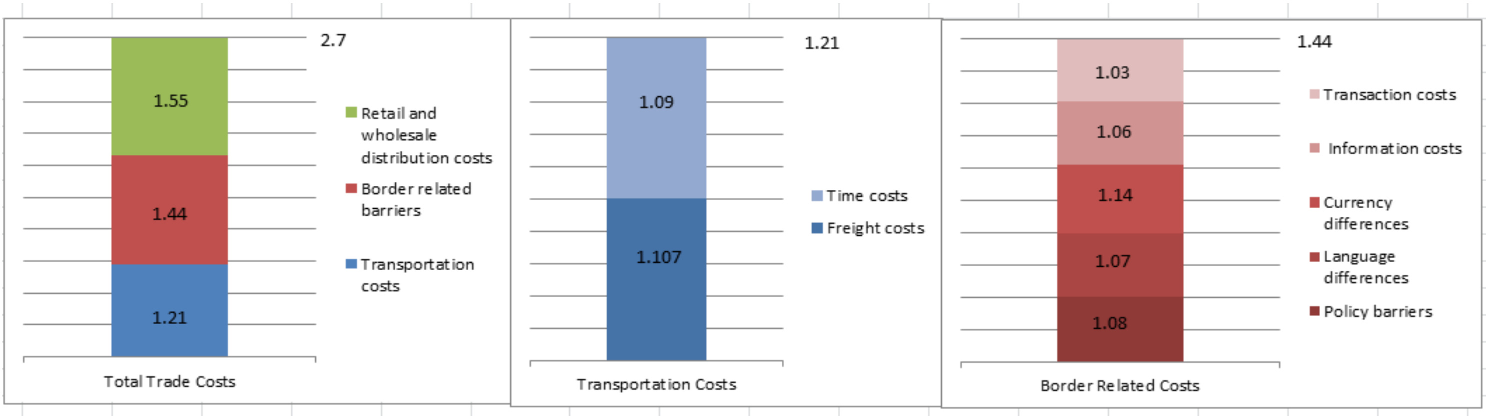
Again, the time barrier is summed up to the average time to cover the distances to reach the ROW-countries, and the time cost tariff equivalent is achieved by using formula 13 as well.

The full spread sheet of the time value tariff construction is called Time_value_tariff_initial.xlsx and is available upon request.

4.5.3 The total initial levels of tariff equivalent trade barriers

Getting back to Figure 4.6, which displays the structure of the total trade tariff equivalent, it is shown that the transportation costs part is assessed by the previous parts of chapter four, with an average of respectively 9% and 10,7% for time costs and freight costs.

Figure 4.6. Overview of tariff equivalents per type of trade costs.



Source: Compiled by Author, based on Anderson & Van Wincoop, 2004.

The retail and border related costs equivalents are set as constant for all combinations(1,55 and 1,44 respectively). Therefore, the total initial trade barrier is derived by the formula (14):

(14) $Total\ initial\ trade\ barrier = Time\ costs\ barrier \times Freight\ costs\ barrier \times 1{,}55 \times 1{,}44$

Again, the infeasible routes are set as 1 also for the retail and border related costs barriers. Together with the routes that are physically feasible to complete, the total initial trade barrier tariff equivalent is therefore set. An example of the total trade barrier tariff equivalent in ad-valorem form is given in the following Table 4.21.

Table 4.21. Total trade barrier tariff equivalent for Marseille and four countries.

Trade barrier	Destination			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	2.563	3.078	2.798	3.047
Marseille RA	2.603	2.881	2.665	2.868
Marseille IWW	3.085	3.790	3.279	1.000

Source: Compiled by Author.

The complete spread sheet with an overview of the time costs, freight costs, retail costs, border costs and total initial trade barrier is called Initial_Tariff_build.xlsx and is available upon request. The excel file fully answers the sub-question:

"What is the initial barrier to trade between the 83 European ports and the EU-member states, per mode of transport?"

4.5.4 Elasticity Assessment

As described earlier in the Methodology section, the GSIM model requires three sorts of elasticities to be inputted; composite demand elasticity, elasticity of substitution and export supply elasticity. The elasticity of substitution is set at 10 and the export supply elasticities are set at 1,5 for all combinations, as done by Francois and Hall(2003) as well in their examples.

The composite demand elasticity is based on the port and mode specific elasticities, corrected for the market shares of the ports and the modes. Therefore, the port and mode specific elasticities need to be derived first. These specific elasticities are also used to correct the total tariff equivalents derived in section 4.5.3, as GSIM is not capable to incorporate these specific demand elasticities that differ per port and mode.

Because there is too little data available on specific demand elasticities for ports and modes, the elasticities are derived and estimated according to own reasoning. Therefore, two effects are taken into consideration; Mode substitution and Port competition. The reasoning is as follows:

- <u>Mode dominance:</u> The higher the dependency of a port on one mode, the fewer possibilities exists to substitute from this mode to others that are present to reach the hinterland. Therefore, the demand for this dominant mode would be rather price inelastic. If there is less dependency on a single mode, and the other modes can act as substitutes, the demand for the mode would be rather price elastic.

- <u>Port competition:</u> If there is dependence on one mode in a port, and there are competitive ports in the near area available, it is assumed that the demand for the dominant mode gets more elastic, since other ports can offer the same mode of hinterland transportation. So, when a port is very depending on road transport as means of hinterland transportation, and the price for road transport increases, it is likely that the shippers will choose a different port that offers the road transport for a lower price, since other modes inside the port cannot act as substitutes.

This reasoning is translated into Table 4.22. The degree of mode dominance is illustrated on the vertical side of the table, the degree of port competition on the horizontal. For each mode the relevant effect of mode dominance and port competition on elasticity of demand for the mode is showed in plusses and minuses. As shown, the effect of port competition is only relevant when there is a single dominant mode of transport. Then, the more competition there is, the more elastic the demand gets (towards two plusses). For mode dominance, the effect on price elasticity is rather inelastic (a minus) for the dominant mode, but there is an elastic effect for the two smaller modes if they are substitutes of each other (a plus). Substitution is assumed between modes if they have comparable market shares. If there are two dominant modes, the dominant modes are assumed to be substitutes of each other and there is an elastic effect for both. If there are three modes with a similar market share, there is a large elastic effect for all of them, due to substitution between the modes.

Table 4.22. Mode dominance and port competition and their effect on mode demand elasticities

	Effect on elasticity for each mode						
		mode	port	mode	port	mode	port
Mode Dominance ↓	**3 pretty equal subs**	*13*		*23*		*33*	
	all modes	++	0	++	0	++	0
	2 dominant modes	*12*		*22*		*32*	
	dominant modes	+	0	+	0	+	0
	less dominant mode	-	0	-	0	-	0
	1 Very dominant mode	*11*		*21*		*31*	
	dominant mode	-	-	-	+	-	++
	2 minor but subs	+	0	+	0	+	0
	2 minor both not subs	-	0	-	0	-	0
		single port		**couple**		**high competition**	
		Port Competition →					

Source: Compiled by Author

The meaning of the signs is shown in Table 4.23. The degree of elasticity in a neutral phase of 0 effect is set at -0,8, because transport is known to be rather inelastic. The plusses and minuses are considered as the effect on top of the -0,8. So, a plus in box 11 of Table 4.22 means a price elasticity for the two minor modes of -0,8+-0,3=-1,1.

Table 4.23. Meaning of signs related to elasticities

Sign	--	-	0	+	++
effect on elasticity	0,6	0,3	-0,8	-0,3	-0,6

Source: Compiled by Author

Taken together the two effects of Table 4.22 and implementing the degrees of elasticities, the resulting elasticities per mode and per type of mode dominance and port competition are shown in Table 4.24. The elasticities vary along the -0,5 and -1,4 according to this analysis. Now, all ports need to be identified in which box they belong, based on the market shares (the mode dominance) of the modes in the ports (the modal splits) and the presence of ports in the near area (the port competition).

Table 4.24. Sum of the two effects and the resulting elasticity per combination of mode dominance and port competition

Sum of the two effects			
3 pretty equal subs	*13*	*23*	*33*
all modes	++	++	++
2 dominant modes	*12*	*22*	*32*
dominant modes	+	+	+
less dominant mode	-	-	-
1 Very dominant mode	*11*	*21*	*31*
dominant mode	--	0	+
2 minor but subs	+	+	+
2 minor both not subs	-	-	-

The elasticities of demand			
Start at -0.8 , then use plusses and minusses Table 4.20.			
3 pretty equal subs	*13*	*23*	*33*
all modes	-1,4	-1,4	-1,4
2 dominant modes	*12*	*22*	*32*
dominant modes	-1,1	-1,1	-1,1
less dominant mode	-0,5	-0,5	-0,5
1 Very dominant mode	*11*	*21*	*31*
dominant mode	-0,2	-0,8	-1,1
2 minor but subs	-1,1	-1,1	-1,1
2 minor both not subs	-0,5	-0,5	-0,5

Source: Compiled by Author

The identification of ports and their degree of mode dependency and competitive surrounding is done according to Table 4.25.

Table 4.25. Requirements for grouping of ports on the scale of mode dominance and port competition

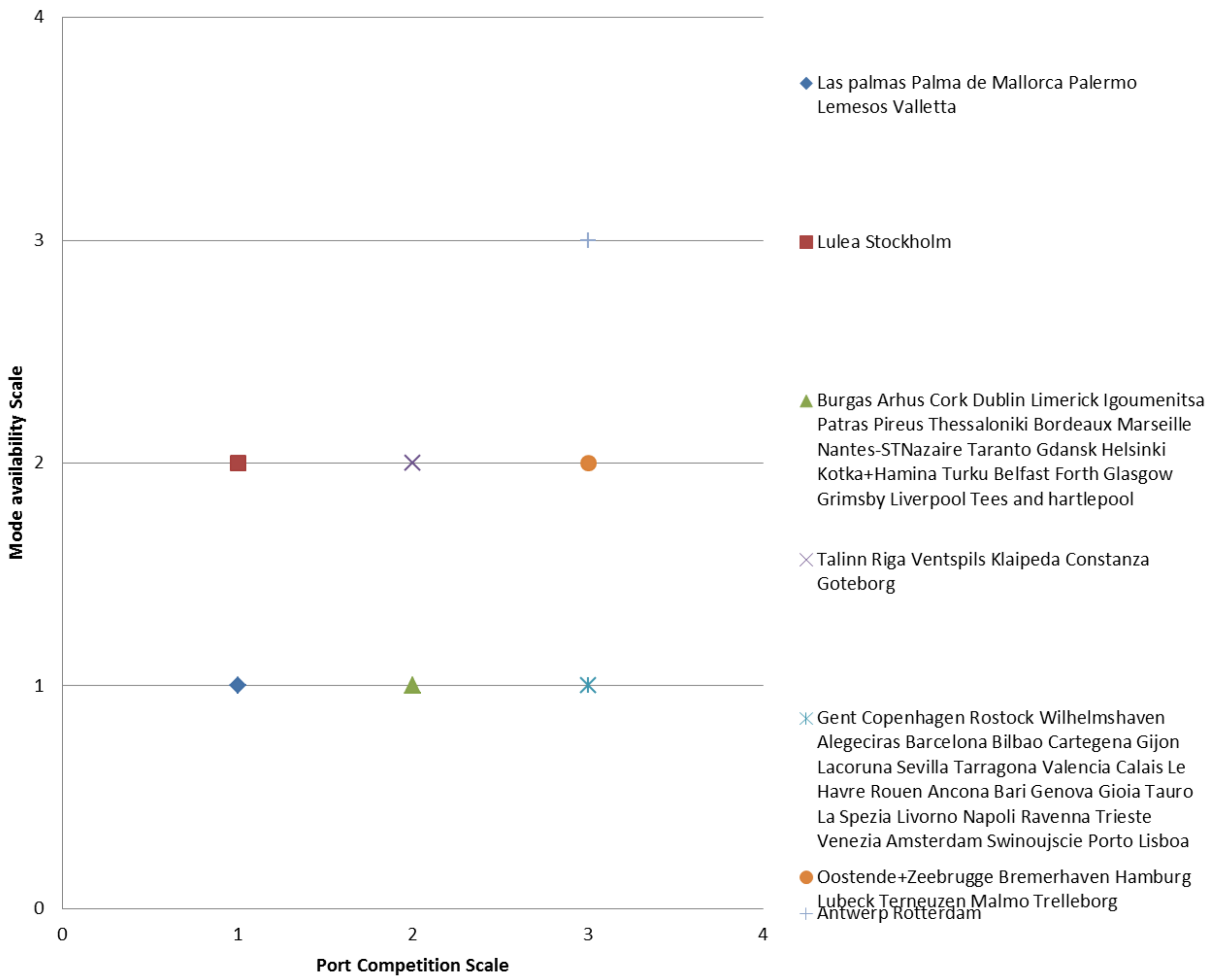
Mode dominance:		Port competition:		
Options:	Scale	**options:**	Scale	
1 very dominant mode (larger than 40% difference)	1	**Single**	1	(Islands and far away)
2 dominant modes (2nd mode>30%, 3rd<10%)	2	**Couple**	2	
3 equal (2nd + 3rd>41%, 3rd>10%)	3	**Multiple**	3	

Source: Compiled by Author

If there is a mode in a port that has a larger than 40% difference of market share with the other modes, this port has a dominant mode. There are two dominant modes if the second largest mode has a market share higher than 30% and the least dominant mode has a share of less than 10%. The modes are considered to have equal dominance when the second and third largest together resemble more than 41% and the third is larger than 10%. In absolute numbers, there are still considerable differences along the modes but a third mode is considered as competitive for the others if it has more than 10% market share.

Regarding port competition, there is no competition if a port is the only present in the area. This is for instance the case for Island ports and very distant ports like Las Palmas or Lulea . If there are a couple of ports clustered (up to 4), the second scale is applied. When there are more than 4 ports clustered in the near area of each other, the most competitive scale of 3 is applied. This is for instance only the case for the Hamburg-Le Havre range and for Great Britain.
The list of ports categorized according to these two divisions is shown in Table A10 of the Appendix. Further, Figure 4.15 does also show the ports grouped in the categories of mode dependency and port competition.

Figure 4.15. Core ports grouped per determinant of the demand elasticity



Source: Compiled by Author

As shown in the figure, there are only two ports, Antwerp and Rotterdam, which have both a competitive surrounding of ports nearby and three competitive modes. There are further not so many ports with the lowest scale of port competition. The largest groups are the ports with only one dominant mode and quite some port

competition. This figure and categorization shows that most European ports only have one dominant mode (road transport) and only a few are able to deliver true multimodal options of hinterland transportation.

Given their group as shown in Figure 4.15, these groups are linked with the elasticities per group given in Table 4.24. In this way, the ports get the corresponding price elasticities of demand. This overview of all elasticities per mode and port is shown in Table A11 of the Appendix.

Given the elasticities per mode and per port, these specific elasticities are used to determine the composite demand elasticity used in GSIM. This is done by first calculating the weighted elasticity per mode according to formula (15):

(15) $$weighted\ average\ elasticity\ per\ mode = \sum\left(\left(\frac{Freight\ per\ mode\ per\ port}{Total\ of\ EU\ freight\ handled\ by\ this\ mode}\right) \times specific\ elasticity\right)$$

This step meant the following weighted average elasticities per mode of transport, shown in Table 4.26.

Table 4.26. Elasticities per mode corrected by market shares

Weighted elasticity	
Total Road	-1.046
Total Rail	-1.005
Total IWW	-1.315

Source: Compiled by Author

Then, these mode specific elasticities are weighted again on their total freight share to determine the total composite demand elasticity, using Table 4.27 and formula (16).

Table 4.27. Total tonnes of freight per mode

Total freight per mode (1000tonnes)	
Total Road	675,736.53
Total Rail	176,811.63
Total IWW	76,053.64
Total	928,601.81

Source: Compiled by Author

(16) $$Total\ weighted\ composite\ demand\ elasticity = weighted\ average\ elasticity\ Road \times \left(\frac{total\ road\ freight}{total\ EU\ incoming\ freight}\right) + weighted\ average\ elasticity\ Rail \times \left(\frac{total\ rail\ freight}{total\ EU\ incoming\ freight}\right) + weighted\ average\ elasticity\ IWW \times \left(\frac{total\ IWW\ freight}{total\ EU\ incoming\ freight}\right)$$

The composite elasticity of demand is then estimated at -1,062. A slightly elastic price elasticity of demand according to this analysis. The full elasticity analysis is available in the Excel file: Elasticity_build.xlsx
The partial demand elasticities derived do also serve to correct the total trade barrier tariff equivalents which were earlier derived. This is because GSIM itself cannot handle these partial demand elasticities for an asymmetric matrix. So, by taking the

total trade barrier tariff equivalents, the tariff corrected by the price demand elasticity per port and mode is calculated by formula (17):

$$Total\ Trade\ barrier\ tariff\ equivalent\ corrected\ for\ elasticity = \big((Total\ Tariff - 1) * Specific\ Elasticity * (-1)\big) + 1$$

Using the derived total trade barrier tariff equivalents for Marseille in Table 4.21 as an example, the corrected trade barriers are then as in Table 4.28, using the elasticities of -0,8 for Road, -1,1 for Rail and -1,1 for IWW (See Appendix Table A11).

Table 4.21. Total trade barrier tariff equivalents for Marseille and four countries

Trade barrier	Destination			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	2.563	3.078	2.798	3.047
Marseille RA	2.603	2.881	2.665	2.868
Marseille IWW	3.085	3.790	3.279	1.000

Source: Compiled by Author.

Table 4.28. Total trade barrier tariff equivalents corrected for elasticities

Trade barrier	Destination			
Origin	Belgium	Bulgaria	Czech Republic	Denmark
Marseille RO	2.251	2.662	2.438	2.638
Marseille RA	2.763	3.069	2.831	3.054
Marseille IWW	3.294	4.069	3.507	1.000

Source: Compiled by Author.

The full matrix with the corrected trade barriers can be found in Initial_Tariff_build.xlsx. These tariff equivalents are used as the initial tariff equivalent basis used for the GSIM analysis.

5. Methodology and Data; The new trade barrier tariff equivalents due to TEN-T Projects

The third and last step to complete the GSIM data necessary to run the model is to establish the final trade barrier tariff equivalent that takes the infrastructural improvements of TEN-T into consideration. This part therefore gives answer to the sub-question:

“What is the barrier to trade between the 83 European ports and the EU-member states, per mode of transport, after considering the TEN-T projects to be finalised?”

The improvements of the TEN-T projects are translated into the time costs tariff equivalent part of the total tariff. These improvements are expected to reduce the bottlenecks between ports and countries, implying a reduction in the time costs tariff barrier part of the transportation costs tariff equivalent. (See Figure 4.6) This reduction in the trade barrier tariff equivalent enables GSIM to calculate the new throughput volumes of the European ports and the related modal splits.

As discussed earlier, two scenarios of TEN-T projects are taken to calculate the impacts. The first is the scenario on Priority Projects of the 2007-2013 framework. The funds for these projects are already awarded with a total of €5,7 billion. The second scenario is the Core Network approach of the new 2014-2020 framework, implemented after the 2011 revision of TEN-T. The funds for these projects are not yet allocated, but a total of €25 billion[15] is expected to be awarded under the Connecting Europe Facility. These projects are likely to be much more spread out across Europe, especially considering the 83 Core Ports identified.

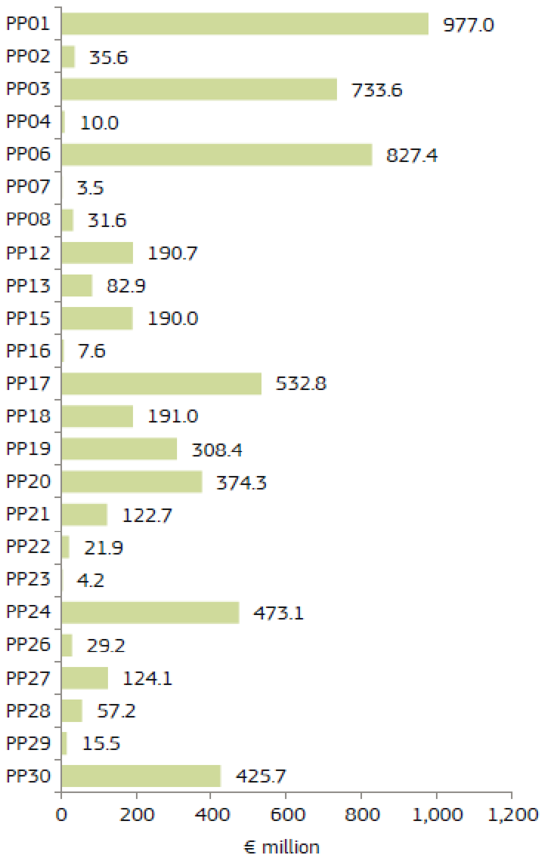
In this section of Chapter 4, first the Priority Projects are discussed together with their implication for the trade tariff equivalent. A new trade barrier for all ports and country combinations is calculated accordingly. Secondly, an estimation is made on what the effects of the Core Network scenario will have on the time costs tariff equivalent. Again, a new trade barrier is identified.

5.1 The TEN-T Priority Projects Scenario

The 30 TEN-T Priority Projects are shown and listed in sections 9.1 and 9.2 of the Appendix. Regarding these projects, a total of €5,7 billion was awarded to 153 specific projects. An overview of the funding per project is given in Figure 4.16. It shows a wide disparity of funding across the projects. Some cover almost 20% of the total budget (project 1) and others are only marginally funded.

[15] 80% of €31,7 billion as stated in the EC MEMO of 19/10/2011.

Figure 5.1. Funding per Priority Project



Source:(TEN-T EA, 2012)

For every Priority Project, the TEN-T Executive Agency has published the details of every specific project, including the amount of funds, the type of project and the actual status.

There are projects that only involve studies on the possibility to carry out work on the infrastructure in the future, others are construction projects with much higher costs and grants received from the EU.

As explained earlier in the thesis, funding from the EU happens only on a limited scale. The maximum degree of funding for construction works is 20% of the total costs of the construction. In some cases, this percentage is lower. The rest is paid by governments or private parties.

It is therefore difficult to assess exactly the 20% of European funding impact on the status of the infrastructure. It is therefore assumed that the European funds have stimulated the other funding that much that without the European Union's contribution the project would not have taken place. The EU grant is therefore assumed to have full impact on the construction of the infrastructure. It should however be kept in mind that the actual amount of money used to establish all the works regarding the Priority Projects is much higher than the €5,7 billion of only EU grants.

To have true impact on the condition of the infrastructure and on the tariff equivalent, only the funds are taken into consideration awarded by the TEN-T budget. Cohesion and Structural funds are also often used to grant Priority Projects but is not part of this thesis' assessment.

For every project the estimation is made what the impact would be on the time costs barrier that is constructed in the earlier stages of this thesis. This is based on the intuition of the author. Projects that are study-type projects are assumed to be of crucial importance for completion of the entire project, but because of the limited size and its soft-nature, the impact on the time-barrier is assumed to be a 10% reduction.

All relevant projects that are considered as influential on the bottlenecks earlier established are assessed on their possible impact. The complete list of projects considered can be found in the Appendix (Section 9.12 to 9.15). They are listed per mode of transport and the details are illustrated in boxes of which the following box is an example.

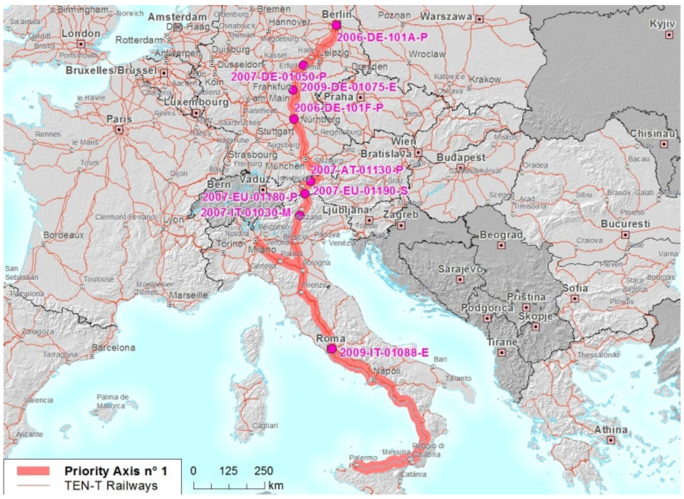
Title of the Project.

Project nr. …….		***Type.*** Short description of the project		
EU subsidy **% of total**	€ amount of subsidy % of total costs			
			Old:	
Impact on bottleneck:		Name of Bottleneck % impact	Old barrier	hours
New Bottleneck:		New barrier hours		
Added track km		For the works which add km's of infrastructure		

Apart from this overview of projects and bottleneck implications, the Priority Projects are discussed and analysed more extensively in this section as well.

Priority Project 1: Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo

Figure 5.2. Overview of PP1.



Source: (TEN-T EA, 2012)

This railway axis from Berlin up to Palermo connects the major urban areas of Germany, Austria and Italy. The increased capacity of the railways and crossing of the mountainous regions must increase a modal shift from road to rail. The most important part of this axis is the construction of the Brenner Base tunnel with a length of 55 km underground. It will create the necessary high capacity rail corridor through Austria. Three projects that are funded partially by TEN-T funds are identified as influential for current bottlenecks in place. One project in Germany influences the capacity bottleneck between Hamburg and Germany, by improving the section between Nuremberg and Furth. The other projects are related to the Brenner Base Tunnel, of which the first is the core construction of this tunnel and the others are improves the capacity of a railway section of the Austrian section before the tunnel. These works reduces the time barrier that is caused by the capacity bottleneck between Austria and Italy. The total amount of funds and reduced hours of barriers are indicated below.

Table 5.1. Impacts from projects PP1.

Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2006-DE-101f-P			
Rail improvements Nuremberg-Furth.	€ 3,300,000	0.1	
2007-AT-01130-P			
Rail improvements Kundl-Baumkirchen before Brenner Tunnel.	€ 58,300,000	0.1	40
2007-EU-01180-P/S			
Brenner Base Tunnel Construction and studies.	€ 786,000,000	0.4	160
TOTAL	€ 847,600,000	0.60	200

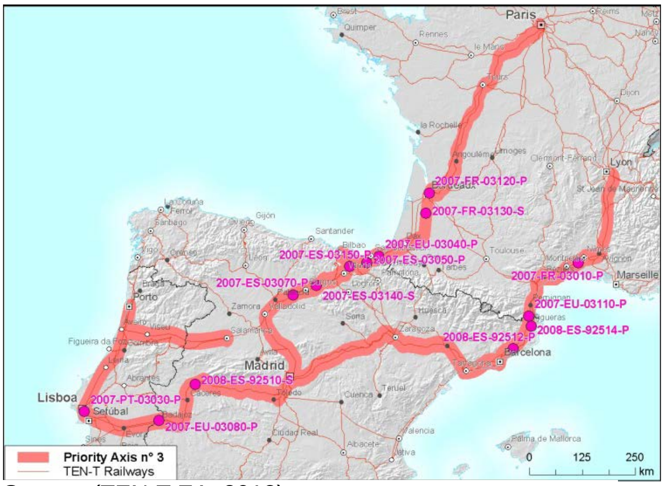
Source: Compiled by Author

Priority Project 2: High-speed railway axis Paris-Bruxelles/Brussels-Köln-Amsterdam-London: PBKAL

This axis does not influence the indicated freight bottlenecks because it only enables high speed rail connections for passenger transport.

Priority Project 3: High-speed railway axis of southwest Europe

Figure 5.3. Overview of PP 3.



Source: (TEN-T EA, 2012)

Ensuring the railway connectivity between France, Spain and Portugal, this railways axis provides works to increase capacity, remove the bottlenecks associated with border barriers between France and Spain and Spain and Portugal and enables some high-speed connections for freight trains.

Besides many projects that improve passenger transport by rail, there are also four projects identified which reduce freight bottlenecks and barriers.

These projects are a new high speed rail track between Spain and Portugal, adding extra kilometres and reducing bottlenecks between Spain and Portugal. There is also a project that improves the connectivity around Bilbao and two projects focussing on the France-Spain border crossing. These projects should remove the bottleneck in place because of the different gauges used in the two countries.

Table 5.2. Impacts from projects PP3

High-speed railway axis of southwest Europe				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2007-EU-03080-P				
Spain-Portugal new line, double track, high speed.	€	312,660,000.00	0.75	110
2010-ES-92255-S				
Study: Rail improvements for a high speed accessible region of Bilbao.	€	2,350,385.00	0.05	
2007-EU-03110-P				
2007-EU-03040-P				
High speed and standard gauge between France and Spain.	€	126,550,000.00	0.33	44
TOTAL	€	441,560,385.00	1.13	154

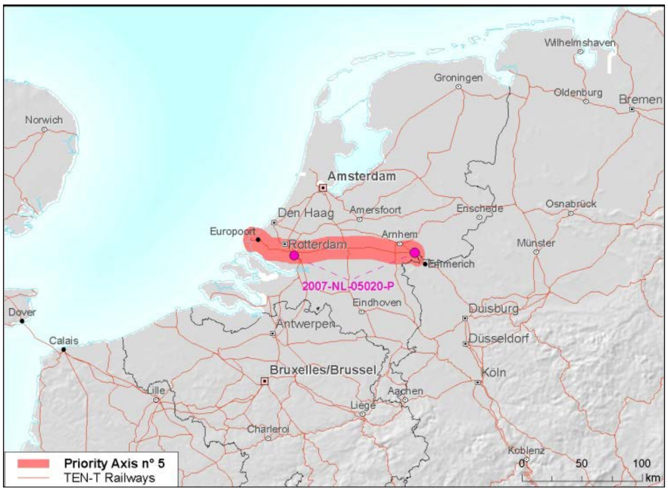
Source: Compiled by Author

Priority Project 4: High-speed railway axis east

This axis only involves improvements of passenger transport.

Priority Project 5: Betuwe Line

Figure 5.4. Overview of PP 5



Source: (TEN-T EA, 2012)

The 160 km freight dedicated rail track between the Port of Rotterdam and the German border is an essential link to connect Europe's biggest port with the industrial zone of the Ruhr-area. The track was already completed in 2007 but still a bottleneck has to be removed at the Dutch-German border and near Kijfhoek. There, the electrification system need to be adapted to European standards of the 5/25 kVAC supply.

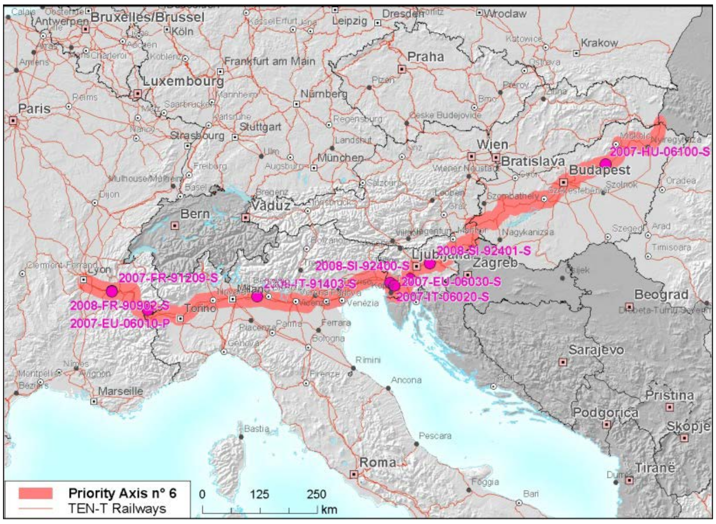
Table 5.3. Impact from Projects PP5

Betuwe line				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2007-NL-05020-P				
Legacy Systems adaptation of 15/25 kVAC at border NL-DE .	€	19,880,000	0.75	
TOTAL	€	19,880,000	0.75	0

Source: Compiled by Author

Priority Project 6: Railway axis Lyon-Trieste-Divača/Koper-Divača-Ljubljana-Budapest-Ukrainian border

Figure 5.5. Overview of PP6



Source: (TEN-T EA, 2012)

This 1700 km rail axis from west to east crosses multiple Member States and important urban areas. The passages through the Alps are crucial to make rail transport attractive as road substitute but they also imply high construction costs. Three projects are identified as relevant to reduce freight bottlenecks, of which one is the main construction of tunnels between Lyon and Turin.

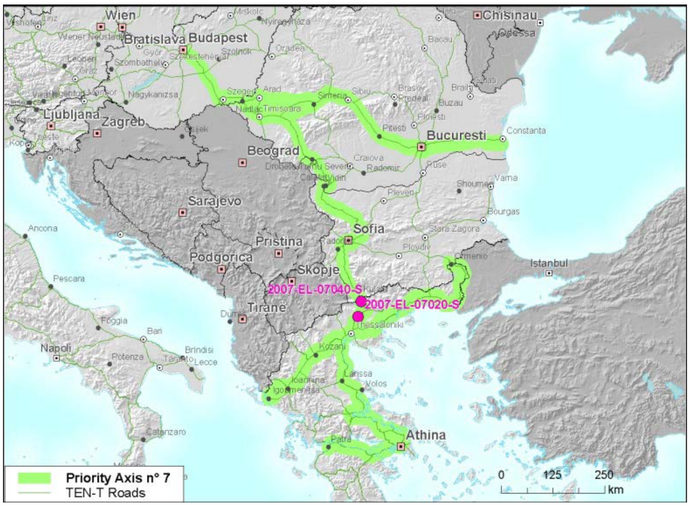
The new track between Lyon and Turin involves the construction of 80km of new tracks and several tunnels to be made. This is a very expensive project, making a rail connection possible that crosses the Alps. However, there were no rail bottlenecks identified by the author regarding this track, so these construction works only add extra kilometres.

Table 5.4. Impacts from Projects PP6

Railway axis Lyon-Trieste-Divača/Koper-Divača-Ljubljana-Budapest-Ukrainian border				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2007-EU-06010-P				
New rail link between Lyon and Turin covering an 80km track and two new tunnels.	€	671,800,000		80
2007-IT-06020-S				
Study on a new track between Ronchi and Trieste.	€	24,000,000		30
2010-SI-92232-S				
Upgrading electrification and single tracks.	€	1,100,000	0.75	
TOTAL	€	696,900,000	0.75	110

Priority Project 7: Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest

Figure 5.6. Overview of PP7



This project involves the improvement of several motorway sections in South-East Europe. Road conditions are weak in this youngest part of the EU. The start of construction is planned around 2014. So far, only some studies have been carried out to examine the necessary works to be done. These studies are however crucial and their impact is therefore set at 10% on the current time barrier.

Source: (TEN-T EA, 2012)

Table 5.5 Impacts from PP7

Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2006-HU-92201-S				
Study to approve and tender out new motorway, relieves Budapest.	€	5,160,000	0.016	
2007-EL-07020-S				
It concerns studies for re-aligning/upgrading two road sections on the vertical axis Thessaloniki-Serres-Promachonas.	€	2,350,000	0.016	
TOTAL	€	7,510,000	0.03	0

Source: Compiled by Author

Priority Project 8: Multimodal axis Portugal/Spain-rest of Europe

Most of the funds associated with this project are granted by the Structural or Cohesion Funds, not from TEN-T funds. Since this thesis assesses only projects which are co-financed through the TEN-T funds, the projects falling under this priority project were not taken into consideration. Further, some projects have an overlap with PP19 and are discussed together in the respective section of PP19. For instance the 84 kilometre new track for mixed traffic between Madrid and Galicia.

Priority Project 9: Railway axis Cork–Dublin–Belfast–Stranraer

This project was completed in 2001 and therefore not relevant for the bottlenecks assessed in 2008. The three largest cities of Ireland Belfast, Cork and Dublin have been connected with each other through a better rail link. For the future, traffic management systems and further investments are planned to be carried out.

Priority Project 10: Malpensa Airport

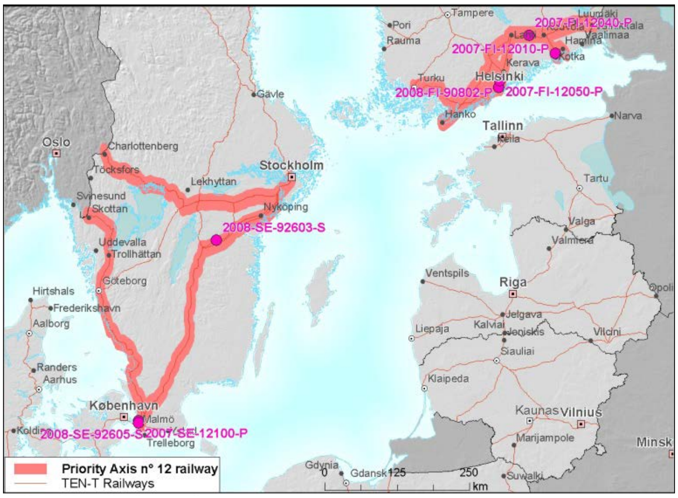
The Malpensa Airport project was already completed in 2001 and did also not influence the established 2008 bottlenecks because air freight transport is not included in this thesis assessment. Though it is worth mentioning that the airport functions successfully, helped by its strategic location North-West of Milan. Both road and rail links between Milan, Switzerland and Varese crosses the airport's area.

Priority Project 11: Øresund Bridge

This 8 km long bridge crosses the Øresund straight and connects Denmark with Sweden. Both road and rail traffic can cross the strait. It is a very important link between Central-Europe and the Nordic countries. The project was completed in 2000, without any cost overruns. Its completion did not affect the established 2008 bottlenecks.

Priority Project 12: Nordic Triangle railway/road axis

Figure 5.7. Overview of PP 12.



Source: (TEN-T EA, 2012)

Priority Project 12 considers both rail and road improvements in both Sweden and Finland. Both passenger and freight transport works are taking place. This axis has to improve the connectivity with the Baltic States, Russia and central Europe.

There are two rail freight projects that influence the assessed time barriers. These include the rail connection between Kotka and Kouvola and the Citytunnel project around Malmo. Further, five road projects are assessed. These include works around Stockholm, Helsinki, Goteborg and Trelleborg.

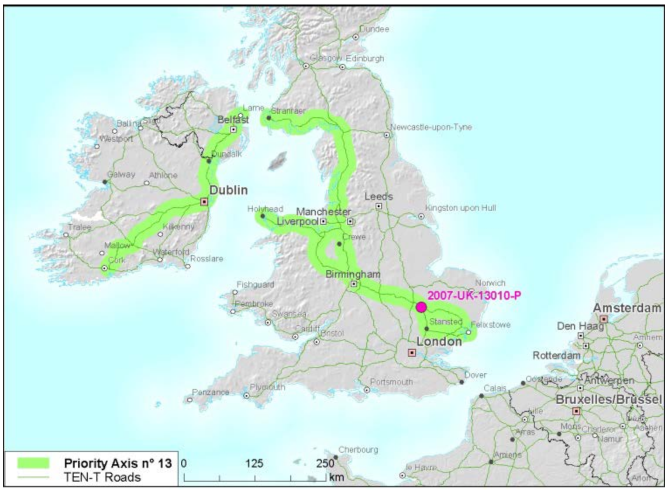
Table 5.6 Impacts from PP 12

Nordic Triangle railway/road axis			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2007-FI-12010-P			
Upgrading 60 km rail connection and new railway to Kotka.	€ 6,600,000		60
2007-SE-12100-P			
New lines, tunnels, stations and an upgrade of the Oresund connection.	€ 51,830,000	0.75	17
2007-SE-12090-P			
Better and efficient transport across the ring road of Stockholm.	€ 56,150,000	0.166	
2008-FI-90800-P			
New 51 km highway between Turku and Helsinki.	€ 7,790,000	0.05	51
2008-FI-90801-S			
Studies for the completion of three important road links, including the Helsinki ring road.	€ 5,500,000	0.011	
2008-SE-92607-P			
Partly new 10km motorway between Trelleborg and Vellinge.	€ 5,340,000		10
2009-SE-92600-S			
Studies for a new tunnel to relieve traffic from Gothenburg.	€ 2,140,000	0.016	
TOTAL	€ 135,350,000	0.99	138

Source: Compiled by Author

Priority Project 13: Road axis United Kingdom/Ireland/Benelux

Figure 5.8. Overview of PP13



Source: (TEN-T EA, 2012)

Along this axis, new roads are being constructed or existing roads are upgraded to better connect Britain with Ireland and Northern Europe. Three projects have impact on the existing bottlenecks and will increase the capacity of the network around Birmingham, London and Belfast.

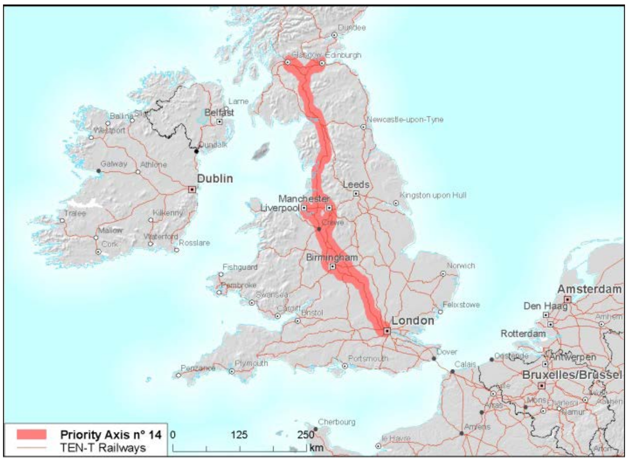
Table 5.7. Impacts from PP 13.

Road axis United Kingdom/Ireland/Benelux				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2007-UK-13010-P				
Three schemes of Motorway upgrades, A14, M6 and A1.	€	23,997,440	0.066	
2009-UK-13027-E				
Traffic management to reduce congestion between Felixstowe and Birmingham.	€	11,670,000	0.133	
2009-UK-92708-S				
Doubling the capacity between Belfast and Larne port, study.	€	2,165,000	0.013	
TOTAL:	€	37,832,440	0.212	0

Source: Compiled by Author

Priority Project 14: West Coast Main Line UK

Figure 5.9. Overview of PP 14.



Source: (TEN-T EA, 2012)

This upgrade of an 850 km rail track did not fall under the 2007-2013 framework but was not yet incorporated in the infrastructure status as established in the initial time barriers. Therefore, this project is taken into consideration and so it has an impact on the bottlenecks. The total project costs more than £8 billion and a fraction was granted by the EU. It did remove the complete bottleneck of the congested axis from South to North Britain.

Table 5.8. Impacts from PP 14

West Coast Main Line UK				
Project	**Subsidy**		**Reduced barrier**	**Added km**
-				
Upgrading of a congested 850 km long rail track.	€	40,000,000	0.5	
TOTAL:	€	40,000,000	0.5	0

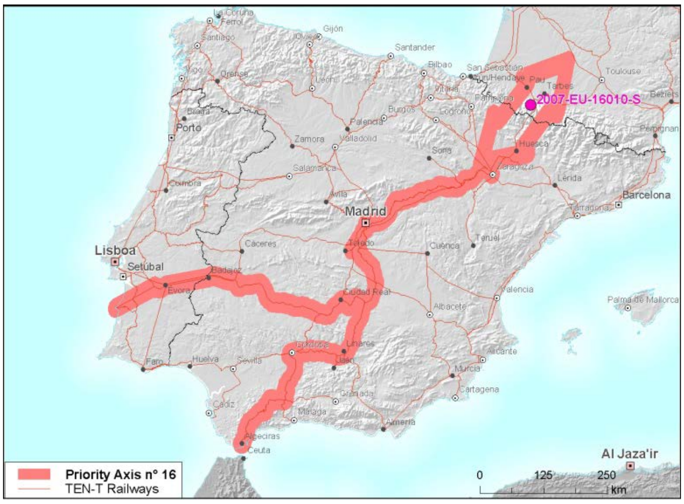
Source: Compiled by Author

Priority Project 15: Galileo

Galileo is Europe's initiative to provide a state-of-the-art global navigation satellite system, providing a highly accurate, global positioning service under civilian control. Through 2007-2013 period, 190.000.000 euro was awarded for studies. However, the impact of this amount on the relevant modes of transport is hard to determine, therefore it is not taken into consideration.

Priority Project 16: Freight railway axis Sines/Algeciras-Madrid-Paris

Figure 5.10. Overview of PP 16



Source: (TEN-T EA, 2012)

A high capacity freight axis of railways between the ports of Algeciras and Sines and the rest of Europe is developed under PP16. The connection was missing and a new link that crosses the Pyrenees is also planned. The constructions should facilitate the integration of the European standard gauge as well, an important constraint for rail freight transport towards Spain and Portugal. Many of the subsidies were granted through other funds, only the new axis across the Pyrenees is part of TEN-T funds. The construction of this axis has not yet begun. However an economic co-operation has been set up between France and Spain to improve coordination of projects.

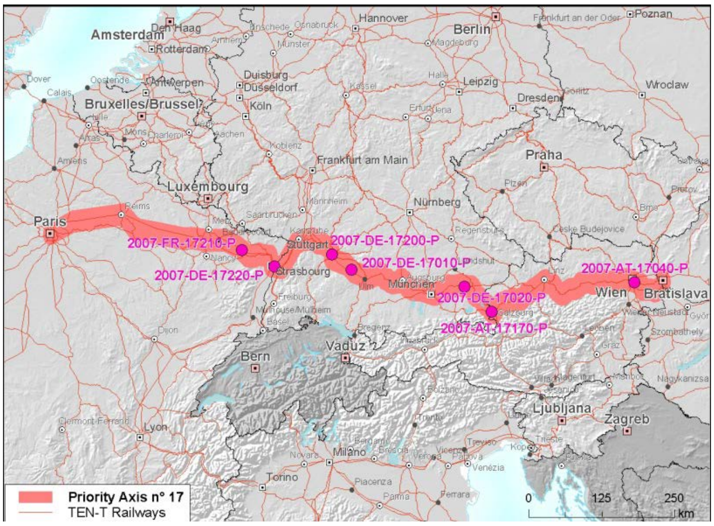
Table 5.9. Impact from PP 16

Freight railway axis Sines/Algeciras-Madrid-Paris				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2007-EU-16010-S				
Set up of EEIG between Spain and France.	€	5,000,000	0.33	0
TOTAL:	€	5,000,000	0.33	0

Source: Compiled by Author

Priority Project 17: Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava

Figure 5.11. Overview of PP 17



Source: (TEN-T EA, 2012)

This East-West axis crosses the centre of Europe and involves many projects with impacts on the derived hinterland bottlenecks for ports. A total of ten sub-projects reduce a total of 5 bottlenecks around Germany and Austria. Especially near Munich, Wien and Frankfurt. The total amount of grants awarded lies around 400 million Euros.

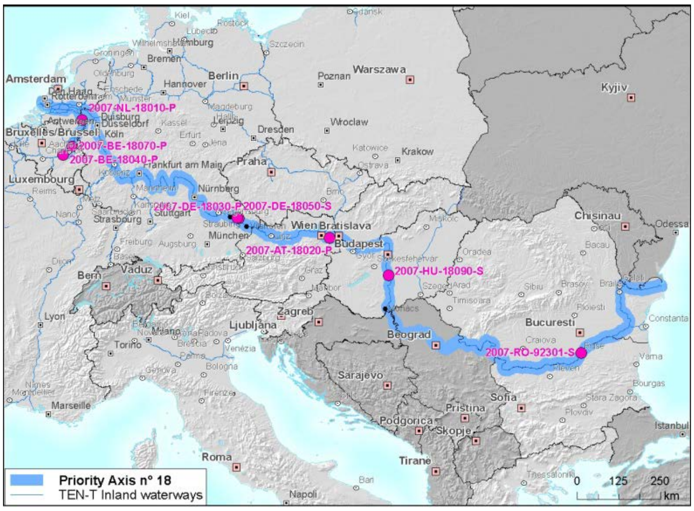
Table 5.10. Impacts from PP17

Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2006-DE-1004A-S			
Studies for new line between Stuttgart and Ulm.	€ 2,968,000	0.025	
2007-DE-17010-P			
2007-DE-17200-P		0.05	
2006-DE-1005-P			
Wendlingen-Ulm part; new line, tunnels. Stuttgart-Wendlingen part; tunnels, track etc. Augsburg-Munich; upgrade of capacity	€ 218,680,000	0.225	117
2007-AT-17040-P			
2010-AT-91136-S		0.33	44
Works for better connectivity of Vienna. Study regarding a new freight terminal in Wien.	€ 120,918,476	0.25	
2007-AT-17170-P			
2007-DE-17020-P			
Works will partially decrease the German-Austrian bottleneck in capacity.	€ 46,424,272	0.1	
2007-DE-17220-P			
Doubling the capacity at this French-German track between Kehl and Appenweier.	€ 26,950,000	0.1	
2007-DE-60320-P			
ERTMS system for Rail installed at Mannheim-Basel section.	€ 11,625,000	0.08	
TOTAL	€ 427,565,748	1.16	161

Source: Compiled by Author

Priority Project 18: Waterway axis Rhine/Meuse-Main-Danube

Figure 5.12. Overview of PP18



Source: (TEN-T EA, 2012)

PP18 is the only complete waterway axis of TEN-T. It follows the Rhine, Meuse, Main and Danube from the North Sea up to the Black Sea. Some parts of this axis face restrictions because of too shallow depths and low bridges. These are supposed to be removed under this priority project. Four sub-projects eliminate the current bottlenecks estimated earlier in the thesis.

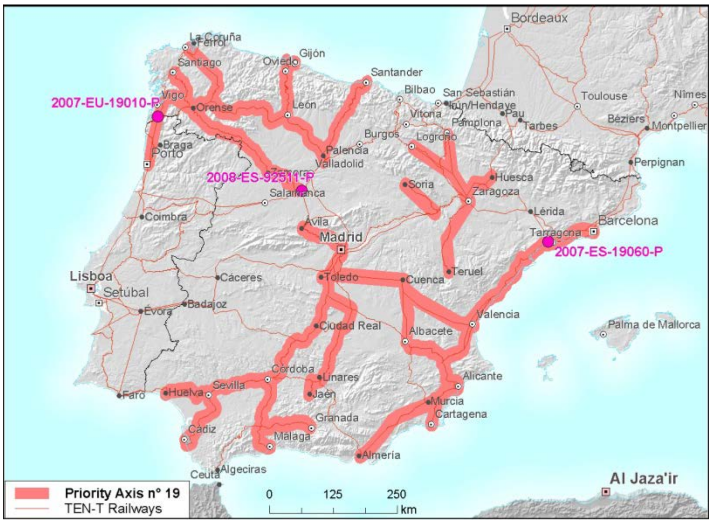
Table 5.11. Impacts from PP18

Waterway axis Rhine/Meuse-Main-Danube			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2007-AT-18020-P			
Improvement of the river bed, enabling sufficient draught at this section East of Vienna.	€ 22,420,501	0.83	
2007-DE-18030-P			
2007-DE-18050-S			
Uplifting the currently low rail bridge of Deggendorf up to 8m. Research to improve the draught at Straubing.	€ 23,510,000	0.57	
2007-HU-18090-S			
Elimination of draught restrictions on the Hungarian part of the Danube.	€ 4,000,000	0.33	
TOTAL:	€ 49,930,501	1.73	0

Source: Compiled by Author

Priority Project 19: High-speed rail interoperability in the Iberian Peninsula

Figure 5.13. Overview of PP 19



Source: (TEN-T EA, 2012)

This project aims at making the current rail network at the Iberian Peninsula interoperable with the European Network. It involves the preparation of a network that fits with the European standard gauge and is capable of providing access to high-speed trains. The European Rail Traffic Management System also has to be installed. Both passenger and freight transport will benefit from the developments. Two specific projects are highlighted.

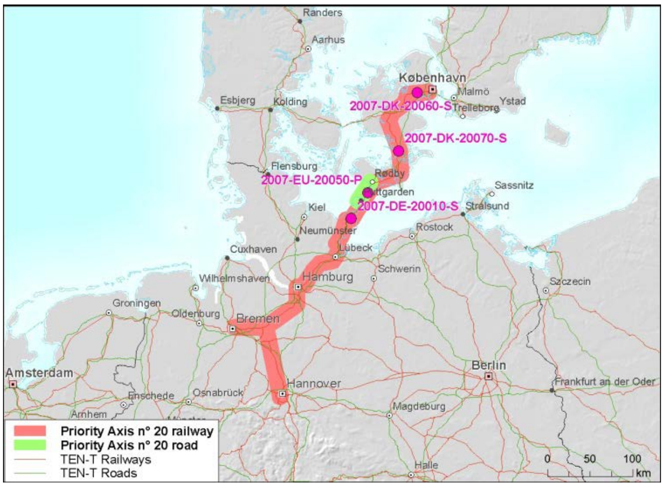
Table 5.12. Impacts from PP19

High-speed rail interoperability in the Iberian Peninsula			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2009-ES-19091-E			
New 83 km high speed track for mixed traffic.	€ 35,202,000	0.25	83
2007-EU-19010-P			
High speed track between the North of Portugal and Spain.	€ 244,140,000		60
TOTAL:	€ 279,342,000	0.25	143

Source: Compiled by Author

Priority Project 20: Railway axis Fehmarn belt

Figure 5.14. Overview of PP20



This project involves the construction of a bridge or tunnel to cross 19 kilometres over the Fehmarn Strait. In this way, it directly links Germany with Denmark. The project involves besides the construction of the crossing also the improvements of several rail sections in Denmark and Germany in order to facilitate the increased capacity along this axis. It relieves the western part of the Danish rail network considerably. It is estimated that the freight transport times are reduced by two hours from Hamburg to Copenhagen.

Table 5.13. Impact from PP20

Railway axis Fehmarn belt			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2006-DE-DK-3009-S			
2007-DE-20010-S			
2007-DK-20060-S			
2007-DK-20070-S			
2007-EU-20050-P			
Studies and construction.	€ 307,842,000	1.00	0
TOTAL:	€ 307,842,000	1.00	0

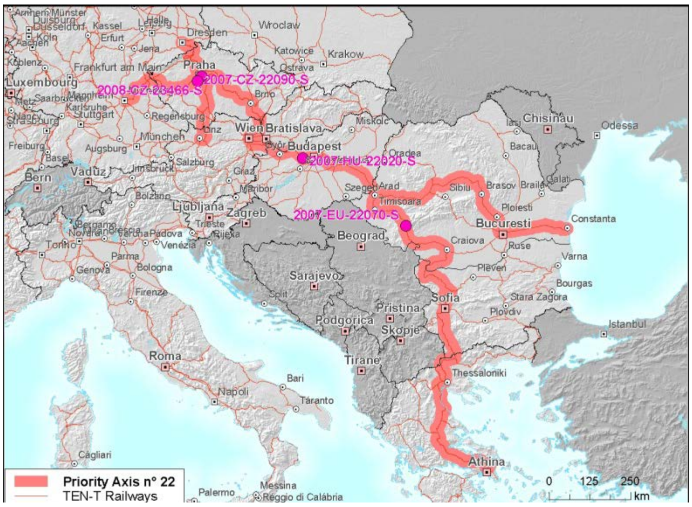
Source: Compiled by Author

Priority Project 21: Motorways of the sea

This priority project is co-financed for €122 million from the TEN-T funds with the aim to shift cargo from land to sea. The maritime links between Member States are not yet fully exploited and they can serve as an environmental friendly and cost-effective mode. Therefore, more efficient and frequent maritime logistic services need to be developed. However, it is not possible to estimate the impact of this project on land infrastructure bottlenecks and on the shift it creates towards the sea. It has therefore been left out of consideration.

Priority Project 22: Railway axis Athina–Sofia–Budapest–Wien–Praha–Nürnberg/Dresden

Figure 5.15. Overview of PP22

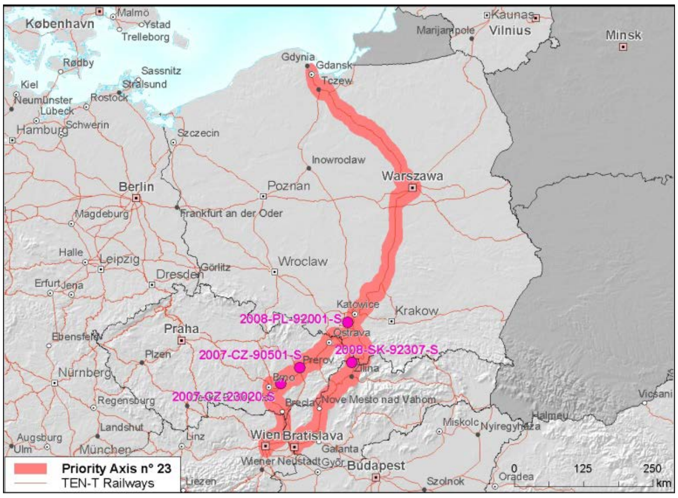


Source: (TEN-T EA, 2012)

This Priority Project has much potential and is important to reduce the many rail bottlenecks present in Eastern-Europe. However, so far only some small studies are done by TEN-T to examine the works that are needed. The construction is planned after 2013. Therefore, no possibility exists to assess the impact under the current TEN-T framework.

Priority Project 23: Railway axis Gdańsk–Warszawa–Brno/Bratislava-Wien

Figure 5.16. Overview of PP 23



Source: (TEN-T EA, 2012)

This axis will enable a true multimodal corridor to be created from Gdansk towards Central Europe. Modernisation of tracks and links is necessary. Freight trains will be able to cross Poland at faster speeds, up to 120 km/h. Six projects are identified as relevant for the bottlenecks which were identified earlier in Czech Republic, Poland and Slovakia.

Table 5.14. Impacts from PP 23

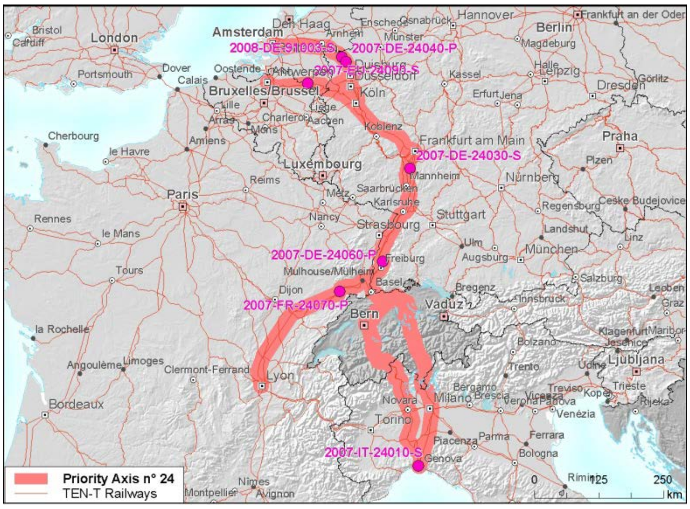
Railway axis Gdańsk–Warszawa–Brno/Bratislava-Wien				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2006-CZ-92101-S				
2006-CZ-92109-S				
Studies for modernization of two sections between Prague and SK/CZ border.	€	4,700,000	0.05	
2010-PL-92245-S				
2006-PL-92608-S				

Project	Subsidy	Reduced barrier	Added km
2009-PL-60151-P			
Studies for modernisation of Katowice station and surroundings. Studies for modernization Warsaw junction. Project to modernize rail tracks with ETCS.	€ 16,902,657	0.25	
2009-SK-60108-P			
Implementing ETCS and higher speeds around SK/CZ border.	€ 2,025,000	0.333	
TOTAL:	€ 23,627,657	0.633	0

Source: Compiled by Author

Priority Project 24: Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen

Figure 5.17. Overview of PP 24



Source: (TEN-T EA, 2012)

This high capacity axis from Rotterdam towards Genoa must facilitate more trains at higher speeds over a range of more than 2000km. Although this axis is already a well used axis for freight transport by rail, several sections need to be improved to serve as an even better alternative for other modes. Critical sections are Duisburg-Emmerich-Basel, the possibility to create an "Iron Rhine" between Antwerp and Germany and a railway section between the Rhine and the Rhone. In total, six specific projects are identified with a total of €3 billion funded by the TEN-T funds.

Table 5.15. Impacts from PP 24

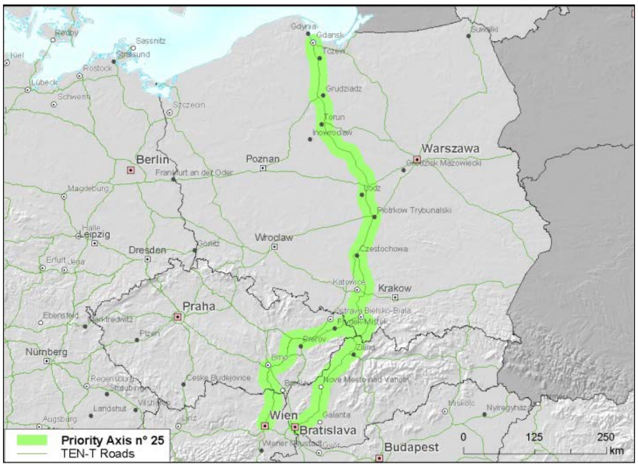
Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2007-DE-24040-P			
2007-DE-60320-P			
2009-DE-24070-E			
Increasing the capacity of this high traffic piece between NL-Duisburg. Implementing ETCS for Duisburg-Emmerich. New interlockings to facilitate interoperable rail service between Emmerich and Basel.	€ 98,338,302	0.25	
2007-DE-24060-P			
Increase in capacity between Karlsruhe and Basel.	€ 46,656,550	0.32	
2007-EU-24090-S			

Studies for the creation of a rail freight link from Antwerp towards Germany, relieving part Brussels-Germany. 'Iron Rhine'	€	2,630,500	0.075	
2007-FR-24070-P	€	-	0.333	
New high speed track with freight possibilities between Rhine-Rhone.	€	198,000,000	0.125	140
TOTAL:	€	345,625,352	1.103	140

Source: Compiled by Author

Priority Project 25: Motorway axis Gdańsk–Brno/Bratislava-Vienna

Figure 5.18. Overview of PP25



Source: (TEN-T EA, 2012)

This project covers the same axis as PP 23 but is now involving road transport instead of rail. The congested port of Gdansk will be attributed with a new road connection and a new motorway of 900 km is constructed in Slovakia. Other motorways are upgraded, which is a necessity in Poland. The condition of the road is relatively weak in this country. Up to now, only studies have been carried out through TEN-T funds to assess the exact circumstances and necessities at which the construction works have to be undertaken. The studies involve in a motorway improvement near Katowice and construction of the A1 west of Warsaw. The studies are assumed to have a 10% impact on future works.

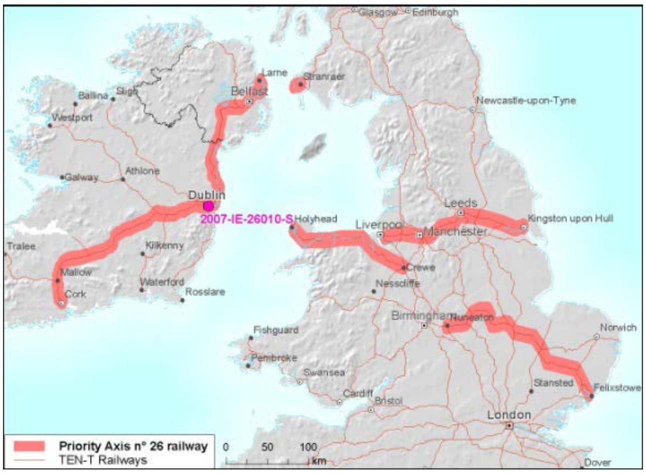
Table 5.16. Impacts from PP25

Motorway axis Gdańsk–Brno/Bratislava-Vienna				
Project	**Subsidy**		**Reduced barrier**	**Added km**
2009-PL-92005-S				
2009-PL-92004-S				
2005-PL-92603-S				
Three studies towards upgrading of the motorways around Katowice.	€	2,722,575	0.016	
2005-PL-92604-S				
Study for the construction of a new highway West of Warsaw.	€	11,000,000	0.03	
TOTAL:	€	13,722,575	0.046	0

Source: Compiled by Author

Priority Project 26: Railway/road axis Ireland/United Kingdom/continental Europe

Figure 5.19. Overview of PP 26.



Source: (TEN-T EA, 2012)

Priority Project 26 considers several rail and road projects to connect Ireland with England and improve the inland connectivity of Britain as well. Regarding the rail improvements there is one project that improves a current bottleneck between Tees and Hartlepool and London by increasing the capacity of the track.

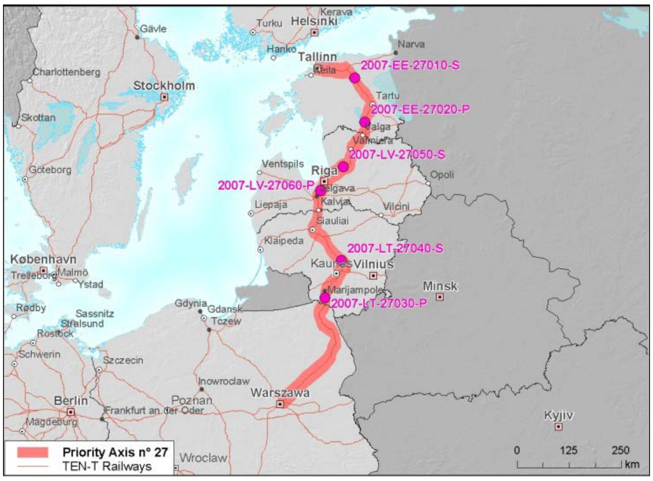
Table 5.17. Impacts from PP26

Railway/road axis Ireland/United Kingdom/continental Europe			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2009-UK-26029-E			
Improve a rail section and enable higher capacity between Felixstowe and Nuneaton.	€ 9,234,000	0.1	
TOTAL:	€ 9,234,000	0.10	0

Source: Compiled by Author

Priority Project 27: "Rail Baltica" axis: Warsaw-Kaunas-Riga-Tallinn-Helsinki

Figure 5.20. Overview of PP 27



Source: (TEN-T EA, 2012)

This strategic rail axis links four 'young' Member States: Estonia, Lithuania, Latvia and Poland. Further, it also increases the connectivity with Finland through other modes and through Russia. The line is an existing one, but different operating systems, gauges and numbers of tracks are in place. It is a very important link for the three seaports of Tallinn, Riga and Helsinki, and is close to the port of Klaipeda.

Table 5.18. Impacts from PP27

"Rail Baltica" axis: Warsaw-Kaunas-Riga-Tallinn-Helsinki			
Project	**Subsidy**	**Reduced barrier**	**Added km**
2006-LT-92401-S			
Study on the relevant technical design of infrastructure between Poland and Lithuania.	€ 2,700,000	0.025	
2007-EE-27010-S			
2007-LT-27040-S			
2007-LV-27050-S			
Studies on the feasibility and technical measurements to implement European gauge in the Baltic area.	€ 18,170,000	0.08	
2007-EE-27020-P			
Upgrading the single rail track in Estonia.	€ 9,300,479	0.25	
2007-LT-27030-P			
Construction of new cross border sections with Latvia and Poland.	€ 45,703,402	0.725	
2007-LV-27060-P			
Upgrading of a single rail track in Latvia of 152km.	€ 10,065,744	0.25	
TOTAL:	€ 85,939,625	1.33	0

Source: Compiled by Author

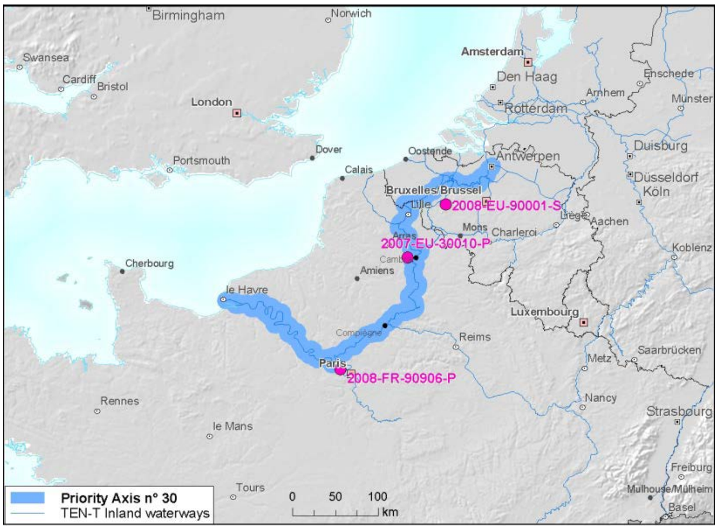
Priority Project 28: EuroCap-Rail on the Brussels-Luxembourg-Strasbourg railway axis

This project only involves passenger transport dedicated to high-speed rail improvements. Therefore it is not taken into consideration for this freight transport analysis.

Priority Project 29: Railway axis of the Ionian/Adriatic intermodal corridor

This project is still in the design phase and only some small studies have been done. Yet, it is important for the future that this link in Greece will be established. Several ports are going to be connected through rail. Now, only few Greek ports are connected through rail with their hinterland.

Figure 5.21. Overview of PP30



Priority Project 30: Inland Waterway Seine-Scheldt

The link between the Seine and the Scheldt is currently missing. It is not possible to navigate with the larger barges from North-France to Belgium and The Netherlands. Therefore, this project should remove the missing link and make this connection accessible for barges up to 6000 tonnes (class Vb). The new link covers the section between Ghent and Compiegne and is the second priority project that involves inland waterways. More than €400 million is used to eliminate the bottlenecks. The ports of Le Havre and Belgium will be better connected and are expected to have more possibilities to transport cargo by barge to their hinterland.

Table 5.19. Impacts from PP30

Inland Waterway Seine-Scheldt				
Project	Subsidy		Reduced barrier	Added km
2007-EU-30010-P				
Connection of Seine with Scheldt including eliminating bottlenecks.	€	420,190,000	1.67	
TOTAL:	€	420,190,000	1.67	0

Source: Compiled by Author

After considering all these projects of the 2007-2013 TEN-T Framework for Priority Projects, the overall statistics are as follows:

Table 5.20. Overview of projects that influenced the time barriers to trade

Mode	Number of Projects	Total Grants	Total Reduced hours	Total additional km of infrastructure	€/hour
Road	14	€ 135,985,015	1.28	138	€ 106,238,293
Rail	52	€ 3,588,546,767	10.39	985	€ 345,517,694
IWW	5	€ 470,120,501	3.4	0	€ 138,270,736
Others[16]		€ 312,000,000			
Total	71	€ 4,506,652,283	15.07	1123	€ 299,127,325

Source: Compiled by Author

A total of 71 projects have been taken into consideration in this scenario of TEN-T priority projects assessment. These projects sum up to more than €4.5 billion of granted funds, including the Galileo and Motorways of the sea. Most of the projects and grants were dedicated to rail transport improvements. This mode clearly gets the most attention from the European Commission. However, relatively it also costs the most to reduce one hour of time bottlenecks regarding rail infrastructure; almost €350 million of grants. It should also be kept in mind that these grants only form 20% of the total project costs, at maximum.

Road infrastructure got the least attention in terms of funds, but also remains the cheapest way to reduce time barriers according to this analysis. However, the Seine-Scheldt project puts quite some pressure on the IWW investments needed to reduce bottlenecks. Without that €420 million, IWW investments are by far the cheapest way to reduce absolute hours of bottlenecks. On the other hand, IWW also needs by far most hours to reach the destinations.

[16] Galileo and Motorways of the sea.

Concluding, the TEN-T framework of 2007-2013 directly reduced 15 hours of time barriers along the European infrastructure network of roads, rail tracks and inland waterways. It further added 1123 kilometres of new infrastructure, costing in total €4.5 million.

By eliminating some time barriers under this scenario, this also meant new time barriers between ports and their hinterlands, implying new tariff equivalents of time costs and therefore also new tariff equivalents of total trade costs to be put into GSIM as new tariff equivalents.(Formula 14) These can be found in the Time_value_Tariff_NEWPP.xlsx and PP_tariff_build.xlsx, thus answering the sub-question:

“What is the barrier to trade between the 83 European ports and the EU-Member States, per mode of transport, after considering the TEN-T projects to be finalized?”

5.2 The Core Network Scenario

The second scenario of infrastructure improvements entails the consideration of the proposed works under the 2014-2020 TEN-T Framework of the Core Network. This revised framework also strives to include 83 ports into the Trans-European Network of Transport. Because this scattered approach might decrease the opportunities of modal shifts in ports to sustainable modes, this scenario is assessed and compared with the 2007-2013 framework of Priority Projects.

Having only the availability of rough descriptions of projects for the Core Network as displayed in the Appendix section 9.3, this second scenario outcome should be interpreted with some care. It is only publicly known that the Connecting Europe Facility contributes for 80% of €31.7 regarding the Core Network. Further, the specific projects for each section of the Core Network are still under application and not yet decided upon. The second scenario is thus made by using only these rough descriptions which are made publicly available.

The second scenario of infrastructure improvements starts with the initial status of the infrastructure as derived in section 4.6.1. This tariff equivalent was used as final tariff equivalent in GSIM for the first scenario but is used as initial tariff equivalent in the second scenario. The final trade barrier incorporates the new time barriers established by considering the rough descriptions of the Core Network works.

The list of pre-identified sections of the Core Network is assessed whether the section improvements have impact on the established bottlenecks that are still in place after the 2007-2013 project consideration. Not all sections turned out to have any impact on the bottlenecks, or some bottlenecks were already removed after the 2007-2013 works. The list of the sections that did impact the bottlenecks in place is listed in the Appendix, Table A12.

Some of the sections only involve some studies, which were again assumed to have 10% impact on the current time barrier. The most influential section of improvement is seen along the Elbe. The draught restrictions along the Elbe from Hamburg to Prague are preventing the full usage of this waterway. The Priority Projects did not improve this bottleneck but the proposed upgrading of the Elbe under the 2014-2020 framework has the potential to remove the 6 hour time barrier between Hamburg and Prague.

A total of 25 sections will have an estimated impact of 15.44 hours of removed time barriers. (15.07 for the Priority Projects) Again, the focus of the projects lies on the infrastructure of the rail network. Road infrastructure is not even once improved under the 2014-2020 framework. This indicates a strong policy that aims at removing freight transport by road to the other modes.

The total number of identified sections by the EC is 127. Given the fact that the budget of the Core Network lies at €25.4 billion (80% of €31.7 billion), it is estimated that the 25 influential sections of the Core Network need as much funds as the Priority Projects to reduce a total of 15 hours of time barrier. [17] Around €5 billion for 15.44 hours of the Core Network works against €4.5 billion to reduce 15.07 hours under the Priority Projects.

The newly derived time barriers are again fit into the total trade cost barrier tariff equivalent by using the formula (14). A second run of GSIM is then performed with the initial and new tariffs and the estimated transport flows between ports and their hinterlands from scenario 1.

The Core Network final time barrier tariff equivalents are stated in spread sheet Time_value_tariff_NEWCN.xlsx and the related spread sheet with final total trade barrier tariffs under CN_Tariff_build.xlsx This second scenario also partially gives answer on sub-question three:

“What is the barrier to trade between the 83 European ports and the EU-member states, per mode of transport, after considering the TEN-T projects to be finalized?”

[17] 25/127*25.4= 5 billion.

6. Results and Analysis

The results of the two scenario impact-analyses of TEN-T are obtained through GSIM simulation. The GSIM output takes several forms, including; percentage changes of port hinterland volumes per port and mode, changes in imported port related transport flows for EU27 countries, changes in the contributions of the three modes per port in absolute and relative values and total European figures of modal splits and cargo transported values. In this section, the results are presented in several forms and further analysed and interpreted.

It should be noted that the results for the infeasible transport connections are not displayed. These 1701 combinations of 63 origin points and 27 EU countries were physically impossible to make with the given mode of transport. For example, inland waterway transportation is physically impossible for several Mediterranean ports. The value of transported flows for these mode and port combinations was therefore zero and no change could have occurred or will occur because of TEN-T intervention. This made no change in the results for these origin-destination combinations. They are therefore not presented, allowing a focus on the relevant results. A list of these connections is provided in the Appendix, Table A13.

In Section 6.1, the results and analysis of the Priority Project Scenario are presented. Section 6.2 provides the results and analysis of the Core Network scenario and section 6.3 makes a comparison between the two.

6.1 Priority Project Scenario

In the Methodology chapters, the trade values, total initial trade barriers and total final trade barriers were determined, taking into consideration the relevant Priority Projects and their impact on bottlenecks. Now, the impact of the 71 considered projects that reduced 15 hours of bottlenecks, costing €4.5 billion is estimated through GSIM. The GSIM model with all the results can be accessed as well through the Excel file; New GSIM - SC1. PP.xlsx

The absolute change in cargo values that are handled in the 83 European ports and transported further into Europe is displayed in the following Figure 6.1. The ports are clustered on location to make the results easier to interpret. It is decided to show all port-figures together, in order to have the possibility to directly compare the absolute, relative, port and mode figures at the same time.. Figure 6.2 illustrates the absolute changes in port throughput as well, but divided in mode contribution. Figure 6.3 shows the relative changes in percentages and 6.4 the percentage changes of modal splits, per port.

Figure 6.1. Value changes of port throughput to the European hinterland, per port

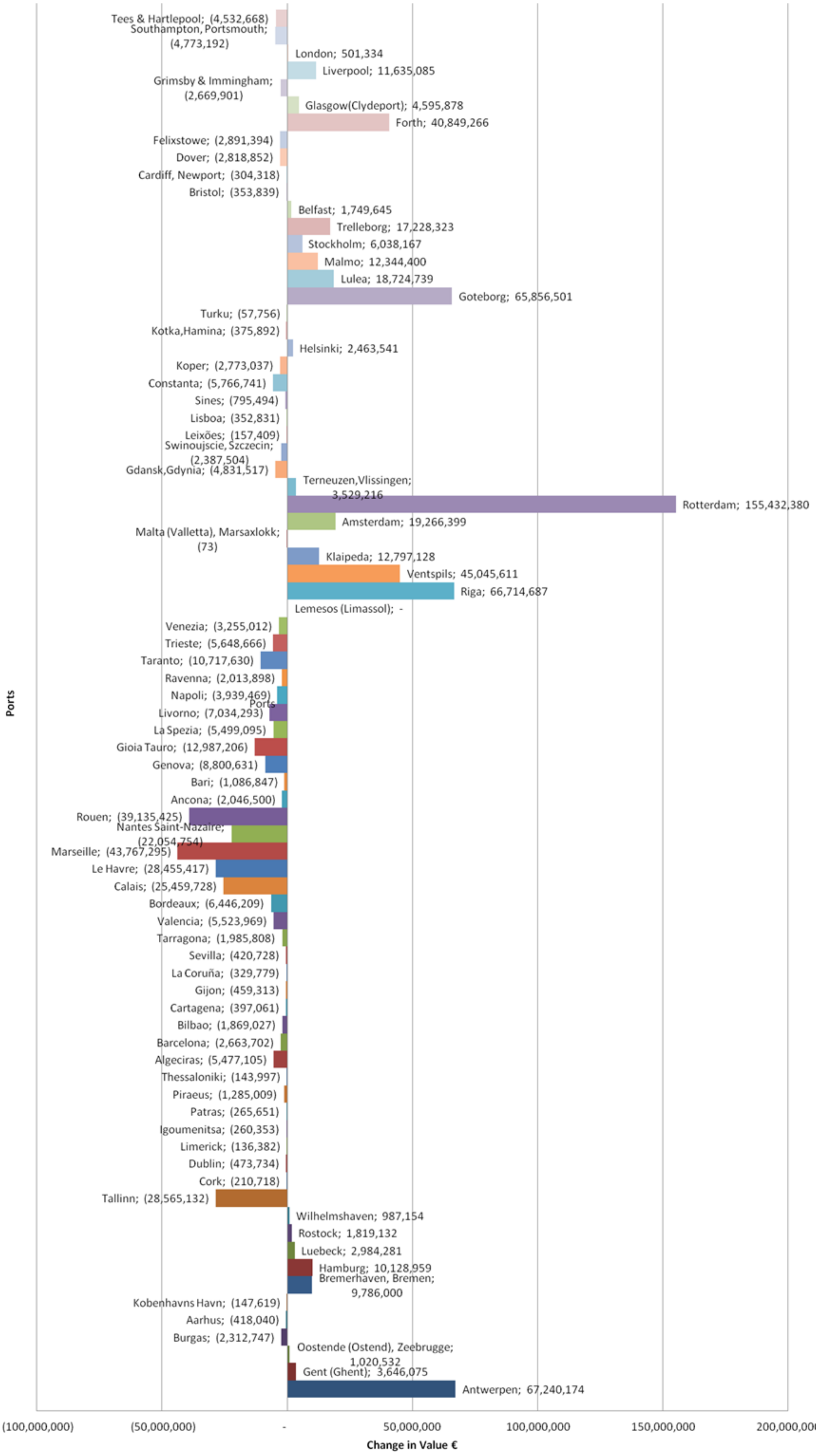


Figure 6.2. Value changes of port throughput to European hinterland, with contribution of modes

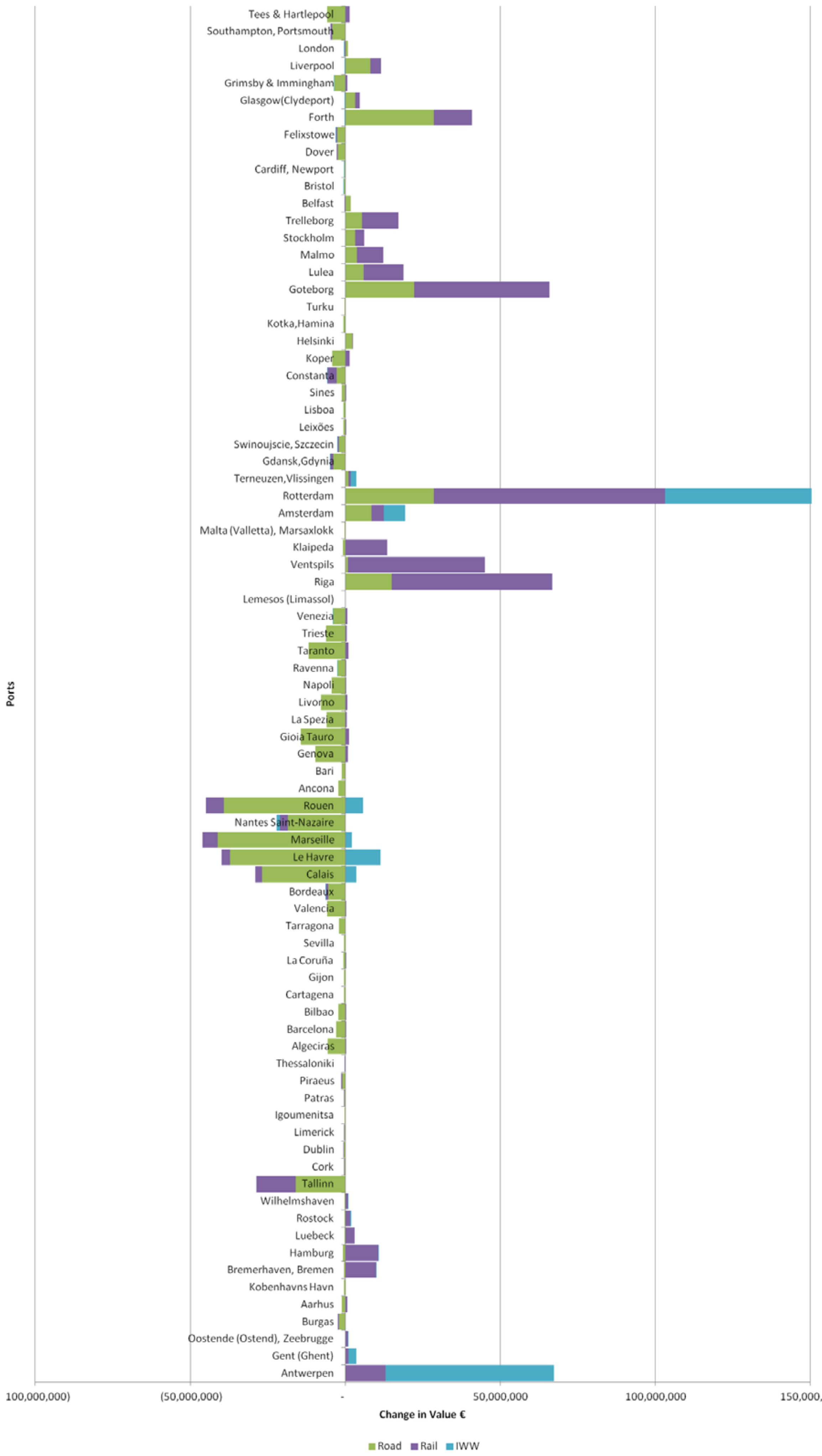


Figure 6.3. Percentage changes of port throughput to the European hinterland

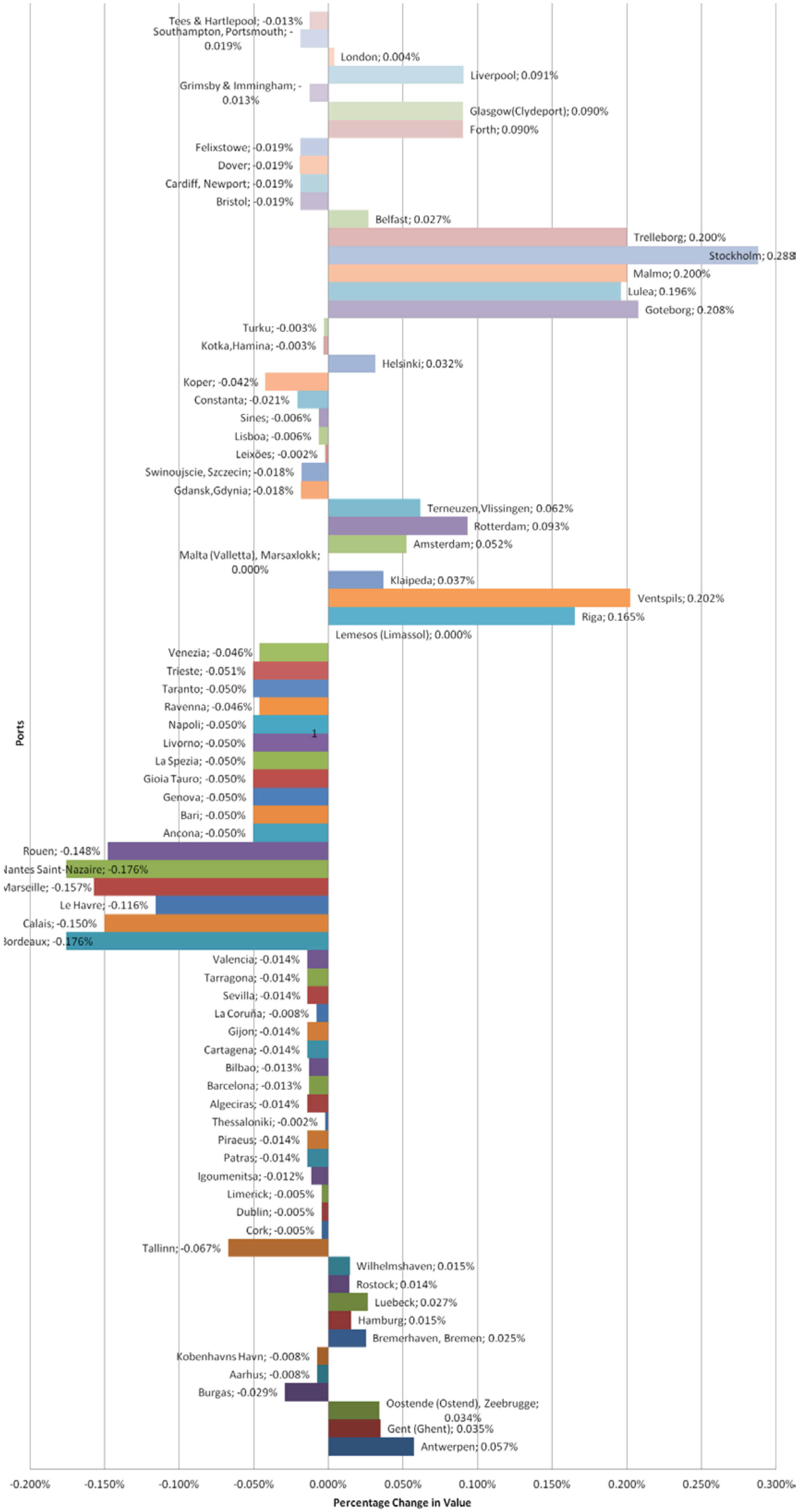
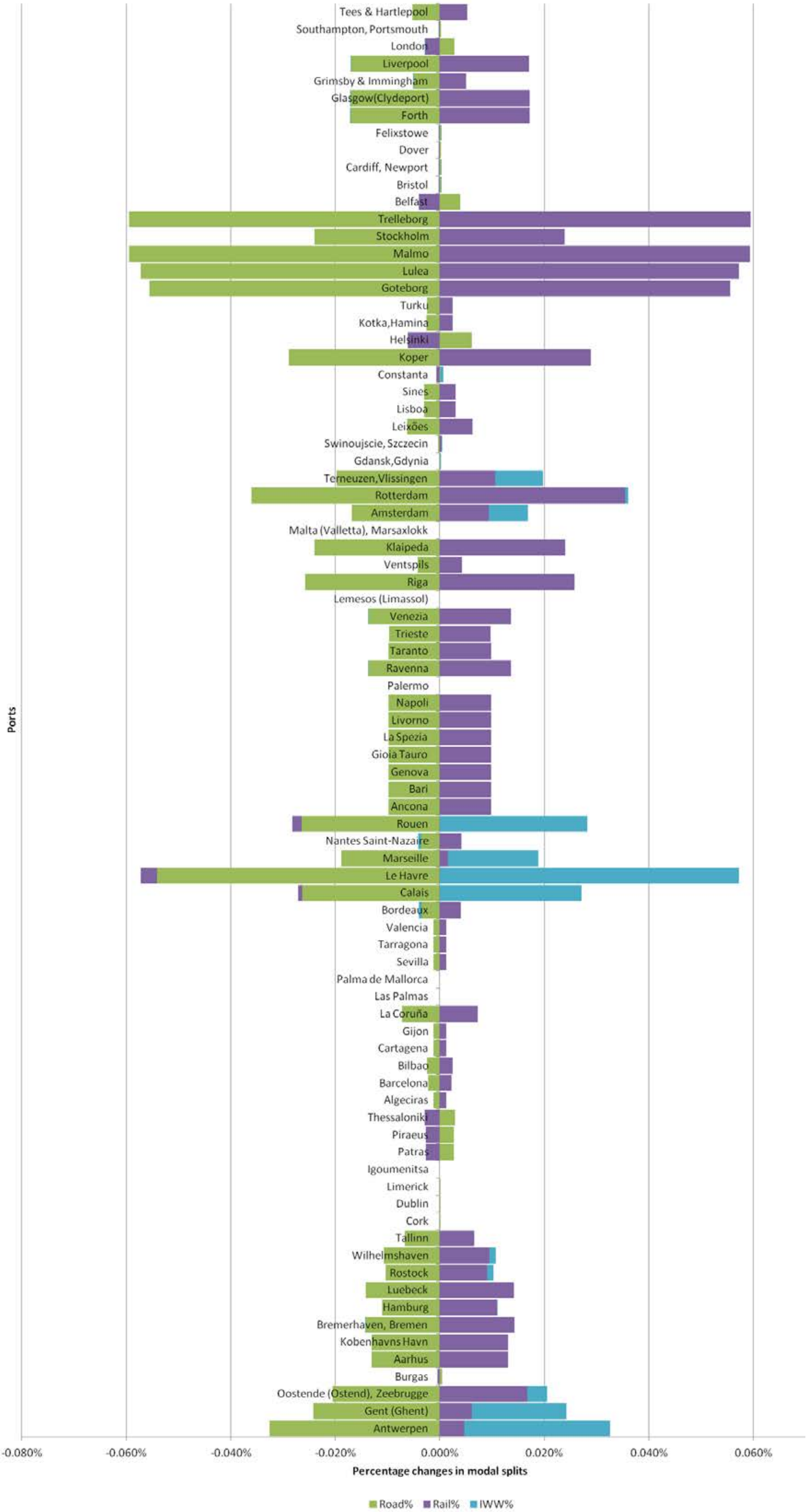


Figure 6.4. Percentage changes of the modal split per European port



We will start with the interpretation of Figure 6.1. Figure 6.1 shows that there are ports that benefit in terms of throughput changes and ports that lose considerably in terms of the size of cargo handlings determined for the European hinterland. Rotterdam is the port that benefits the most, in absolute terms. It gathers an extra value of €155 million. This is by far the largest positive outlier following the implementation of the Priority Projects. Interestingly, the other Dutch ports do not show that large changes in the value of throughput, although they are located in the vicinity of Rotterdam. As Figure 6.2 shows, the explanation of the performance of the Port of Rotterdam lies in its Rail and IWW transport possibilities. They account for significant shares of the increase in throughput following TEN-T projects. This is also true for Antwerp, that also performs well in absolute figures, due to especially the contribution of the IWW mode.

Other clustered port area's that benefit in absolute terms from the Priority Projects are the ports in the Baltic States (with the exception of Tallinn), the German ports, Swedish ports and a couple of ports in Britain (Figure 6.1). Where the change in German and Baltic ports is more or less because of the impact of improved rail traffic, the Swedish and British ports also considerably benefit from increased road hinterland connections. (Figure 6.2)

Interestingly, all Italian, French, Spanish and Greek ports lose absolute volumes of throughputs due to TEN-T Priority Projects. As shown in Figure 6.2, their most dominant mode, road transport, loses out relatively in terms of volume of throughput, while their rail systems are not well developed, and possibilities of inland waterway transport do not exist. This leads to these ports losing cargo volumes to other ports. Only the French waterways can retrieve some of the volumes lost by the road mode of transport. It can be concluded from here, that it might be valuable for French, Spanish and Greek ports that TEN-T contributes more in the rail possibilities for these ports. Up to now, TEN-T is lacking at this point.

Figure 6.2 shows further that most absolute volume increases are gained by rail transport, which also received most attention of European funds. Road transport loses out relatively around the Mediterranean, but is also seen to capture some shares in other parts of Europe. In The Netherlands, Sweden and UK this is the case. The IWW mode of transport gains relatively, except for Bordeaux and Nantes and Saint-Nazaire; ports that have lost volumes because of TEN-T driven IWW improvements near other French ports like Le Havre, Calais, Marseille and Rouen.

It is necessary to say that in absolute terms of changes are actually quite marginal. Related to the total value of the flows from ports to their hinterlands, the percentage changes are low. This is shown in Figure 6.3. Percentage changes range from -0.18% to 0.29% stemming from the realised (2007-2013) and considered infrastructure improvements (2014-2020) of the TEN-T Priority Projects. This weak effect can be explained by the fact that infrastructural improvements are only part of the total trade barrier. Other factors such as partner reliability, the implied costs and efforts of changing routes and transport chains and the focus on cost minimization are also important. This implies that the effect of infrastructure improvement is only one of the other effects which cause strategies of companies' and logistics service providers' to change. Transport infrastructure improvements do cause total barriers to decrease, but other barriers remain in place. Further, the total reduced hours of 15 due to TEN-T projects is also not that large, many bottlenecks still remain in place. However, the percentages do show significant differences between ports and their handled volumes for European hinterland countries. In relative terms, the Swedish and Baltic ports have truly benefited from the projects compared to other ports. (Figure 6.3) It is also clear that in relative terms, the French and Italian ports 'suffer' most. The relative deterioration of throughput positions for Spanish and Greek ports is only marginal.

Figure 6.4 shows the relative changes in the use of modal splits for the European ports following the Priority Project interventions. Looking at the percentages, also here there are only small changes; ranging from -0.06% to 0.06 percent for the share of modes in ports hinterland transport flows. The Priority Project interventions therefore do not seem to lead to a significant shift in the use of rail and IWW transport, a conclusion that is also supported by the European figures later on. However, it is interesting to see that especially rail and IWW transport have (to a limited extent) increased their shares of volumes of throughputs in ports. More notably, the increase in the shares of the rail and IWW modes of transport offset the lost share of the road transport mode, showing a symmetric picture. In most cases, rail transport has taken over the percentage share of road transport. But especially in France and Belgium, IWW has benefited most relatively. In The Netherlands, the seemingly large contributions of IWW in the increased volumes have proven to be less significant in relative terms. The share increase in Rotterdam is marginal, caused by the large volume the port handles.

Regarding the changes in import values of the EU Member States and ROW, two other figures are illustrative. Figures 6.5 and 6.6 show the absolute and percentage changes in the values imported by the 27 EU Member States, attributable to the Priority Projects. They do not show the EU Member States that benefit most from TEN-T measures, but rather focus on the change in imports, as places of destination. Countries crossed for goods to arrive in certain destinations could have benefited as well from improved infrastructure, but this analysis cannot conclude anything about these cross-trade volumes because only exported and imported values are input for GSIM, not the split out of cross-country figures.

Table 6.5 shows that in absolute terms only a couple countries really import more rail, road and IWW transport flows due to TEN-T projects. Of course, shipping and air transport figures are not taken into consideration and there cannot be drawn any conclusion because of this fact for total import figures Belgium, Germany, Estonia, The Netherlands and the UK seem to benefit from the inland mode infrastructure improvements. The countries losing volumes of imports most notably are France, Italy and Sweden. Sweden was one of the key benefactors in terms of port throughput changes, but these increased volumes are probably destined for other EU countries. In relative terms, the increased volumes of Germany and the UK are decreased and Slovakia is one of the main new cargo destinations (Figure 6.6).

The true benefactor in terms of absolute and relative numbers of imports due to TEN-T projects done in the EU is interestingly ROW. The seven countries compiling ROW share this benefit, of course, but it is still a very high increase compared to the others. The EU does therefore not only create possibilities of improved transport inside the EU, but also the transport patterns from EU towards non-EU countries. The EU's connectivity with other non-EU countries is thus increased as well. On the other hand, this conclusion should be read with some care as the ROW column only incorporates seven columns and no shipping and air freight transport.

Figure 6.5. Change in € value of imported goods from European ports, per Member State

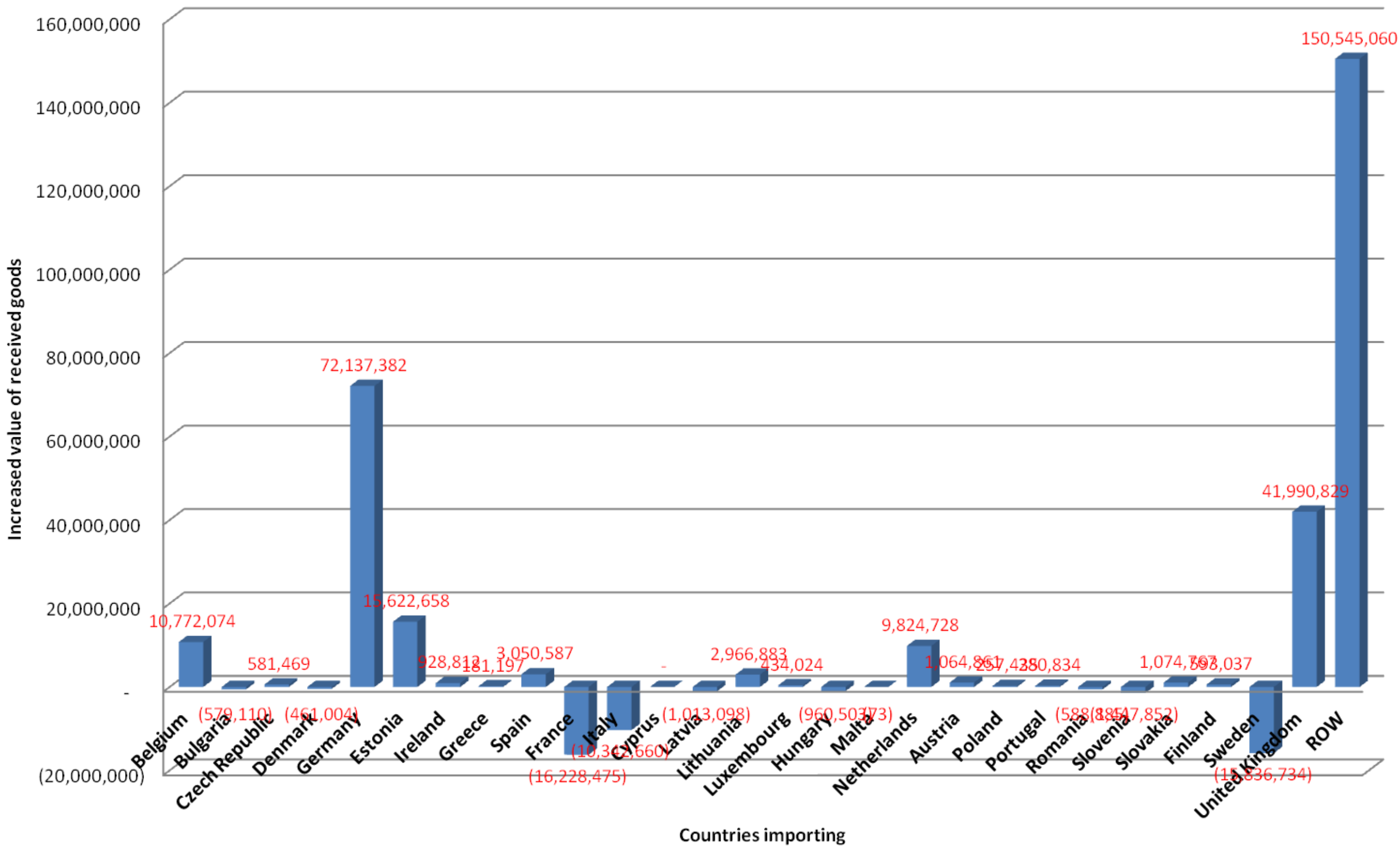
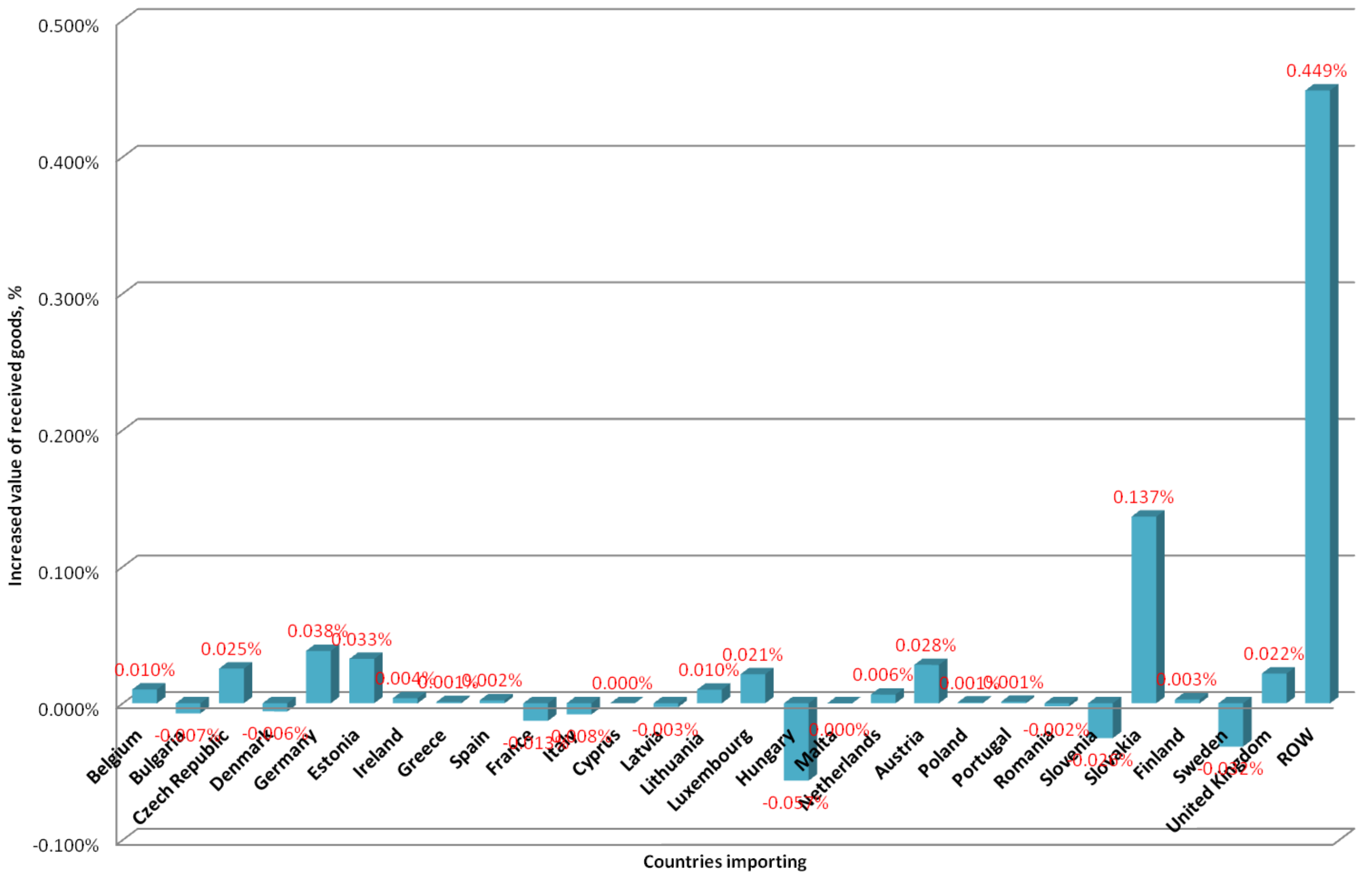


Figure 6.6. Percentage change in value of imported goods from ports, per Member State



The overall European impact figures from Priority Project intervention is shown in Table 6.1.

Table 6.1. Initial, New and the change of transport figures for the EU due to TEN-T PP.

	Initial situation		New Situation		Change	
Mode	Initial Transport Value	European Modal Split	Transport value after TEN-T PP	New modal split	Value Change	Split change
Road	€ 1,031,167,mln	72.5%	€ 1,030,989 mln	72.4%	€ -177 mln	-0.03%
Rail	€ 273,546 mln	19.2%	€ 273,848 mln	19.3%	€ 302 mln	0.02%
IWW	€ 117,355 mln	8.3%	€ 117,496 mln	8.3%	€ 140 mln	0.01%
Total	€ 1,422,069 mln		€ 1,422,334 mln		€ 264 mln	

Source: Compiled by Author

In total, an added transport value of €265 million is the consequence of the implementation of the Priority Projects. This value is achieved by the increase in Rail and IWW value, as shown in the Table. The overall road transport value from ports to EU27 Member States has declined.

In terms of European modal splits, the percentage change is marginal. Road transport still accounts for 72.49% of total port related traffic, only 0.03% lower than without bottlenecks removal due to the Priority Projects. Rail has gained a 0.02 share and IWW and 0.01% share. This study therefore shows that the reduced time barriers between ports and their hinterland have not resulted in the decrease necessary to shift more road transport away to rail and IWW. This may be because too many other barriers are still in place, related to infrastructure but also because other identified barriers such as freight costs and border related costs have not changed.

It is worth mentioning that the share increase for rail transport has cost more than €3 billion in TEN-T grants, while the increase for IWW transport only costs half a billion Euros. (Table 5.20) Either, it is harder to shift traffic to rail than to IWW or it is more difficult after a certain point of infrastructure improvements to keep attracting cargo from other modes.

6.2. The Core Network Scenario

The second TEN-T scenario modeled through GSIM and assessed on its contribution towards European port volumes and modal splits is the Core Network. 25 relevant projects (Appendix Table A12) of the Core Network for the 2014-2020 framework were identified and assessed on their impact. Again, the complete GSIM model and results can be found in file: New GSIM-SC1.CN.xslx. The four main figures are shown behind each other on the next pages.

Figure 6.7. Value changes in € of port hinterland flows towards EU27 due to Core Network, per port

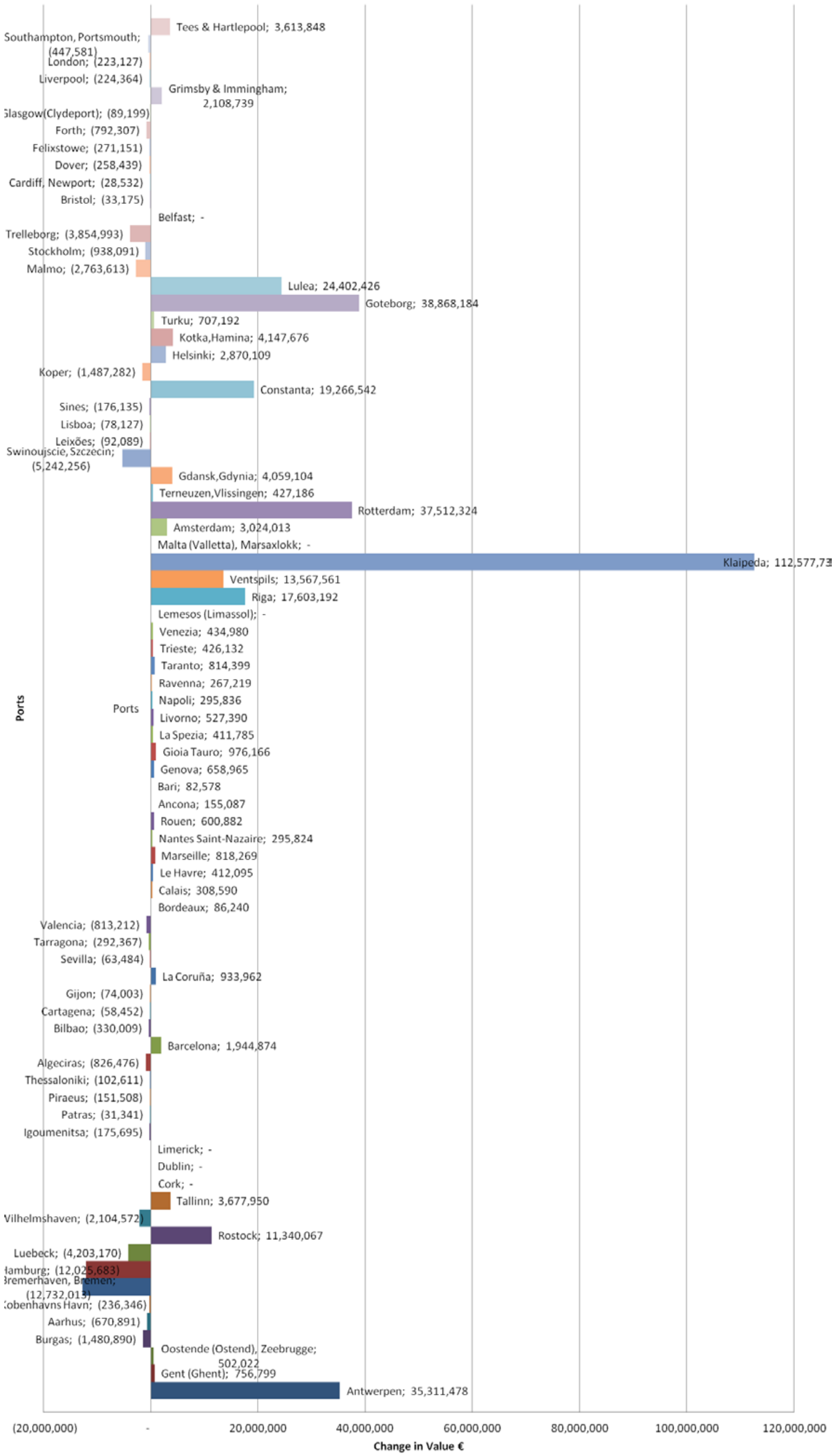


Figure 6.8. Changes in port hinterland values towards EU27 due to Core Network, divided over the modes

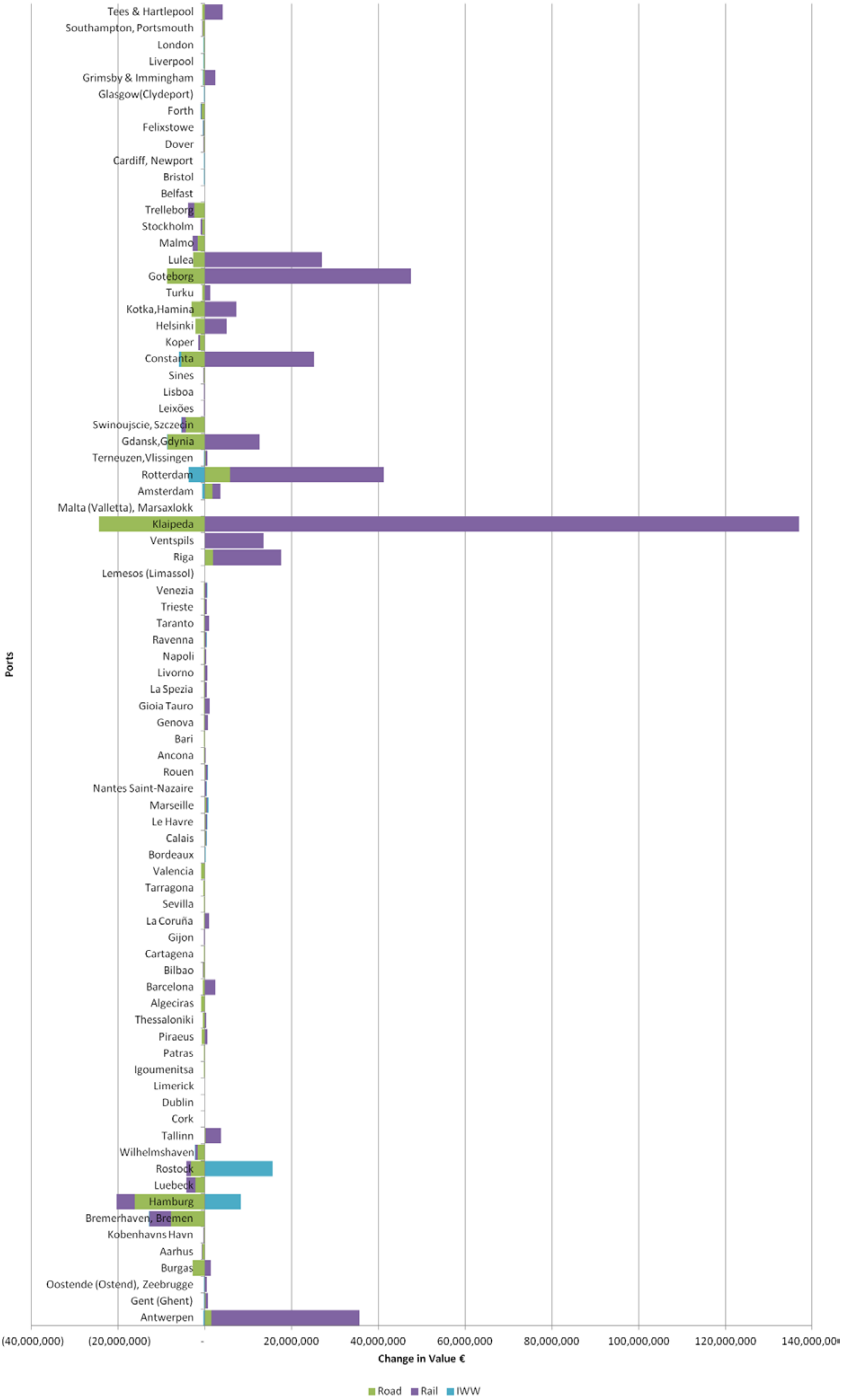


Figure 6.9. Percentage changes of port Hinterland flows values due to the Core Network

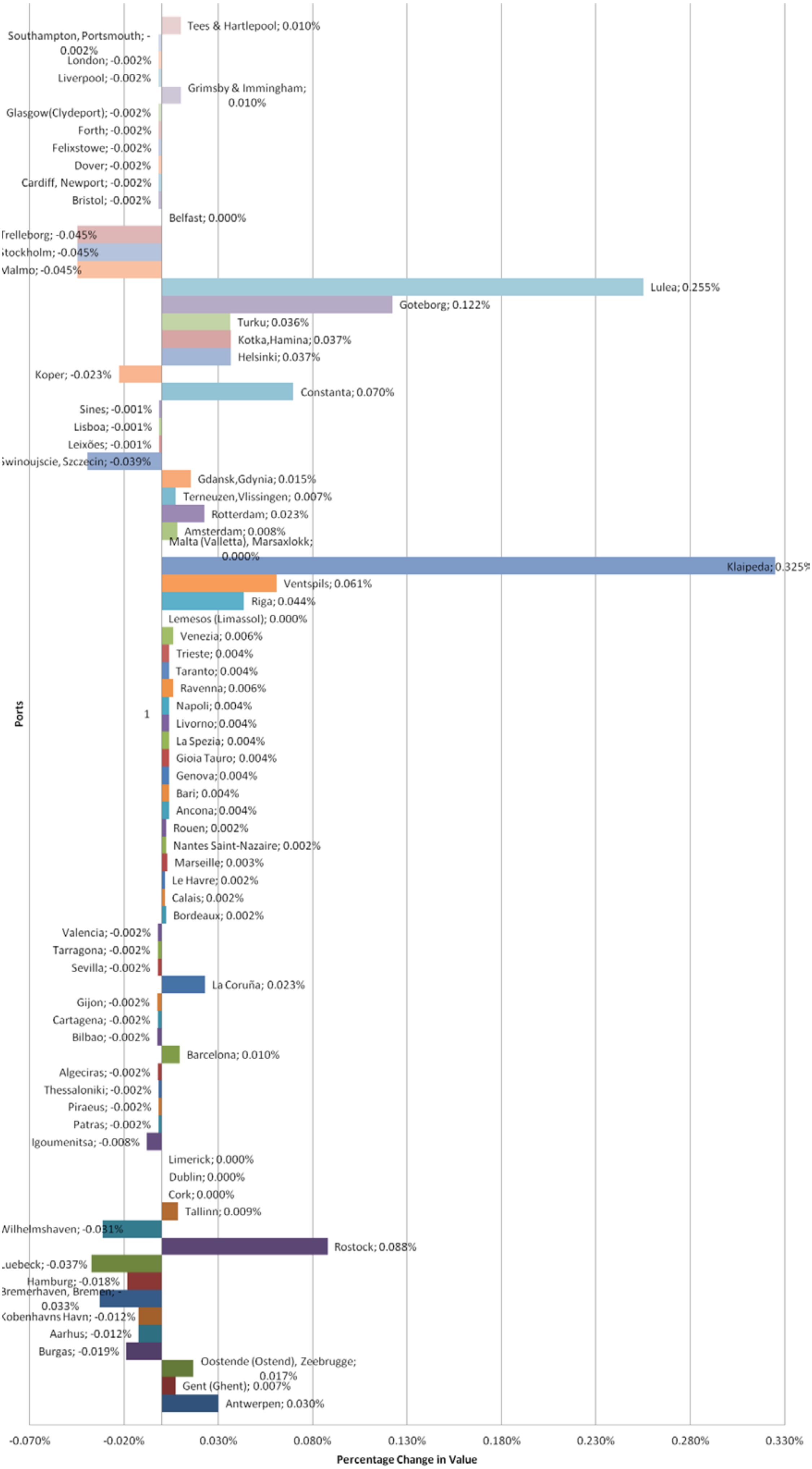


Figure 6.10. Percentage changes of modal splits per port because of Core Network

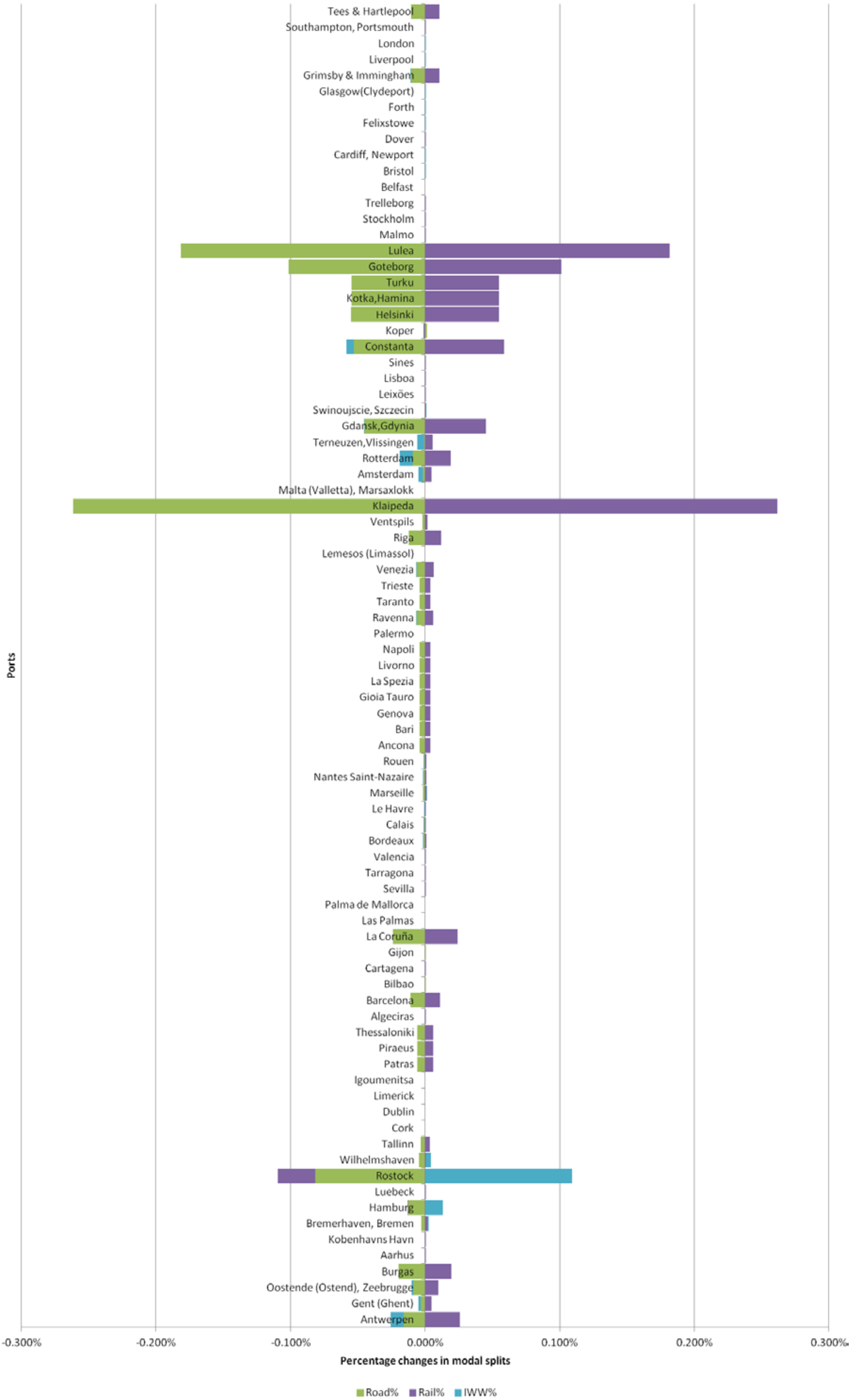


Figure 6.7 shows the absolute expected change of hinterland value flows of European ports due to the Core Network Scenario projects. The Baltic States perform well again with Klaipeda as the main volume winner. The Dutch ports show also volume increases due to Core Network intervention. Further, Antwerp, Constanta and the Finnish ports show also some gains.

Looking at the decomposition of the increase in volumes in Figure 6.8, it is shown that rail transport is again the main contributor to increased port hinterland flows. It has offset the decrease in road transport. Interestingly, this was not the case for Germany. The German ports, except for Rostock, are expected to experience a decrease in value of their hinterland flows and even rail transport is suffering in absolute terms. On the other hand, Hamburg and Rostock experience an increase in the usage of IWW, probably because of the works being planned along the Elbe.

Another aspect worth mentioning is the fact that many ports do not experience a change in their volumes because of the Core Network approach. This is strange, since the Core Network had aimed at improving the hinterland connections of 83 European ports, but as the analysis shows up to now, it is expected that the works for the 2014-2020 framework will not contribute that much for all of these ports.

Looking at the relative changes presented in Figure 6.9, the changes for the Baltic States are also relatively considerable in terms of percentages. Lulea, Goteborg, Constanta and Rostock are expected to benefit significantly in terms of added hinterland transport volumes, compared to the situation before the Core Network implementation. However, again, the changes in percentages are not very high ranging from -0.045% to 0.325%.

Figure 6.10 shows that due to the Core Network projects, road transport suffers the most in terms of modal split changes. Rail experiences an increase in the percentage of rail usage per port almost in every case, except for Rostock. IWW shows also some slight reductions in its relative share Antwerp, Ghent, Rotterdam, Amsterdam and Constanta. It might be the case that rail is so much stimulated that it also attracts cargo earlier transported by barge. Further, the intermodal shifts to not exceed the 0.25% change. Also the Core Network experiences problems in truly reducing the total barriers to trade and in achieving a shift in the used modes of transport.

Again, it is shown in the symmetry of Figure 6.10 that most changes in modal splits are offset by changes within the same port. The modes seem to be in-port substitutes, rather than witnessed inter-port substitution. Also the Core Network experiences difficulties in achieving a new spread of cargos over Europe.

The changes in imported volumes per EU Member State due to the Core Network intervention are presented in Figures 6.11 and 12.

Figure 6.11. Absolute changes in port hinterland flows imported by EU27 countries, Euros

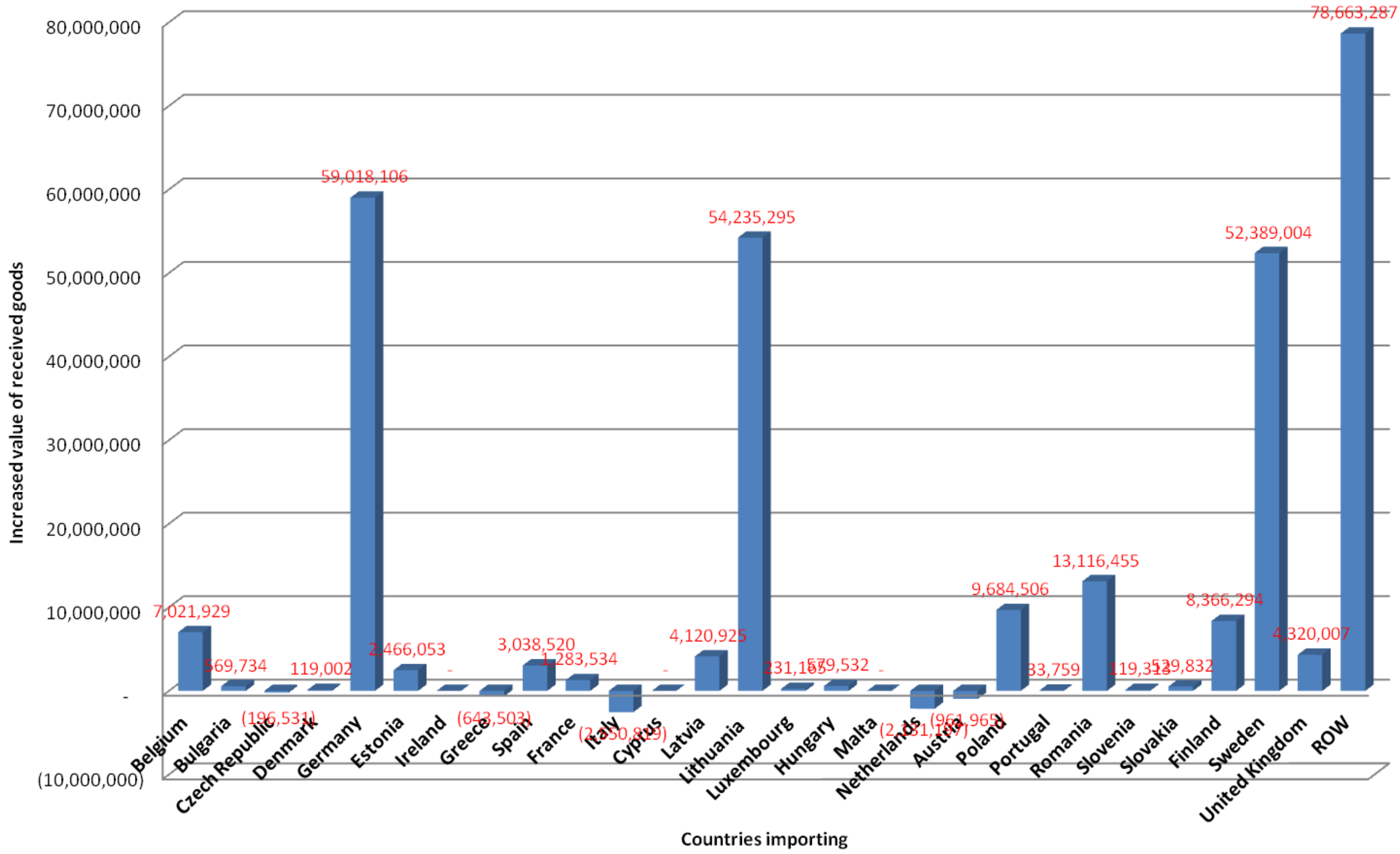


Figure 6.12. Percentage changes in imported port hinterland flow volumes per EU27 country, in Euros.

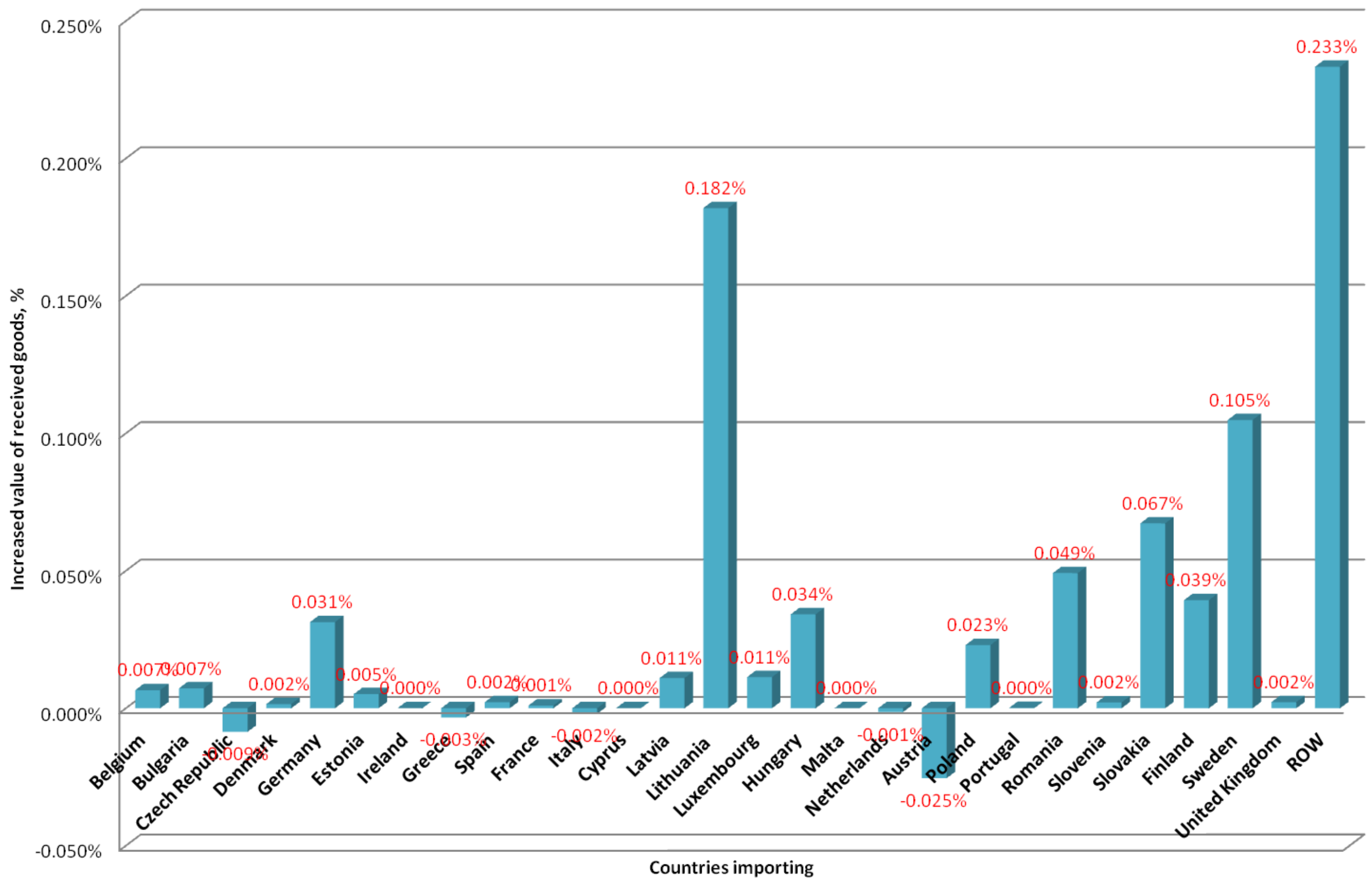


Figure 6.11 shows that multiple countries benefit from the Core Network in terms of importing port related cargo. Especially Germany, Lithuania, Poland, Romania and Sweden are expected to receive more imports; some even more than €50 million. Large decreases are not so much expected. Only The Netherlands, Italy and Austria seem to have less imported hinterland flow values. This figure supports the status of The Netherlands as a European gateway. Although infrastructure improvements have created better possibilities for the Dutch ports to handle cargo to the hinterland, which is also expected through GSIM in Figures 6.1 and 6.7, the cargos are not destined for locations in The Netherlands as the imports are likely to drop according to Figure 6.11.

In relative terms, the import increase of Germany is put into perspective of their total imports, leading to a smaller relative figure in Figure 6.12. Still, the increase for Lithuania is remarkable, also in relative terms. Where Klaipeda is expected to benefit significantly from infrastructural investments of the Core Network, the country is also expected to import a higher share. This high percentage might be explained by the fact that Klaipeda does not function so much as Gateway port and the cargos that increased the port throughputs have a destination in the country itself. It might also be possible that the improved infrastructure has increased possibilities to trade more with neighbouring countries, importing volumes from foreign ports.

Again it is illustrated that ROW is expected to benefit as well from the proposed projects of the Core Network in terms of imports. The accumulated share of multiple non-EU countries is the highest, confirming the dependence of non-EU countries on EU infrastructure.

The complete transport figures of the EU after consideration of the 25 identified Core Network projects to be completed in 2014-2020 is provided in Table 6.2. The comparison is made between the situation after Priority Project evaluation (initial) and after Core Network implementation.

Table 6.2. Initial, New and change of EU transport figures due to the Proposed Core Network

	Initial situation		New Situation		Change	
Mode	Initial Transport Value after PP	European Modal Split	Transport value after TEN-T CN	New modal split	Value Change due to CN	Split change
Road	€ 1,030,989 mln	72.5%	€ 1,030,894 mln	72.5%	€ -95 mln	-0.02%
Rail	€ 273,848 mln	19.3%	€ 274,219 mln	19.3%	€ 370 mln	0.02%
IWW	€ 117,496 mln	8.2%	€ 117,514 mln	8.2%	€ 18 mln	0.00%
Total	€ 1,422,334 mln		€ 1,422,628 mln		€ 293 mln	

Source: Compiled by Author

A total of €293 million in increased transport value for the EU is expected to take place because of the infrastructural improvements planned to be made in the 2014-2020 Financial Framework and all other factors are assumed to remain equal. Road transport is expected to be reduced if this line of projects is implemented and rail transport accounts for the highest change in transport value; around € 370 million.

Only a very small increase in IWW transportation from ports is expected due to the Core Network.

In terms of modal splits, the percentage changes are again marginal. Port related road transport is expected to be reduced with 0.02%, rail transport will increase with 0.02%. Again, the improvements in infrastructure have proved to be too marginal to have a large effect on the modal splits. Other barriers stay in place as well.

6.3. Comparison between the results of the two TEN-T policies

A comparison of the two scenario results is made to determine the effectiveness of the TEN-T policies and to see what the scattered Core Network approach implies for the possible shift towards sustainable modes and the related volumes, compared to the initial 2007-2013 policy.

The results in terms of port volumes between the two scenarios show relatively the same port clusters benefiting and losing from the two policies (Figure 6.1 and 6.7). The Netherlands, Belgium, The Baltic States and some Nordic States ports benefit from both scenarios. Further, there is very little growth or even losses in volumes are expected for the Mediterranean ports in both scenarios. However, the relative intensity of the two policies in terms of volumes differs. The Priority Project scenario shows higher relative impacts in volumes for both benefiting as 'losing' ports. (Figure 6.3) Although the percentages are small, the relative differences are quite large among the ports. This is different for the Core Network Scenario were only a few ports gain and lose some percentages of volumes (Figure 6.9) but the polarization is not as large as it is for the Priority Project scenario. In that sense, it is possible to say that the effects of the Core Network policy are indeed favoring a more equal spread of transport freight across European Ports than the Priority Projects do. Especially the losses for the Mediterranean ports in the 2007-2013 policy period are changed into small gains for 2014-2020.

This spread is also seen in the results for the importing countries in both scenarios. The Priority Project scenario shows larger differences in import volume changes between the gaining and losing countries (Figures 6.5 and 6.6). In this case there are also more countries that lose shares of imports than in the scenario of the Core Network (Figures 6.11 and 6.12). The latter scenario shows the spread as well in countries that gain imports of port related flows, with more countries gaining shares than in scenario one.

In terms of the modal split division of ports, The Core Network (Figures 6.8 and 6.10) and the Priority Projects (Figures 6.2 and 6.4) show also differences. Where the Priority Projects have shown increases in especially Rail and IWW transport and even in some cases in Road transport, the Core Network prediction only shows the gains in volume and share increases for rail transport. Road transport only loses freight to rail and IWW transport is only planned to be funded in the case of the Elbe. This pattern might show that under the Priority Project 2007-2013 Framework, all modes of transport are able to benefit from infrastructure investments done across the hinterlands of ports. On the other hand, the Core Network especially shows volume increases for rail transport, which even enabled IWW freight to be captured by Rail transport.[18] Both the scheme and focus of funding and co-financing are skewed under the Core Network, or the wider approach of funding a wider range of ports and their related hinterland infrastructure might only benefit rail transportation. The overall European figures seem to support these statements as well. The Priority Project approach enabled both the European usage share of Rail and IWW to increase at the expense of road transport (Table 6.1), while the Core Network approach only enabled the share of Rail transport to grow (Table 6.2).

These figures indicate that the Core Network approach is more successful in achieving a higher spread of cargo distribution across European ports with more European countries benefiting from imports as well, while the Priority Project approach can be seen as more useful to achieve a larger spread of cargo flows over the three main inland modes of transport. The latter effect is supported by a relatively high volume increase for the benefitting ports, where the Core Network has volume increase expectations spread more evenly over ports.

However, we also conclude that the significance of especially the percentage changes of volumes and modal splits is not high enough to make sweeping statements over the intermodal and volume effects of the two TEN-T policies. The decrease in total trade barriers because of infrastructure improvements has proven to be too small to see really significant changes.

[18] See Figure 6.10; in the case of Antwerp, Rotterdam, Ghent, Zeebrugge, Ravenna, Amsterdam and Constanta.

7. Conclusions, recommendations and shortcomings

7.1 Conclusion and recommendations

Regarding the 2011 revision of the TEN-T policy that has enabled a Core Network structure to be in place for the coming 2014-2020 financial framework, this thesis compared this new structure with the previous Priority Project structure in terms of port hinterland volume changes and modal splits. These impacts are of relevance to assess whether the new TEN-T policy reaches one of its aims in stimulating more multimodal transport with the usage of sustainable modes. Therefore, both structures are considered as two scenarios under the following research question:

"*What is the impact of creating a Core Network as TEN-T policy on the volumes and modal splits of European Seaports?"*

A review of academic literature has proved that multi modal transport can be beneficial in terms of costs, prices and sustainability. A crucial point for rail and inland navigation is to have sufficient volume to fill their capacities. Without the necessary volume, the advantage of economies of scale is not reached. Key infrastructure in the form of efficient terminals and transhipment points are crucial as well in order to stay cost-efficient and sustainable. It is proved that stimulation of multimodal transport through policy can be effective. This thesis assessed whether TEN-T is such an effective policy.

The thesis has followed GSIM as quantitative methodology to come to an answer regarding the research question. This method has proven itself in especially impact assessments of trade policy. The standard GSIM sizes had to be expanded to be able of assessing the impact of infrastructure improvements in the EU, with the 27 EU Member States as hinterland of 83 Core Ports. The inland modes of road rail and inland waterway navigation are incorporated for every port.

An initial trade barrier was set up between the origin points of the 83 ports and the 27 EU destination countries, per mode of transport. The trade barrier consists of transport related costs, border related costs and the costs of distribution and wholesale of goods. Specific transport related costs were determined for the routes between the 83 ports and EU Member States. Part of these transport costs is the time value costs, which is determined by the state of the infrastructure. An assessment of infrastructural bottlenecks is carried out as part of the thesis analysis as well.

The improvements made through the two TEN-T policies are translated to the initial bottlenecks derived. It was this small decrease in the total trade barrier equivalent that enabled GSIM to calculate changes in the earlier established transport flow values between ports and their hinterlands.

The analysis of the effects from the two policies on the infrastructure bottlenecks has proven that the total reduced hours of time barriers for the Priority Projects was estimated at 15 hours. Further, an additional 1123 kilometres were added in this framework period of 2007-2013. The EU co-financing costs of these projects totalled € 4,506 million. The reduction of rail bottleneck hours proved to be the most expensive; € 345 million per reduced hour. Road and IWW bottlenecks were both around the three times cheaper to remove. Regarding the Core Network plans, it was estimated that the 25 relevant plans of the Core Network will reduce time barrier hours of around the 15.4 hours, making use of an estimated €5 billion as well.

The GSIM results have shown some interesting patterns of changing port hinterland flow values and the role the inland modes play in that respect. The Priority Project structure results showed a wide disparity in ports that benefited from the TEN-T policy and ports that lost hinterland flow values. Most benefiting ports were able to gain rail and inland waterway transport volumes due to the Priority Project intervention. The losing ports were mostly depending on road as main hinterland mode, which declined in most of the cases in terms of transported values.

However, the relative changes of port hinterland volumes remained marginal and ranged in between -0.18% to 0.3%. Though, the changes ranged considerably among ports. The relative change in modal splits per ports was also low; -0.06% to 0.06%. Under this TEN-T strategy, a true shift between the modes was therefore also not shown. In total, European rail transport benefited with 0.02% and Inland Waterway transport with 0.01%. They offset the decrease of -0.03% for road transport. Still, a total of €264 million of extra transport value has been created in the EU due to the TEN-T policy.

The results of the Core Network Scenario showed especially an absolute and relative port hinterland volume increase for the port of Klaipeda. This port benefits from many infrastructural projects done in Lithuania, especially aimed at rail transport. This example showed that ports do benefit from infrastructural projects nearby or in their hinterland. However, the relative changes again turned out to be very marginal, up to 0.3% for both port volume changes as for modal split changes. It can therefore be questioned whether infrastructure improvements really can influence transport patterns and modal splits. Other factors such as transport costs, reliability of partners, and barrier related costs might be more influential. Further, the costs of changing a transport chain are assumed to be significant as well. This restricts the shippers or logistic companies to change mode or ports of call.

Under the assessment of the planned Core Network it was shown that especially rail transport increased in transporting port related flows. It even captured in some cases the shares of inland waterway transportation. It can be therefore questioned whether this amount of rail stimulation from the EU is desirable. Also in the total European modal split changes due to the Core Network, rail benefited only with a 0.02% increase. The increase in transported value by IWW remained marginal. The

Core Network has created especially a spread of increased port related volumes, but a fewer spread across the modes of transport stimulated.

An interesting conclusion from the analysis of the port related flow values of the importing countries is that in both scenarios the non-EU countries included in ROW also benefited considerably in imports from EU ports. The EU does therefore not only create possibilities of improved transport inside the EU, but also the transport patterns from EU towards non-EU countries. The TEN-T projects increase the connectivity of the EU as a whole with the rest of the world.

In answering the research question, it can be concluded that the effect of the new Core Network on port volumes in total is marginal, less than 0.03%. The same holds for the effect on modal splits of ports and Europe as a whole. Rail transport has been the mode that gained most in modal shares. Together with inland navigation, they have gained some shares of road transportation. Both assessed TEN-T policies are therefore questioned to be influential on the transport volumes and modal splits in Europe.

However, the division of the two scenarios has showed some arguments for the statement that the type of policy does have an influence on the degree of modal shift attained. The Core Network has proven to stimulate the usage of predominantly rail transport and not so much the use of inland waterways. Further, road transport is totally neglected in its approach.

As stated before, the Core Network approach seems to achieve a higher spread of cargo distribution across European ports with more European countries benefiting from imports. On the other hand, the Priority Project approach was more effective in attaining a higher spread of cargo flows over the three main inland modes of transport. The new TEN-T policy might therefore have problems in achieving one of its targets; stimulating multi modality and intermodal transport. The creation of more spread in cargo distributions across ports, as proved trough GSIM, and the focus on predominantly rail transport will both provide difficulties in achieving pure multi modality.

Although the GSIM results gave some indication for the statements done above, the results in modal shifts and volume changes were all relatively small. A pure shift towards the usage of sustainable modes is not achieved. In order to do so, the EU should also remove other barriers apart from infrastructure bottlenecks. The main transport barrier remains freight costs and tariffs for road transport or subsidies for rail and inland waterway transportation might be more effective than improving infrastructure connections.

Further, it is recommended to award more attention and financing for inland waterway transport. In this thesis it has proven itself as a very cost-efficient mode of transport in reducing bottlenecks. The freight cost comparison done has also proved that in terms of costs, inland navigation can even compete with road transport on short distances less than 500 kilometers.

The decreasing focus of co-financing road infrastructure projects has also attracted the attention. There are still many condition and capacity bottlenecks in place in the EU and technology developments ensures road transport as possible environmental friendly mode as well. In our opinion, road transport deserves more funding in TEN-T policy as well.

7.2. Shortcomings and research suggestions

Overall, it was necessary to make a lot of assumptions during the data building process of this thesis. The assumptions are applied in a general way, where it might have been more appropriate to carry out more specific investigations in case of for instance bottlenecks, trade patterns or port throughput figures. However, the limited time available made it necessary to make use of as much as information that was already available on a large scale. This procedure is applied to the port throughput figures, port modal splits, bilateral trade patterns, freight costs estimations, time barrier estimations and time reducing impacts from infrastructure works. The author admits that in theory, it would have been possible to carry out a more thorough analysis. However, there is confidence enough that the generalised data has been built up carefully and that the results can be interpreted as plausible. The exact outcomes are depending on the assumptions made, but an indicative picture of the consequences of the TEN-T policies is certainly provided.

Regarding the methodology, the GSIM analysis does not take into consideration the more regularly used indicators for port competition and modal choice from a shippers perspective such as; port throughput times, port and mode reliability, port and mode capacity and specific port pricing. Further, there is no market-analysis included to predict what the exact demands of the hinterland countries will be. However, the shippers perspective and market analysis were also not ‘necessary’ in terms of Partial Equilibrium and GSIM methodology. A market clearing is achieved based on a system of demand and supply, resulting in a set of prices at which demand and supply are equalised.

In light of the GSIM methodology, a clearer picture would have been achieved when also shipping was taken into consideration as a fourth mode. Now, the three land modes are assumed to transport the outgoing freight from the ports. This assumption neglects the short sea shipping that is performed inside Europe, as well as the shipping flows from European countries to the Rest of the World. This would have been the desired set up of the model as all flows and modes would have been captured. However, a lack on short sea shipping data and the lack of data with the division of outgoing freight per land modes and sea mode made this an impossible task. Though, it is an interesting addition for future research or projects to spent time on.

Because GSIM cannot split out the transport volumes of the countries crossed, this is a limitation of the research carried out. Only figures were derived of importing countries and exporting ports. This might be an area for further research to spent time on.

Moreover, a specific analysis on border related trade costs per country pair could have been carried out to make an even more specific trade barrier division. However, this thesis focussed on the transport part of trade barriers, the analysis has therefore restricted itself to the specific freight and time costs of trade. It would have been interesting for a more trade barrier focussed thesis to spent time on the exact bilateral trade barriers within Europe.

Due to a lack of data and information on the Core Network projects, this part of the TEN-T analysis has become less extensive than the Priority Project scenario analysis. Attempts were made to access the TENtec information system of DG MOVE to gain more recent publications and information on the specific projects and grants carried out. The public portal of TENtec was however under construction which meant a provision of information for this analysis restricted to the rough descriptions as in Appendix section 7.2. This also meant that a desired analysis of port infrastructure improvements is lacking in this thesis. It is known that there are TEN-T grants determined for specific port projects such as Maasvlakte 2 and Jadeweser port project. Specific port infrastructure would have been a perfect addition to this thesis as well as a very interesting analysis to carry out. Again, this leaves space for future research to shed light in the grants awarded to ports and their impact on European port flows.

Finally, some parts of the analysis done in the thesis might have deserved a more thorough look and analysis. For instance, it was exceptionally interesting to make the overall view of European transport flows related to ports. There was however no time and necessity to analyse all bilateral transport flows more in depth in this thesis.

8. Bibliography

Anderson, J., & Van Wincoop, E. (2004). Trade Costs. *Journal of Economic Literature*, 691-751.

ANP. (2010, October 27). *Oost-Nederland de dupe van niet-optimaal gebruik Betuwelijn*. Retrieved July 12, 2012, from Reformatisch Dagblad: http://www.refdag.nl/polopoly_fs/anp_5840431_1_511290!image/3458954711.jpg

Blauwens, G., Vandaele, N., Van de Voorde, E., Vernimmen, B., & Witlox, F. (2006). Towards a modal shift in freight transport? A business logistics analysis of some policy measures. *Transport Reviews* , 239–251 .

Bureau Voorlichting Binnenvaart. (2011). *Modal split figures per port*. Retrieved July 15, 2012, from BVB: http://www.bureauvoorlichtingbinnenvaart.nl

Burgess, A., Van 't Zelfde, D., Maurer, H., Rudzikaite, L., & Wolters, P. (2011). *Intermodal Yearbook 2011/2012.* Brussels: European Intermodal Association.

Central Intelligence Agency (CIA). (2012, July). *The World Factbook*. Retrieved July 16, 2012, from Central Intelligence Agency: https://www.cia.gov/library/publications/the-world-factbook

Christidis, P., & Ibanez Rivas, J. (2012). *Measuring Road Congestion.* Luxembourg: JRC.

DG MOVE. (2011, December 19). *LIST OF PRE-IDENTIFIED PROJECTS ON THE CORE NETWORK.* Retrieved July 13, 2012, from DG MOVE: TEN-T/Infrastructure: http://ec.europa.eu/transport/infrastructure/revision-t_en.htm

DG TREN. (2010). *EU energy in figures, CO2 emmissions per sector.* European Commission.

Economic Commission for Europe Inland Transport Committee. (2005). *Inventory of most important bottlenecks and missing links in the European Waterway Network.* New York: United Nations.

ETISPLUS. (2010). *ETISPLUS*. Retrieved July 15, 2012, from ETISviewer: http://viewer.etisplus.net/

European Commission. (2011). *A Roadmap for moving to a competitive low carbon economy in 2050.* Brussels: COM(2011) 112.

European Commission. (2011). *EU Transport in figures, Statistical Pocketbook 2011.* Luxembourg: Publications Office of the European Union.

Eurostat. (2012, July 10). *Transport Statistics*. Retrieved July 15, 2012, from Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database

Francois, J., & Hall, K. (2003). Global Simulation Analysis of Industry-Level Trade Policy.

Frémont, A., & Franc, P. (2010). Hinterland transportation in Europe: Combined transport versus road transport. *Journal of Transport Geography*, 548-556.

Google Maps. (2012). Retrieved July 15, 2012, from https://maps.google.nl/

Inland Navigation Europe. (2005). *Map of European Waterways*. Retrieved July 26, 2012, from Inland Navigation Europe: http://www.inlandnavigation.eu/uploads/Maps/map_waterways_europe.jpg

Meyer-Ruhle, O., Beige, S., Greinus, A., Erhardt, T., Bozuwa, J., Harmsen, J., et al. (2008). *Statistical coverage and economic analysis of the logistical sector in the EU. (SEALS).* Brussels: EC, DG TREN.

Parola, F., & Sciomachen, A. (2009). Modal split evaluation of a maritime container terminal. *Maritime Economics and Logistics*, 77-97.

Petersen M.S., B. J. (2009). *Report on Scenario, Traffic Forecast and Analysis of Traffic on the TEN-T, taking into Consideration the External Dimension of the Union – Final Report.* Copenhagen: funded by DG TREN.

Port of Rotterdam. (2010, June 23). *Rotterdam modalsplit in top 3*. Retrieved July 15, 2012, from Port of Rotterdam: http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/20100623_03.aspx

Port of Rotterdam. (2011). *Info on White paper on transport*. Retrieved July 3, 2012, from Port of Rotterdam: http://www.portofrotterdam.com/en/News/Pages/white-paper-transport.aspx

PriceWaterhouseCoopers & EBS Business School. (2009). *How will supply-chains evolve in an energy-constrained, low carbon world?* Dusseldorf: PriceWaterhouseCoopers.

Priemus, H. (1999). On modes, nodes and networks: Technological and spatial conditions for a breakthrough towards multimodal terminals and networks of freight transport in Europe. *Transportation Planning and Technology*, 83–103.

S. Newton, Y. H. (2010). *Ports and their connections within the TEN-T.* Zoetermeer: NEA, funded by DG TREN.

TEN-T EA. (n.d.). *2007-NL-05020-P*. Retrieved July 12, 2011, from TEN-T Executive Agency: http://tentea.ec.europa.eu/en/ten-t_projects/ten-t_projects_by_country/the_netherlands/2007-nl-05020-p.htm

TEN-T EA. (2011, November). *30 Priority Projects.* Retrieved July 13, 2012, from TEN-T Exectutive Agency: http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/

TEN-T EA. (2012, April 12). *Projects managed by TEN-T EA.* Retrieved July 13, 2012, from TEN-T Executive Agency: http://tentea.ec.europa.eu/en/ten-t_projects/statistics/projects_managed.htm

Van Klink, H., & Van den Berg, G. (1998). Gateways and Intermodalism. *Journal of Transport Geography*, 1-9.

Veldman, S., & Buckmann, E. (2003). A Model on Container Port Competition: An Application for the West European Container Hub-Ports. . *Maritime Economics & Logistics*, 3-22.

1.

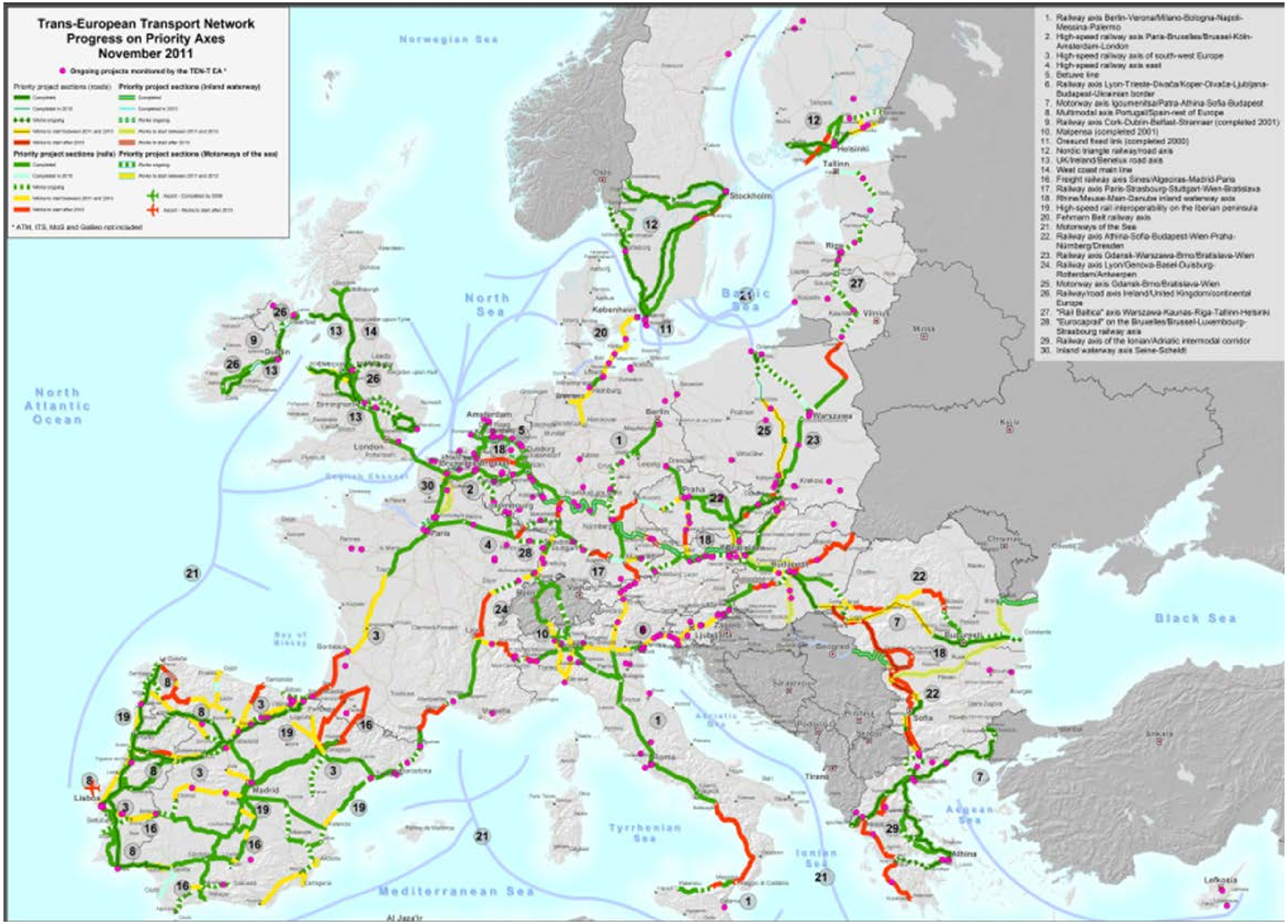
9. Appendix

9.1 List of Priority Projects

1. Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo
2. High-speed railway axis Paris-Bruxelles/Brussels-Köln-Amsterdam-London: PBKAL
3. High-speed railway axis of southwest Europe
4. High-speed railway axis east
5. Betuwe line: COMPLETED 2007
6. Railway axis Lyon-Trieste-Divača/Koper-Divača-Ljubljana-Budapest-Ukrainian border
7. Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest
8. Multimodal axis Portugal/Spain-rest of Europe
9. Railway axis Cork–Dublin–Belfast–Stranraer: COMPLETED 2001
10. Malpensa airport: COMPLETED 2001
11. Øresund bridge: COMPLETED 2000
12. Nordic Triangle railway/road axis
13. Road axis United Kingdom/Ireland/Benelux
14. West coast main line: COMPLETED 2009
15. Galileo
16. Freight railway axis Sines/Algeciras-Madrid-Paris
17. Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava
18. Waterway axis Rhine/Meuse-Main-Danube
19. High-speed rail interoperability in the Iberian Peninsula
20. Railway axis Fehmarn belt
21. Motorways of the Sea
22. Railway axis Athina–Sofia–Budapest–Wien–Praha–Nürnberg/Dresden
23. Railway axis Gdańsk-Warszawa-Brno/Bratislava-Wien
24. Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen
25. Motorway axis Gdańsk-Brno/Bratislava-Vienna
26. Railway/road axis Ireland/United Kingdom/continental Europe
27. "Rail Baltica" axis: Warszawa-Kaunas-Riga-Tallinn-Helsinki
28. "Eurocaprail" on the Brussels-Luxembourg-Strasbourg railway axis
29. Railway axis of the Ionian/Adriatic intermodal corridor
30. Inland Waterway Seine-Scheldt

Source: (TEN-T EA, 2011)

9.2 Map of Priority Projects (Source: (TEN-T EA, 2012)



9.3 List of identified Core Network Corridors for the 2014-2020 Framework

1. Baltic – Adriatic Corridor

Helsinki – Tallinn – Riga – Kaunas – Warszawa – Katowice
Gdynia – Katowice
Katowice – Ostrava – Brno – Wien
Katowice – Žilina – Bratislava – Wien
Wien – Graz – Klagenfurt – Villach – Udine – Venezia – Bologna – Ravenna

Pre-identified sections	Mode	Description/dates
Helsinki - Tallinn	Ports, MoS	port interconnections, (further) development of multimodal platforms and their interconnections, MoS (including icebreaking capacity)
Tallinn - Riga - Kaunas - Warszawa	Rail	(detailed) studies for new UIC gauge fully interoperable line; works for new line to start before 2020; rail – airports/ports interconnections
Gdynia - Katowice	Rail	upgrading
Gdynia, Gdansk	Ports	port interconnections, (further) development of multimodal platforms
Warszawa - Katowice	Rail	upgrading
Katowice - Ostrava - Brno - Wien & Katowice - Žilina - Bratislava - Wien	Rail	upgrading, in particular cross-border sections PL-CZ, PL-SK and SK-AT; (further) development of multimodal platforms
Wien - Graz - Klagenfurt - Udine - Venezia - Ravenna	Rail	upgrading and works ongoing; (further) development of multimodal platforms
Trieste, Venice, Ravenna	Ports	port interconnections, (further) development of multimodal platforms

2. Warszawa – Berlin – Amsterdam/Rotterdam – Felixstowe – Midlands

BY border – Warzsawa – Poznań – Frankfurt/Oder – Berlin – Hannover – Osnabrück – Enschede – Utrecht – Amsterdam/Rotterdam – Felixstowe – Birmingham/Manchester – Liverpool

Pre-identified sections	Mode	Description/dates
BY border - Warszawa - Poznań - DE border	Rail	upgrading existing line, studies for high speed rail
PL Border - Berlin - Hannover - Amsterdam/Rotterdam	Rail	upgrading of several sections (Amsterdam – Utrecht – Arnhem; Hannover – Berlin)
West-German Canals, Mittellandkanal, Hannover – Magdeburg - Berlin	IWW	upgrading
Amsterdam locks	IWW	studies ongoing
Felixstowe – Midlands	Rail, port, multimodal platforms	interconnections port and multimodal platforms

3. Mediterranean Corridor

Algeciras – Madrid – Tarragona
Sevilla – Valencia – Tarragona
Tarragona – Barcelona – Perpignan – Lyon – Torino – Milano – Venezia – Ljubljana – Budapest – UA border

Pre-identified sections	Mode	Description/dates
Algeciras - Madrid	Rail	studies ongoing, works to be launched before 2015, to be completed 2020
Sevilla - Antequera - Granada - Almería - Cartagena - Murcia - Alicante - Valencia	Rail	studies and works
Valencia - Tarragona - Barcelona	Rail	construction between 2014 - 2020
Barcelona	Port	interconnections rail with port and airport
Barcelona - Perpignan	Rail	cross-border section, works ongoing, new line completed by 2015, upgrading existing line
Perpignan - Montpellier	Rail	bypass Nîmes - Montpellier to be operational in 2017, Montpellier - Perpignan for 2020
Lyon - Torino	Rail	cross-border section, works base tunnel to be launched before 2020; studies access routes
Milano - Brescia	Rail	partially upgrading, partially new high-speed line
Brescia - Venezia - Trieste	Rail	works to start before 2014 on several sections
Milano - Mantova - Venezia - Trieste	IWW	studies, upgrading, works
Trieste - Divača	Rail	studies and partial upgrading ongoing; cross-border section to be realised until after 2020
Koper - Divača - Ljubljana - Maribor	Rail	studies and upgrading/partially new line
Ljubljana node	Rail	rail node Ljubljana, including multi-modal platform; rail airport interconnection
Maribor - Zalalövö	Rail	cross-border section: studies, works to start before 2020
Boba- Szekesferhervar	Rail	upgrading
Budapest-Miskolc-UA border	Rail	upgrading

4. Hamburg – Rostock – Burgas/TR border – Piraeus – Lefkosia

Hamburg / Rostock – Berlin – Praha – Brno – Bratislava – Budapest – Arad – Timişoara – Sofia
Sofia – Burgas/TR border
Sofia – Thessaloniki – Piraeus – Limassol – Lefkosia

Pre-identified sections	**Mode**	**Description/dates**
Dresden - Praha	Rail	studies for high-speed rail
Prague	Rail	Upgrading, freight bypass; rail connection airport
Hamburg - Dresden - Praha - Pardubice	IWW	Elbe upgrading
Děčín locks	IWW	studies
Breclav - Bratislava	Rail	cross-border, upgrading
Bratislava - Hegyeshalom	Rail	cross-border, upgrading
Budapest - Arad - Timişoara - Calafat	Rail	upgrading in HU nearly completed, ongoing in RO
Vidin - Sofia - Burgas/TR border Sofia - Thessaloniki - Athens/Piraeus	Rail	studies and works Vidin – Sofia – Thessaloniki; upgrading Sofia – Burgas/TR border
Athens/Piraeus - Limassol	MoS	port capacity and hinterland connections
Limassol - Lefkosia	Ports, multimodal platforms	upgrading of modal interconnection

5. Helsinki – Valletta

Helsinki – Turku – Stockholm – Malmö – København – Fehmarn – Hamburg – Hannover
Bremen – Hannover – Nürnberg – München – Brenner – Verona – Bologna – Roma – Napoli – Bari
Napoli – Palermo – Valletta

Pre-identified sections	**Mode**	**Description/dates**
Kotka/Hamina - Helsinki	Port, rail	port hinterland connections, rail upgrading
Helsinki	Rail	airport-rail connection
RU border - Helsinki	Rail	works ongoing
Turku - Stockholm	Ports, MoS	port hinterland connections, icebraking capacity
Stockholm - Malmö (Nordic Triangle)	Rail	works ongoing on specific sections

Fehmarn	Rail	studies ongoing, construction works Fehmarn Belt fixed link between 2014 and 2020
København - Hamburg via Fehmarn: access routes	Rail	access routes DK to be completed by 2020, access routes Germany to be completed in 2 steps (2020 - 2027)
Hamburg/Bremen - Hannover	Rail	works to be started before 2020
München - Wörgl	Rail	access to Brenner Base Tunnel and cross-border section: studies
Brenner Base Tunnel	Rail	studies and works
Fortezza - Verona	Rail	studies and works
Napoli - Bari	Rail	studies and works
Napoli – Reggio Calabria	Rail	Upgrading
Messina - Palermo	Rail	upgrading (remaining sections)
Palermo - Valletta	Ports, MoS	port hinterland connections
Valletta - Marsaxlokk	Port, airport	traffic management systems to be deployed, upgrading of modal interconnection

6. Genova – Rotterdam

Genova – Milano/Novara – Simplon/Lötschberg/Gotthard – Basel – Mannheim – Köln
Köln– Düsseldorf – Rotterdam/Amsterdam
Köln– Liège – Bruxelles/Brussel– Zeebrugge

Pre-identified sections	**Mode**	**Description/dates**
Genova - Milano/Novara - CH border	Rail	studies; works starting before 2020
Basel - Rotterdam/Amsterdam/Antwerpen	IWW	upgrading
Karlsruhe - Basel	Rail	works to be completed by the end of 2020
Frankfurt - Mannheim	Rail	studies ongoing
Zevenaar - Emmerich - Oberhausen	Rail	works to be completed until 2017
Zeebrugge	Port	locks: studies ongoing

7. Lisboa - Strasbourg

Sines / Lisboa – Madrid – Valladolid
Lisboa – Aveiro – Oporto
Aveiro – Valladolid – Vitoria – Bordeaux – Paris – Mannheim/Strasbourg

Pre-identified sections	Mode	Description/dates
High Speed rail Sines/Lisboa - Madrid	Rail, ports	studies and works ongoing, upgrading of modal interconnection ports of Sines/Lisboa
High speed rail Porto - Lisboa	Rail	studies ongoing
Rail connection Aveiro - ES	Rail	cross-border: works ongoing
Rail Connection Bergara - San Sebastián - Bayonne	Rail	completion expected in ES by 2016, in FR by 2020
Bayonne - Bordeaux	Rail	ongoing public consultation
Tours - Bordeaux	Rail	works ongoing
Paris	Rail	southern high-speed bypass
Baudrecourt - Mannheim	Rail	upgrading
Baudrecourt - Strasbourg	Rail	works ongoing, to be completed 2016

8. Dublin – London – Paris – Brussel/Bruxelles

Belfast – Dublin – Holyhead – Birmingham
Glasgow/Edinburgh – Birmingham
Birmingham – London – Lille – Brussel/Bruxelles
Dublin/Cork/Southampton – Le Havre – Paris
London – Dover – Calais – Paris

Pre-identified sections	Mode	Description/dates
Dublin - Belfast	Rail	Upgrading; Dublin Interconectors (DART)
Glasgow - Edinburgh	Rail	upgrading
High Speed 2	Rail	studies
Swansea - Cardiff - Bristol - London	Rail	upgrading
Dublin, Cork, Southampton, Le Havre	Ports	hinterland connections
Le Havre - Paris	IWW	upgrading
Le Havre - Paris	Rail	studies
Calais - Paris	Rail	preliminary studies

9. Amsterdam – Basel/Lyon – Marseille

Amsterdam – Rotterdam – Antwerp – Brussel/Bruxelles – Luxembourg
Luxembourg – Dijon – Lyon
Luxembourg – Strasbourg – Basel

Pre-identified sections	Mode	Description/dates
Maas	IWW	upgrading
Albertkanaal	IWW	upgrading
Terneuzen	Maritime	locks: studies ongoing
Terneuzen - Gent	IWW	studies, upgrading
Antwerp	Maritime, port	locks: studies ongoing, port: hinterland connections
Canal Seine - Escaut	IWW	design completed, competitive dialogue launched, overall completion by 2018
Waterways upgrade in Wallonia	IWW	studies, upgrading
Brussel/Bruxelles - Luxembourg - Strasbourg	Rail	works ongoing
Strasbourg - Mulhouse - Basel	Rail	upgrading
Rail Connections Luxembourg - Dijon - Lyon (TGV Rhin - Rhône)	Rail	studies and works
Lyon	Rail	eastern bypass: studies and works
Canal Saône - Moselle/Rhin	IWW	preliminary studies ongoing
Rhône	IWW	upgrading

10. Strasbourg – Danube Corridor

Strasbourg – Stuttgart – München – Wels/Linz
Strasbourg – Mannheim – Frankfurt – Würzburg – Nürnberg – Regensburg – Passau – Wels/Linz
Wels/Linz – Wien – Budapest – Arad – Brašov – Bucurešti – Constanta - Sulina

Pre-identified sections	Mode	Description/dates
Rail connection Strasbourg - Kehl Appenweier	Rail	works interconnection Appenweier
Karlsruhe - Stuttgart - München	Rail	studies and works ongoing
München - Mühldorf - Freilassing - Salzburg	Rail	studies and works ongoing
Salzburg - Wels	Rail	studies
Nürnberg - Regensburg - Passau - Wels	Rail	studies; works partly ongoing
Rail connection Wels - Wien	Rail	completion expected by 2017
Wien - Budapest	Rail	studies high speed HU
Arad - Brašov - Bucurešti - Constanta	Rail	upgrading of specific sections; studies high-speed
Main – Main-Donau-Canal – Danube	IWW	studies and works on several sections and bottlenecks; inland waterway ports: hinterland connections
Constanta	Port	hinterland connections

b) Other Sections on the Core Network

Sofia to FYROM border	**Cross-Border**	Rail	studies ongoing
Sofia to Serbian border	**Cross-Border**	Rail	studies ongoing
Timişoara – Serbia border	**Cross-Border**	Rail	studies ongoing
München – Praha	**Cross-Border**	Rail	studies
Nürnberg – Praha	**Cross-Border**	Rail	studies
Wroclaw – Dresden	**Cross-Border**	Rail	upgrading
Wroclaw – Praha	**Cross-Border**	Rail	studies
Graz – Maribor – Pragersko	**Cross-Border**	Rail	studies
Bothnian Corridor: Lulea – Oulu	**Cross-Border**	Rail	studies and works
North-West Spain and Portugal	**Bottleneck**	Rail	works ongoing
Frankfurt – Fulda – Erfurt – Berlin	**Bottleneck**	Rail	studies
Halle – Leipzig – Nürnberg	**Bottleneck**	Rail	works ongoing, to be completed by 2017
Rail Egnathia	**Bottleneck**	Rail	studies ongoing
Inland waterways Dunkerque – Lille	**Bottleneck**	IWW	studies ongoing
Parallel HSR line Paris- Lyon	**Bottleneck**	Rail	preliminary studies ongoing
Sundsvall – Umea – Lulea	**Bottleneck**	Rail	studies and works
Malmö - Göteborg	**Other Core Network**	Rail	works
Bothnian – Kiruna – NO border	**Other Core Network**	Rail	studies and works
Rail connection Shannon – Cork – Dublin	**Other Core Network**	Rail	studies ongoing
Rail connection to Wilhelmshaven and Bremerhaven	**Other Core Network**	Rail	studies ongoing
Zilina – UA border	**Other Core Network**	Rail	upgrading
Ventspils – Riga – RU border	**Other Core Network**	Rail	upgrading
Klaipeda – Kaunas – Vilnius – BY border	**Other Core Network**	Rail	Upgrading, airport interconnection
Katowice – Wroclaw – DE border	**Other Core Network**	Rail	upgrading
Marseille – Toulon – Nice – IT border	**Other Core Network**	Rail	studies high-speed
Bordeaux – Toulouse	**Other Core Network**	Rail	studies high-speed
Tampere – Oulu	**Other Core Network**	Rail	upgrading of sections
Pamplona – Zaragoza - Sagunto	**Other Core Network**	Rail	studies and works

Source: (DG MOVE, 2011)

9.4 List of 83 Core Ports

BELGIUM
Antwerpen
Gent
Oostende, Zeebrugge

BULGARIA
Burgas

DENMARK
Århus
Københavns Havn

GERMANY
Bremerhaven, Bremen
Hamburg
Lübeck
Rostock
Wilhelmshaven

ESTONIA
Tallinn

IRELAND
Cork
Dublin
Limerick

GREECE
Igoumenitsa
Patras
Pireus
Thessaloniki

SPAIN
Algeciras
Barcelona
Bilbao
Cartagena
Gijón
A Coruña
Las Palmas
Palma de Mallorca
Sevilla
Tarragona
Valencia

FRANCE
Bordeaux
Calais, Dunkerque
Le Havre
Marseille
Nantes Saint-Nazaire
Rouen

ITALY
Ancona
Bari
Genova
Gioia Tauro
La Spezia
Livorno
Napoli
Palermo
Ravenna
Taranto
Trieste
Venezia

CYPRUS
Lemesos

LATVIA
Rīga
Ventspils

LITHUANIA
Klaipėda

MALTA
Valletta, Marsaxlokk

THE NETHERLANDS
Amsterdam
Rotterdam
Terneuzen, Vlissingen

ROMANIA
Constanța

SLOVENIA
Koper

FINLAND
Helsinki
Kotka, Hamina
Turku

SWEDEN
Göteborg
Luleå
Malmö
Stockholm
Trelleborg

UNITED KINGDOM
Belfast
Bristol
Cardiff, Newport
Dover
Felixstowe
Forth (Edinburgh)
Glasgow
Grimsby, Immingham
Liverpool
London
Southampton, Portsmouth
Tees and Hartlepool

9.5 Modal splits per port, country, outgoing freight statistics and ROW distances

Table A1. Modal Splits per port

Port	%
Antwerp RO	57%
Antwerp RA	11%
Antwerp IWW	32%
Oostende+Zeebrugge RO	61%
Oostende+Zeebrugge RA	33%
Oostende+Zeebrugge IWW	6%
Bremerhaven+Bremen RO	53%
Bremerhaven+Bremen RA	45%
Bremerhaven+Bremen IWW	3%
Hamburg RO	64%
Hamburg RA	34%
Hamburg IWW	2%
Lübeck RO	50%
Lübeck RA	50%
Lübeck IWW	0%
Barcelona RO	92%
Barcelona RA	8%
Barcelona IWW	0%
Calais+Dunkerque RO	88%
Calais+Dunkerque RA	8%
Calais+Dunkerque IWW	4%
Le Havre RO	84%
Le Havre RA	7%
Le Havre IWW	9%
Marseille RO	82%
Marseille RA	12%
Marseille IWW	6%
Amsterdam RO	76%
Amsterdam RA	3%
Amsterdam IWW	21%
Rotterdam RO	57%
Rotterdam RA	10%
Rotterdam IWW	33%
Costanza RO	48%
Costanza RA	47%
Costanza IWW	5%

Sources: (Port of Rotterdam, 2011) (Burgess, Van 't Zelfde, Maurer, Rudzikaite, & Wolters, 2011) (Bureau Voorlichting Binnenvaart)

Table A2. Modal splits per country

Modal Splits per country			
2010	Road	Rail	IWW
Belgium	69,5%	12,5%	18,0%
Bulgaria	68,1%	10,7%	21,2%
Czech Republic	79,0%	21,0%	0,1%
Denmark	87,0%	13,0%	0,0%
Germany (including former GDR from 1991)	64,9%	22,2%	12,9%
Estonia	45,8%	54,2%	0,0%
Ireland	99,2%	0,8%	0,0%
Greece	98,0%	2,0%	0,0%
Spain	95,8%	4,2%	0,0%
France	82,2%	13,5%	4,3%
Italy	90,4%	9,6%	0,1%
Cyprus	100,0%	0,0%	0,0%
Latvia	38,1%	61,9%	0,0%
Lithuania	59,1%	40,9%	0,0%
Luxembourg	93,5%	2,7%	3,9%
Hungary	75,1%	19,6%	5,3%
Malta	100,0%	0,0%	0,0%
Netherlands	62,3%	4,8%	32,9%
Austria	56,3%	39,0%	4,7%
Poland	81,2%	18,8%	0,1%
Portugal	93,9%	6,1%	0,0%
Romania	49,2%	23,5%	27,2%
Slovenia	82,3%	17,7%	0,0%
Slovakia	74,8%	22,0%	3,2%
Finland	75,0%	24,8%	0,2%
Sweden	60,7%	39,3%	0,0%
United Kingdom	88,7%	11,2%	0,1%

Source: (Eurostat, 2012), tran_hv_frmod

Table A3. Core port and outgoing freight statistics

Outgoing freight per Core Port	
2010, thousand tonnes	
Antwerpen	76,151
Gent (Ghent)	6,773
Oostende (Ostend), Zeebrugge	1,947
Burgas	5,101
Aarhus	3,517
Kobenhavns Havn	1,239
Bremerhaven, Bremen	25,094
Hamburg	42,620
Luebeck	7,290
Rostock	8,363
Wilhelmshaven	4,372
Tallinn	27,544
Cork	3,024
Dublin	6,797
Limerick	1,957
Igoumenitsa	1,458
Patras	1,206
Piraeus	5,833
Thessaloniki	3,933
Algeciras	24,800
Barcelona	13,101
Bilbao	9,274
Cartagena	1,794
Gijon	2,080
La Coruña	2,651
Las Palmas, Gran Canaria	5,550
Palma Mallorca	651
Sevilla	1,905
Tarragona	8,973
Valencia	24,959
Bordeaux	2,373
Calais	10,968
Le Havre	15,930
Marseille	18,035
Nantes Saint-Nazaire	8,126
Rouen	17,124
Ancona	2,626
Bari	1,395
Genova	11,305
Gioia Tauro	16,690
La Spezia	7,064
Livorno	9,037
Napoli	5,062
Palermo	3,333
Ravenna	2,817
Taranto	13,755
Trieste	7,243
Venezia	4,558
Lemesos (Limassol)	581
Riga	26,135
Ventspils	22,343
Klaipeda	22,422
Malta (Valletta), Marsaxlokk	95
Amsterdam	23,943
Rotterdam	107,853
Terneuzen, Vlissingen	3,699
Gdansk, Gdynia	16,957
Swinoujscie, Szczecin	8,601
Leixões	3,982
Lisboa	3,627
Sines	8,177
Constanta	17,898
Koper	4,250
Helsinki	5,073
Kotka,Hamina	7,374
Turku	1,260
Goteborg	20,522
Lulea	6,182
Malmo	4,001
Stockholm	1,357
Trelleborg	5,581
Belfast	4,227
Bristol	1,229
Cardiff, Newport	1,057
Dover	9,584
Felixstowe	10,045
Forth	29,321
Glasgow(Clydeport)	3,301
Grimsby & Immingham	13,554
Liverpool	8,303
London	8,265
Southampton, Portsmouth	16,596
Tees & Hartlepool	23,417

Source: Compiled by Author, based on (Eurostat, 2012), mar_go_aa

Table A4. ROW countries and related distances in km

	Non-EU Countries							Average distance ROW
Port countries	Norway	Russia	Switzerland	West-Balkan	Turkey	Ukraine	Belarus	
Belgium	1925	3598	471	1734	2615	1850	1711	**1986.29**
Bulgaria	2400	2500	1365	287	855	888	1292	**1369.57**
Denmark	729	2541	977	1740	2580	1475	1188	**1604.29**
Germany	906	2432	663	1426	2328	1350	1161	**1466.57**
Estonia	2200	1540	1677	1889	2319	1050	634	**1615.57**
Ireland								**0.00**
Greece	2832	3733	1585	514	1041	1482	1818	**1857.86**
Spain	2597	4300	1316	1934	3056	2818	2735	**2679.43**
France	1655	3670	506	1471	2729	2079	1816	**1989.43**
Italy	2227	3312	678	636	1884	1580	1716	**1719.00**
Cyprus								**0.00**
Latvia	1400	1600	1518	1676	2179	992	554	**1417.00**
Lithuania	1200	1620	1418	1312	1981	854	371	**1250.86**
Malta								**0.00**
The Netherlands	1068	3500	564	1475	2700	1880	1544	**1818.71**
Poland	907	2580	1036	1319	2028	984	682	**1362.29**
Portugal	2723	4534	1557	2400	3715	3249	3112	**3041.43**
Romania	1988	2402	1295	470	1132	623	952	**1266.00**
Slovenia	1799	3502	537	560	1808	1210	1216	**1518.86**
Finland	1100	1968	1992	2218	2720	1477	967	**1777.43**
Sweden	510	240	1802	2234	2821	1648	1196	**1493.00**
United Kingdom	1270	3890	1013	1974	3079	2204	1926	**2193.71**

Source: Compiled by Author, based on (Google Maps, 2012)

9.6 Cost distribution per mode and distance.

Table A5. Transport costs for several European routes per mode up to 500km

Transport costs up to 500 km								
Routes								
	1	2	3	4	5	6	7	Average
Road	300	470	310	170	250	350	360	316
Rail	430	560	800	580	440	450	480	534
IWW	330	410	320	300	290	290	300	320

Source: Compiled by author, based on (Meyer-Ruhle, et al., 2008)

Table A6. Transport costs for several European routes per mode up to 1000km

Transport costs 500-1000 km							
Routes							
	1	2	3	4	5	6	Average
Road	510	520	700	510	700	750	615
Rail	530	520	990	900	750	700	730
IWW	260	480	470	460	490	470	438

Source: Compiled by author, based on (Meyer-Ruhle, et al., 2008)

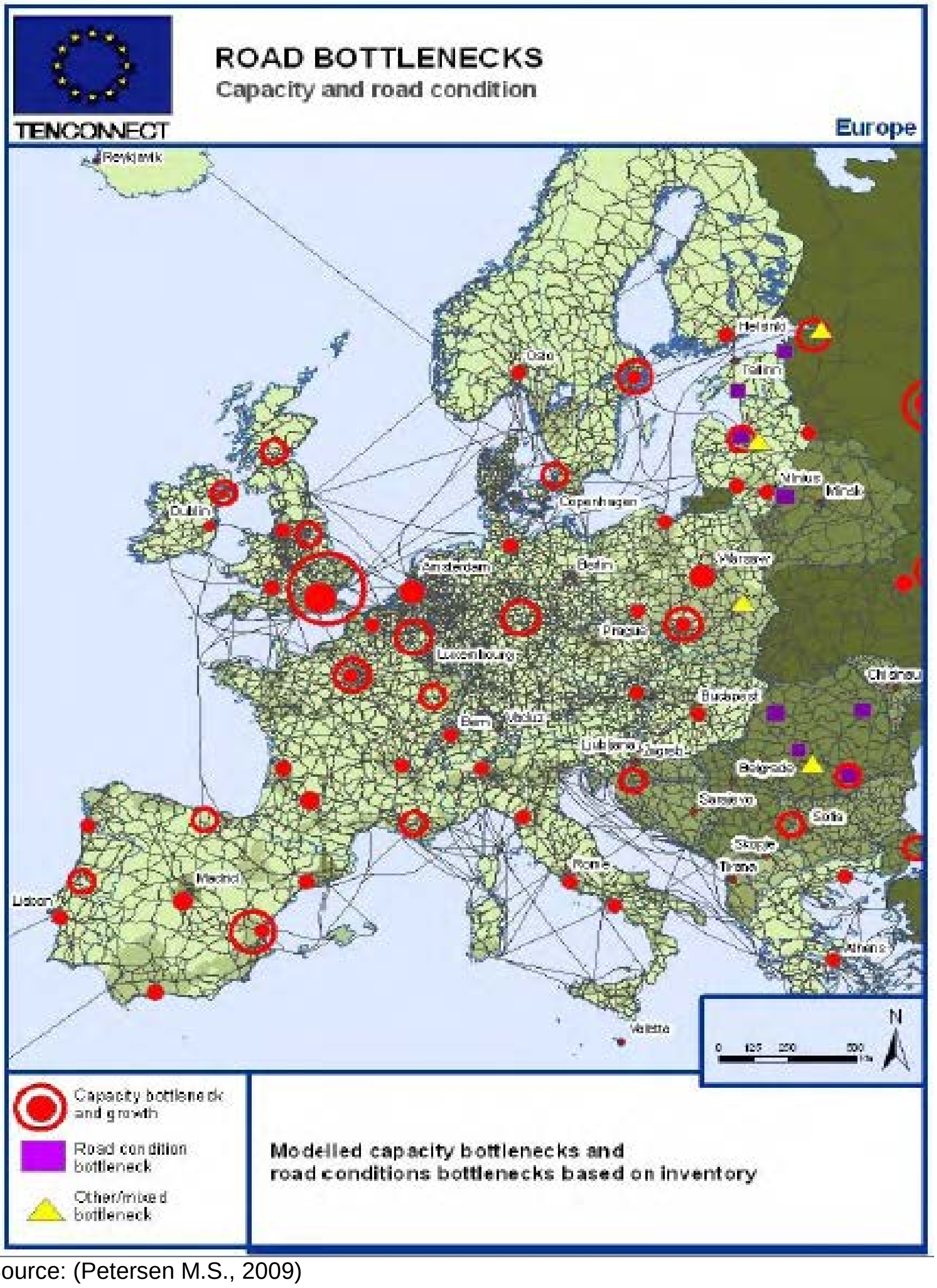
Table A7. Transport costs for several European routes per mode for 1000+km

Transport costs 1000+ km						
Routes						
	1	2	3	4	5	Average
Road	1700	1800	1600	1900	1800	1760
Rail	1250	1450	1250	1450	1200	1320
IWW	750	800	600	750	1000	780

Source: Compiled by author, based on (Meyer-Ruhle, et al., 2008)

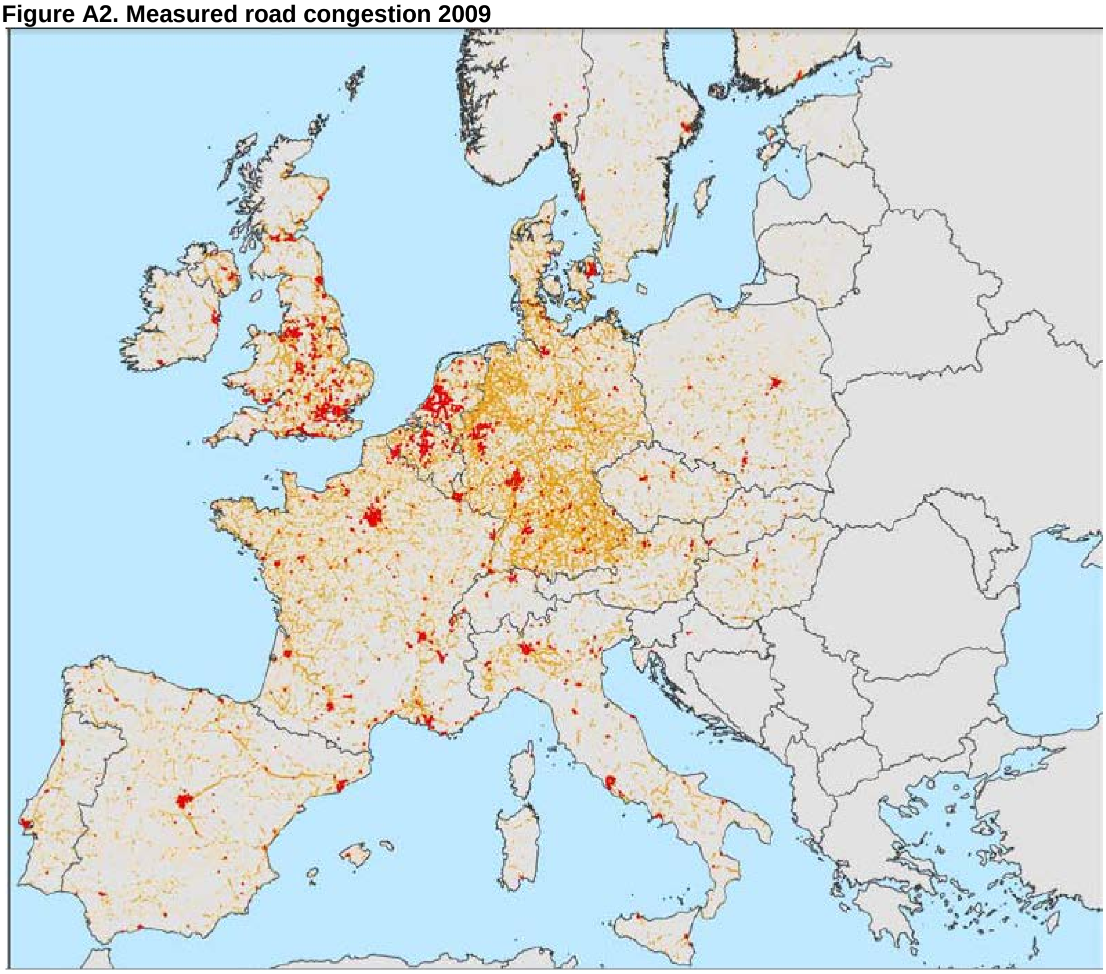
9.7 Specific road congestion and condition bottlenecks.

Figure A1. Capacity and Condition Bottlenecks, 2008



Source: (Petersen M.S., 2009)

Figure A2. Measured road congestion 2009



Source: (Christidis & Ibanez Rivas, 2012)

9.8 Specific Rail bottlenecks

Table A8. Slot and electrification bottlenecks for rail transport per country

1. Slot Restrictions according to TENCONNECT			
Belgium	Antwerp-Brussels	Brussels-Liege	
	Liege-Germany		
Bulgaria	-		
Czech Republic	Prague-Slovakia		
Denmark	-		
Germany	Hamburg-Essen	Essen-Frankfurt	
	Frankfurt-Zurich	Stuttgart-Munich	
	Hamburg-Munich	Frankfurt-Austria	Osnabruck-Poland
Estonia	Estonia-Russia		
Ireland	-		
Greece	-		
Spain	Barcelona		
France	Paris-Dijon	Dijon-Marseille	Paris
Italy	Milan	Venice-Austria	
Cyprus	-		
Latvia	Riga		
Lithuania	-		
Luxembourg	-		
Hungary	-		
Malta	-		
Netherlands	Amsterdam-Antwerp		
Austria	Wien		
Poland	Gdansk-Warsaw	Warsaw-Katowice	
	Poznan-Wroclaw	Wroclaw-Katowice	
Portugal	-		
Romania	Constanta-Bucharest		
Slovenia	-		
Slovakia	Slovakia-Hungary		
Finland	-		
Sweden	-		
United Kingdom	London	Liverpool-London	Tees-London
Switzerland	Zurich-France		
Long track barrier		0.5	
City or short haul barrier		0.25	

2.Electrification bottleneck TENCONNECT				
Belgium	-			
Bulgaria	-			
Czech Republic	-			
Denmark	Denmark-Germany	Denmark-Sweden		
Germany	-			
Estonia	-			
Ireland	-			
Greece	Thessaloniki-North			
Spain	La Coruna			
France	Paris	Tours	Lyon	Switzerland
Italy	-			
Cyprus	-			
Latvia	-			
Lithuania	Klaipeda-Vilnius			
Luxembourg	-			
Hungary	-			
Malta	-			
Netherlands	Border Germany			
Austria	-			
Poland	-			
Portugal	-			
Romania	-			
Slovenia	border Austria			
Slovakia	-			
Finland	-			
Sweden	-			
United Kingdom	border-France			
Switzerland	-			
Barrier:	0.75	(Intermodal Yearbook)		

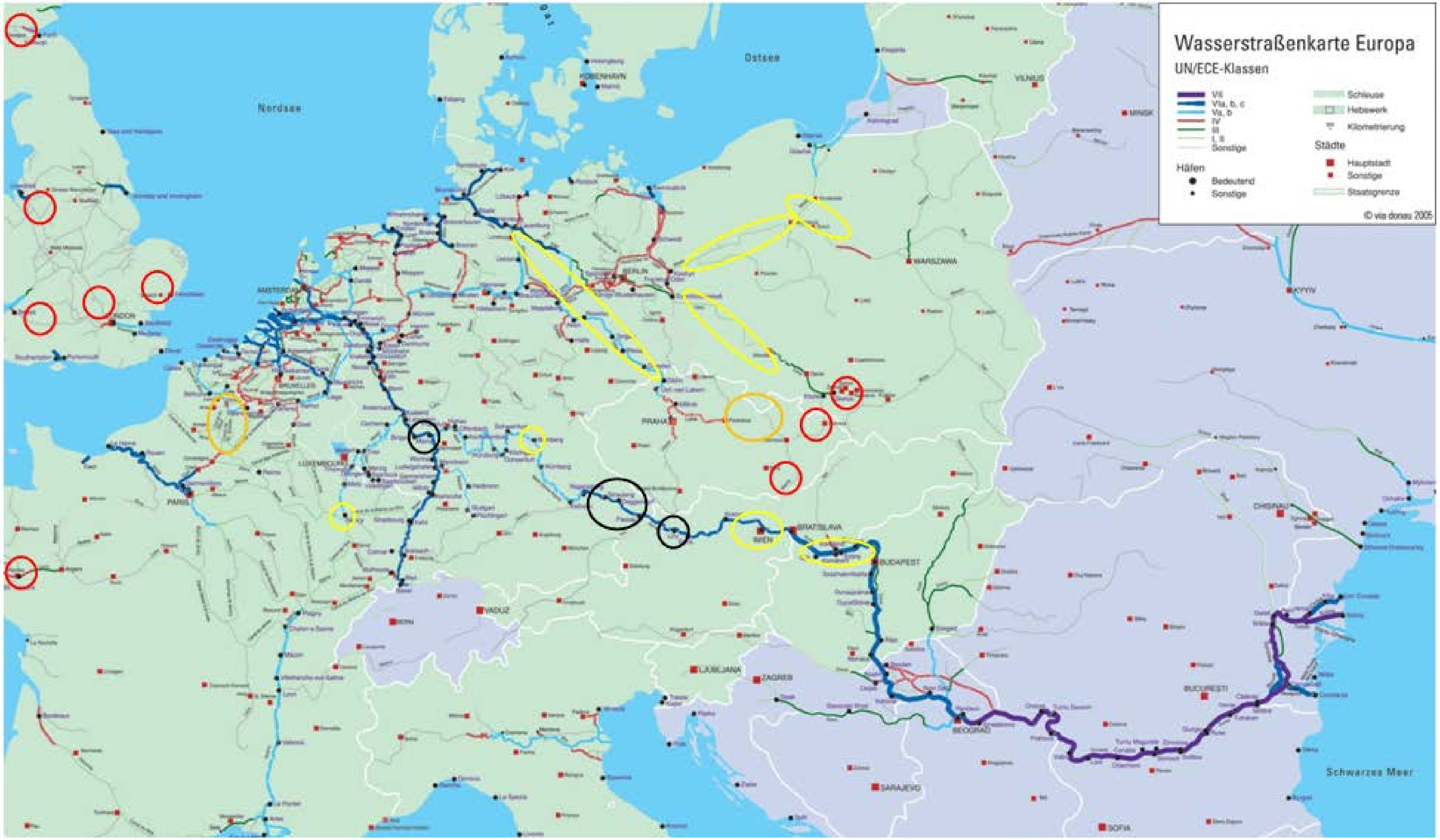
Source: Compiled by author, based on (Petersen M.S., 2009)

Table A9. Single track, border stop and gauge restrictions per country

3.Single Track restriction					4.Border stop bottlenecks	
Belgium	border-Luxembourg				Czech Republic-Slovakia	
Bulgaria	border-Romania	border Greece			Germany-Poland	
Czech Republic	Czech-Germany				Spain-Portugal	
Denmark	Denmark				Italy-Switzerland	
Germany	Hamburg	Rostock	Poland		Finland-Russia	
Estonia	Estonia					
Ireland	-				**Barrier:**	0.333
Greece	Northern					
Spain	Bilbao	Coruna	Portugal	Gijon	**5. Gauge Changes**	
France	-				Poland-Lithuania	
Italy	to Nice				France-Spain	
Cyprus	-					
Latvia	Northern	Southern				
Lithuania	Klaipeda	Northern	Southern		**Barrier:**	0.333
Luxembourg	-				(Intermodal Yearbook)	
Hungary	-					
Malta	-					
Netherlands	-					
Austria	-					
Poland	-					
Portugal	border Spain					
Romania	border-Hungary	Central				
Slovenia	border-Austria					
Slovakia	-					
Finland	Inland	Turku				
Sweden	Goteborg	Inland				
United Kingdom	-					
Switzerland	-					
Barrier:	1	large track				
	0.5	medium				
	0.25	small				

Source: Compiled by author, based on (Petersen M.S., 2009)

9.9 Waterway Map of Europe with identified bottlenecks. Compiled by Author with map from: (Inland Navigation Europe, 2005)



9.10 *Elasticity assessment per European port*

Table A10. Ports categorized on port competition and mode dominance.

Ports and mode and port competition scale							
Ports	Port scale	Mode scale	Block	Ports	Port scale	Mode scale	Block
Antwerp	3	3	33	Ravenna	3	1	31
Gent	3	1	31	Taranto	2	1	21
Oostende + Zeebrugge	3	2	32	Trieste	3	1	31
Burgas	2	1	21	Venetia	3	1	31
Arhus	2	1	21	Lemessos	1	1	11
Copenhagen	3	1	31	Riga	2	2	22
Bremerhaven	3	2	32	Ventspils	2	2	22
Hamburg	3	2	32	Klaipeda	2	2	22
Lubeck	3	2	32	Valletta	1	1	11
Rostock	3	1	31	Amsterdam	3	1	31
Wilhelmshaven	3	1	31	Rotterdam	3	3	33
Tallinn	2	2	22	Terneuzen	3	2	32
Cork	2	1	21	Gdansk	2	1	21
Dublin	2	1	21	Swinoujscie	3	1	31
Limerick	2	1	21	Porto	3	1	31
Igoumenitsa	2	1	21	Lisbon	3	1	31
Patras	2	1	21	Sines	3	1	31
Piraeus	2	1	21	Constanta	2	2	22
Thessaloniki	2	1	21	Koper	3	1	31
Algeciras	3	1	31	Helsinki	2	1	21
Barcelona	3	1	31	Kotka+Hamina	2	1	21
Bilbao	3	1	31	Turku	2	1	21
Cartagena	3	1	31	Goteborg	2	2	22
Gijon	3	1	31	Lulea	1	2	12
La Coruna	3	1	31	Malmo	3	2	32
Las Palmas	1	1	11	Stockholm	1	2	12
Palma de Mallorca	1	1	11	Trelleborg	3	2	32
Sevilla	3	1	31	Belfast	2	1	21
Tarragona	3	1	31	Bristol	3	1	31
Valencia	3	1	31	Cardiff Newport	3	1	31
Bordeaux	2	1	21	Dover	3	1	31
Calais	3	1	31	Felixstowe	3	1	31
Le Havre	3	1	31	Forth	2	1	21
Marseille	2	1	21	Glasgow	2	1	21
Nantes-STNazaire	2	1	21	Grimsby	2	1	21
Rouen	3	1	31	Liverpool	2	1	21
Ancona	3	1	31	London	3	1	31
Bari	3	1	31	Southampton	3	1	31
Genoa	3	1	31	Tees and Hartlepool	2	1	21
Gioia Tauro	3	1	31				
La Spezia	3	1	31				
Livorno	3	1	31				
Napoli	3	1	31				
Palermo	1	1	11				

Compiled by author

9.11 *Ports and their respective elasticities derived, per mode*

Table A11. Estimated elasticities per port and mode

Ports and elasticities per mode .					
	Block		Road	Rail	IWW
Antwerp	33	Split	57%	11%	32%
		Elasticity	-1,4	-1,4	-1,4
Gent	31	Split	69,5%	12,5%	18,0%
		Elasticity	-1,1	-1,1	-1,1
Oostende+Zeebrugge	32	Split	61%	33%	6%
		Elasticity	-1,1	-1,1	-0,5
Burgas	21	Split	86,1%	13,9%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Arhus	21	Split	87,0%	13,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Copenhagen	31	Split	87,0%	13,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Bremerhaven	32	Split	53%	45%	3%
		Elasticity	-1,1	-1,1	-0,5
Hamburg	32	Split	64%	34%	2%
		Elasticity	-1,1	-1,1	-0,5
Lubeck	32	Split	50%	50%	0%
		Elasticity	-1,1	-1,1	-0,5
Rostock	31	Split	64,9%	22,2%	12,9%
		Elasticity	-1,1	-1,1	-1,1
Wilhelmshaven	31	Split	64,9%	22,2%	12,9%
		Elasticity	-1,1	-1,1	-1,1
Tallinn	22	Split	45,8%	54,2%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Cork	21	Split	99,2%	0,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Dublin	21	Split	99,2%	0,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Limerick	21	Split	99,2%	0,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Igoumenitsa	21	Split	100,0%	0,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Patras	21	Split	98,0%	2,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Pireus	21	Split	98,0%	2,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Thessaloniki	21	Split	98,0%	2,0%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Algeciras	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Barcelona	31	Split	92%	8%	0%
		Elasticity	-1,1	-0,5	-0,5
Bilbao	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Cartagena	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Gijon	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5

La Coruna	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Las Palmas	11	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Palma de Mallorca	11	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Sevilla	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Tarragona	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Valencia	31	Split	95,8%	4,2%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Bordeaux	21	Split	82,2%	13,5%	4,3%
		Elasticity	-0,8	-1,1	-1,1
Calais	31	Split	88%	8%	4%
		Elasticity	-1,1	-1,1	-1,1
Le Havre	31	Split	84%	7%	9%
		Elasticity	-1,1	-1,1	-1,1
Marseille	21	Split	82%	12%	6%
		Elasticity	-0,8	-1,1	-1,1
Nantes-ST Nazaire	21	Split	82,2%	13,5%	4,3%
		Elasticity	-0,8	-1,1	-1,1
Rouen	31	Split	82,2%	13,5%	4,3%
		Elasticity	-1,1	-1,1	-1,1
Ancona	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Bari	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Genova	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Gioia Tauro	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
La Spezia	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Livorno	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Napoli	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Palermo	11	Split	0,0%	0,0%	0,0%
		Elasticity			
Ravenna	31	Split	90,4%	9,5%	0,1%
		Elasticity	-1,1	-1,1	-1,1
Taranto	21	Split	90,4%	9,6%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Trieste	31	Split	90,4%	9,6%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Venezia	31	Split	90,4%	9,5%	0,1%
		Elasticity	-1,1	-1,1	-1,1
Lemesos	11	Split	100,0%	0,0%	0,0%
		Elasticity	-0,2	-0,5	-0,5
Riga	22	Split	38,1%	61,9%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Ventspils	22	Split	38,1%	61,9%	0,0%
		Elasticity	-1,1	-1,1	-0,5

Klaipeda	22	Split	59,1%	40,9%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Valletta	11	Split	100,0%	0,0%	0,0%
		Elasticity	-0,2	-0,5	-0,5
Amsterdam	31	Split	76%	3%	21%
		Elasticity	-1,1	-1,1	-1,1
Rotterdam	33	Split	57%	10%	33%
		Elasticity	-1,4	-1,4	-1,4
Terneuzen	32	Split	62,3%	4,8%	32,9%
		Elasticity	-1,1	-0,5	-1,1
Gdansk	21	Split	81,2%	18,8%	0,1%
		Elasticity	-0,8	-0,5	-0,5
Swinoujscie	31	Split	81,2%	18,8%	0,1%
		Elasticity	-1,1	-0,5	-0,5
Porto	31	Split	93,9%	6,1%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Lisboa	31	Split	93,9%	6,1%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Sines	31	Split	93,9%	6,1%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Constanta	22	Split	48%	47%	5%
		Elasticity	-1,1	-1,1	-0,5
Koper	31	Split	82,3%	17,7%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Helsinki	21	Split	75,0%	24,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Kotka+Hamina	21	Split	75,0%	24,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Turku	21	Split	75,0%	24,8%	0,0%
		Elasticity	-0,8	-0,5	-0,5
Goteborg	22	Split	60,7%	39,3%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Lulea	12	Split	60,7%	39,3%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Malmo	32	Split	60,7%	39,3%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Stockholm	12	Split	60,7%	39,3%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Trelleborg	32	Split	60,7%	39,3%	0,0%
		Elasticity	-1,1	-1,1	-0,5
Belfast	21	Split	88,7%	11,2%	0,1%
		Elasticity	-0,8	-0,5	-0,5
Bristol	31	Split	88,7%	11,2%	0,1%
		Elasticity	-1,1	-0,5	-0,5
Cardiff Newport	31	Split	88,7%	11,2%	0,1%
		Elasticity	-1,1	-0,5	-0,5
Dover	31	Split	88,7%	11,3%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Felixstowe	31	Split	88,7%	11,2%	0,1%
		Elasticity	-1,1	-0,5	-0,5
Forth	21	Split	88,7%	11,2%	0,1%
		Elasticity	-0,8	-0,5	-0,5
Glasgow	21	Split	88,7%	11,2%	0,1%
		Elasticity	-0,8	-0,5	-0,5

Grimsby	21	Split	88,7%	11,2%	0,1%
		Elasticity	-0,8	-0,5	-0,5
Liverpool	21	Split	88,7%	11,2%	0,1%
		Elasticity	-0,8	-0,5	-0,5
London	31	Split	88,7%	11,2%	0,1%
		Elasticity	-1,1	-0,5	-0,5
Southampton	31	Split	88,7%	11,3%	0,0%
		Elasticity	-1,1	-0,5	-0,5
Tees and Hartlepool	21	Split	88,7%	11,3%	0,0%
		Elasticity	-0,8	-0,5	-0,5

Source: Compiled by author

9.12 List of Priority Projects and the impact on Bottlenecks, RAIL:

Priority Projects Evaluation and impact on Model.

PP1. **Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo** **SUM:** € 847.600.000

Projects with impact on bottlenecks identified.

2006-DE-101f-P **North-South high speed line Berlin-Palermo, section between Nuremberg and Ebensfeld, part Nuremberg-Fürth**

Completed but influence on bottleneck as estimated on study.

Project nr.		***Type.***		
2006-DE-101f-P		Rail improvements Nuremberg-Furth.		
EU subsidy	€ 3.300.000			
% of total	9,89%			
			Old:	
Impact on bottleneck:		Hamburg-Munich		0,5 hours
		Decreased by 20%		
New Bottleneck:		0,4 hours		

2007-AT-01130-P **Works for construction of new high speed line between Kundl/Radfeld and Baumkirchen**

Ongoing Project

Project nr.		***Type.***		
2007-AT-01130-P		Rail improvements Kundl-Baumkirchen before Brenner Tunnel		
EU subsidy	€ 58.300.000			
% of total	5,00%			
			Old:	
Impact on bottleneck:		Venice-Austria		0,5 hours
		Decreased by 20%		
New Bottleneck:		0,4 hours		
Extra km of track:		40 km		

2007-EU-01180-P/S Brenner Base Tunnel - Works& Studies

Ongoing Project

Project nr. 2007-EU-01180-P/S		***Type.*** Brenner Base Tunnel Construction and studies		
EU subsidy	€ 786.000.000			
% of total	30,45%			
			Old:	
Impact on bottleneck:		Venice-Austria		0,4 hours
		Decreased by 80%		
New Bottleneck:		0 hours		
Extra km of track:		30 km Austria		
		130 km Italy		

PP2. **High-speed railway axis Paris-Bruxelles/Brussels-Köln-Amsterdam-London: PBKAL**

Only passengers, no implications

PP3. **High-speed railway axis of southwest Europe** SUM: € 441.560.385

2007-EU-03080-P Studies and Works for the High-Speed Railway Axis of South-West Europe (PP3) - Lisbon-Madrid Axis: Cross-Border Section Evora-Merida

Project nr. 2007-EU-03080-P		***Type.*** Spain Portugal New line, double track, high speed				
EU subsidy	€ 312.660.000					
% of total	25,00%					
			Old:			Old:
Impact on bottleneck:		Spain-Portugal	0,5 hours		Portugal-border	0,25 hours

	100%		100%
New Bottleneck:	0 hours		0 hours
Extra km of track:	80 km Portugal 30 km Spain		

2010-ES-92255-S **High speed railway line Basque country-French border.**

Project nr.		***Type.***	
2010-ES-92255-S		Rail improvements for high speed accessible region of Bilbao. study.	
EU subsidy	€ 2.350.385		
% of total	50,00%		
			Old:
Impact on bottleneck:		Bilbao	0,5 hours
		Decreased by 10%	
New Bottleneck:		0,45 hours	

2007-EU-03110-P **Works for construction of a high speed railway section between Perpignan and Figueras**
2007-EU-03040-P **High speed railway line Paris-Madrid: section Vitoria-Dax**
Together with PP16.

Project nr.		***Type.***		
2007-EU-03110-P 2007-EU-03040-P		High speed and standard gauge between France Spain.		
EU subsidy	€ 69.750.000		€ 56.800.000	
% of total	25,00%		20%	
				Old:
Impact on bottleneck:		France-Spain		0,333 hours
			100%	
New Bottleneck:			0 hours	

Added Track:	44 km

PP4. **High-speed railway axis east**

Only passenger

PP5. **Betuwe line**

SUM: € 19.880.000

Completed but only:

2007-NL-05020-P **Works for replacement of legacy systems by 15/25 kVAC on two remaining sections in the Netherlands of the railway corridor Rotterdam-Genoa**

Project nr.		***Type.***		
2007-NL-05020-P		Legacy Systems adaptation of 15/25 kVAC at border NL-DE		
EU subsidy	€ 19.880.000			
% of total	20,00%			
			Old:	
Impact on bottleneck:		NLborderGermany	0,75	hours
		Decreased by 100%		
New Bottleneck:		0 hours		

PP6. **Railway axis Lyon-Trieste-Divača/Koper-Divača-Ljubljana-Budapest-Ukrainian border**

SUM: € 696.900.000

2007-EU-06010-P **New Lyon-Turin Rail Link - Franco-Italian Common Part of the International Section (Studies and Works)**

Project nr.		***Type.***		
2007-EU-06010-P		New Rail Link Between Lyon and Turin covering a 80km track and two new tunnels.		
EU subsidy	€ 671.800.000			
% of total	27%			
			Old:	
Impact on bottleneck:			0	hours
		No identified bottlenecks		
New Bottleneck:		0 hours		
Extra Rail track:		40 km Italy 40 km France		

2007-IT-06020-S **Section Ronchi Sud-Trieste**

Project nr.		***Type.***		
2007-IT-06020-S		Study on a New track between Ronchi and Trieste		
EU subsidy	€ 24.000.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		no bottleneck	0	hours
New Bottleneck:		0	hours	
Added track		30	km	

2010-SI-92232-S **Elaboration of the executive design for upgrading of the section of the railway line Poljčane-Pragersko**

Ongoing studies to improve this section.

Project nr.		***Type.***		
2010-SI-92232-S		Upgrading electrification and single tracks		
EU subsidy	€ 1.100.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		borderAustria,electr.	0,75	hours
		Decreased by 100%		
New Bottleneck:		0	hours	

PP9. **Railway axis Cork–Dublin–Belfast–Stranraer**

Already Completed in 2001

PP12. **Nordic Triangle railway/road axis** SUM: € 58.430.000

2007-FI-12010-P **Rail connection from Kouvola to Kotka/Hamina ports, works for improving and construction of a new railway**

yard

Project nr.		Type.		
2007-FI-12010-P		Upgrading 60 km rail connection and new railway		
EU subsidy	€ 6.600.000			
% of total	10,00%			
			Old:	
Impact on bottleneck:		None	-	hours
Extra km:		60km		

2007-SE-12100-P Works for construction of Citytunnel project

Project nr.		Type.		
2007-SE-12100-P		New lines, tunnels, stations and upgrade of Oresund connection.		
EU subsidy	€ 51.830.000			
% of total	9,56			
			Old:	
Impact on bottleneck:		Denmark-Sweden	0,75	hours
		Decreased by 100%		
New Bottleneck:		0 hours		
New track		17 km		

PP. 14 **West Coast Main Line UK** SUM: € 40.000.000

This project was completed and did not fall in the 2007-2013 frame, but did fall in the bottleneck consideration. Therefore, 40mln of 2001-2006 framework incorporated

Project nr.	Type.
-	Upgrading congested 850 km of rail track

EU subsidy	€ 40.000.000			
% of total	<1%	Total of 8bln spent by UK Government		
			Old:	
Impact on bottleneck:		London-Liverpool	0,5	hours
		Decreased by 100%		
New Bottleneck:		0	hours	

PP16. **Freight railway axis Sines/Algeciras-Madrid-Paris**

SUM: € 5.000.000

Only Pyrenean axis taken into consideration through TEN-T budget.

2007-EU-16010-S **Freight Railway Axis Sines-Madrid-Paris: New high capacity line through the Pyrenees**

Project nr.		***Type.***		
2007-EU-16010-S		Set up of EEIG between Spain and France, should finally result in axis between two countries.		
EU subsidy	€ 5.000.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		France-Spain Gauge	0,333	hours
		Decreased by 100%		
New Bottleneck:		0	hours	

PP17. **Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava**

SUM: € 427.565.748

The railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava is an east-west oriented axis crossing very densely populated areas in the centre of Europe. It touches upon four Member States: France, Germany, Austria and Slovakia.

2006-DE-1004A-S **Studies for the new construction of the Stuttgart-Ulm high speed line**

Project nr.		**Type.**		
2006-DE-1004A-S		Studies for new line between Stuttgart and Ulm.		
EU subsidy	€ 2.968.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		Stuttgart-Munich	0,25	hours
		10%		
New Bottleneck:		0,225 hours		

2007-DE-17010-P **Works for the construction of a high speed line between Wendlingen and Ulm**
2007-DE-17200-P **Works for the construction of the high speed line between Stuttgart and Wendlingen**
2006-DE-1005-P **Upgrade of Augsburg-Olching section for high speed railway traffic**

All Projects will decrease the Stuttgart-Munich section.

Project nr.		**Type.**			
2007-DE-17010-P		Wendlingen Ulm part, new line, tunnels, high speed			
2007-DE-17200-P		Stuttgart-Wendlingen part, tunnels, track etc.			
2006-DE-1005-P		Augsburg-Munich upgrade of capacity			
	W-Ulm	St-Wendlingen	Augsburg-Munich		
EU subsidy	€ 101.450.000	€ 114.470.000	€ 2.760.000		
% of total	14,35%	11,61%	5,73%		
				Old:	
Impact on bottleneck:		Stuttgart-Munich		0,225	hours
		100%			
New Bottleneck:		0 hours			
Extra rail track:		117km			

2007-AT-17040-P **Works and studies for upgrading the Wien-Bratislava railway line**
2010-AT-91136-S **Terminal Wien Inzersdorf - Planning**

Project nr.	**Type.**
2007-AT-17040-P	Works for better connectivity of Vienna as a whole and its connection
2010-AT-91136-S	Study regarding new freight terminal in Wien

EU subsidy	€ 118.778.476	€ 2.140.000		
% of total	14,03%	50%		
			Old:	
Impact on bottleneck:	Wien		0,25	hours
		100%		
New Bottleneck:		0	hours	

2007-AT-17170-P Works for the modernisation of the cross border section Salzburg–German border

2007-DE-17020-P Works and studies for upgrading of the section München-Mühldorf-Freilassing, cross-border section DE/AT

Both will decrease same bottleneck

Project nr.	***Type.***
2007-AT-17170-P	Works will partially decrease the German-Austrian bottleneck in capacity
2007-DE-17020-P	German section of border crossing, more capacity

EU subsidy	€ 37.880.000	€ 8.544.272		
% of total	25,00%	25,00%		
			Old:	
Impact on bottleneck:	Frankfurt-Austria		0,5	hours
		20%		
New Bottleneck:		0,4	hours	

2007-DE-17220-P Works for construction and modernisation of the section between Kehl-Appenweier

Project nr.	***Type.***
2007-DE-17220-P	Doubling the capacity at this French-German track.

EU subsidy	€ 26.950.000

% of total	25,00%			
			Old:	
Impact on bottleneck:		Frankfurt-Zurich		0,5 hours
		20%		
New Bottleneck:		0,4 hours		

2007-DE-60320-P **Equipment with ETCS of the railway section from Emmerich to Basel as part of the Corridor A Rotterdam-Genoa**

Partially, this affects the PP17 section, also partially accounted for PP24 section.

Project nr.		***Type.***		
2007-DE-60320-P		ERTMS system for Rail installed at Mannheim-Basel section		
EU subsidy	€ 11.625.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		Frankfurt-Zurich		0,4 hours
		20%		
New Bottleneck:		0,32 hours		

PP19.	High-speed rail interoperability in the Iberian Peninsula	SUM:	€ 279.342.000
	Makes also space for freight transport.		

2009-ES-19091-E Madrid-Galicia high speed mixed traffic rail section: La Hiniesta-Perilla-Otero de Bodas-Cernadilla

Project nr. 2009-ES-19091-E		***Type.*** New 83 km High speed track for mixed traffic.		
EU subsidy	€ 35.202.000			
% of total	20,00%			
			Old:	
Impact on bottleneck:		Coruna		0,5 hours
		50% (partially)		
New Bottleneck:		0,25 hours		
Extra Rail Track:		83 km		

2007-EU-19010-P Oporto-Vigo Axis: Cross-Border Section Ponte de Lima-Vigo

Project nr. 2007-EU-19010-P		***Type.*** High speed track between North Portugal and Spain		
EU subsidy	€ 244.140.000			
% of total	25,00%			
			Old:	
Impact on bottleneck:		none	-	hours
		- (partially)		
New Bottleneck:		- hours		
Extra Rail Track:		60 km		

PP20.	**Railway axis Fehmarn belt**	SUM:	€ 307.842.000

New bridge or tunnel between Germany and Denmark, improving the railway connection between the two countries and some inside the countries

Multiple Projects to be carried out

2006-DE-DK-3009-S **Studies for the Fehmarn belt Fixed Rail-Road Link**
2007-DE-20010-S **Studies for linking to Fehmarn belt fixed link between Lübeck-Puttgarden**
2007-DK-20060-S **Studies for the capacity improvements of the section between Copenhagen and Ringsted**
2007-DK-20070-S **Studies for upgrading the railway access lines to the future Fehmarn Belt fixed link - from Ringsted to Rødby and the intersection in Kastrup**
2007-EU-20050-P **Fehmarn Belt Fixed Link**

Project nr.	***Type.***
2006-DE-DK-3009-S	Studies
2007-DE-20010-S	“
2007-DK-20060-S	”
2007-DK-20070-S	“
2007-EU-20050-P	Actual Construction

EU-subsidy:	€ 5.000.000	€ 12.700.000	€ 10.990.000	€ 11.700.000	€ 267.452.000		
% of total:	50%	50%	50%	50%	24%		
		old:				old:	
Impact on bottleneck:	Denmark-Sweden		0,75 hours		Denmark track		0,25
		100%			100%		
New Bottleneck:		0	hours		0	hours	

PP23.	**Railway axis Gdańsk–Warszawa–Brno/Bratislava-Wien**	SUM:	€ 23.627.657

Again Much potential but most work still needs to be carried out, remains only studies

2006-CZ-92101-S **Studies concerning the modernisation of the railway track line Blazovice-Nezamyslice: preliminary design, EIA, geotechnical documentation**

2006-CZ-92109-S **Studies concerning the optimisation of the railway section between Mosty u Jablunkova at the Slovakian Border and Bystřice nad Olší**

Both partially improve the connection between Prague and Slovakian border, with studies.

Project nr.		***Type.***			
2006-CZ-92101-S		Studies for modernization of two sections between Prague-border			
2006-CZ-92109-S		Studies for modernization of two sections between Prague-border			
EU subsidy	€ 2.300.000	€ 2.400.000			
% of total	49,30%	49,70%			
			Old:		
Impact on bottleneck:		Prague-Slovakia		0,5	hours
		10%			
New Bottleneck:		0,45	hours		

2010-PL-92245-S	**Feasibility study for the modernisation and extension of the Katowice railway junction**
2006-PL-92608-S	**Preparation of modernisation and extension of Warsaw Railway Junction**
2009-PL-60151-P	**Project and development of ETCS level 1 system at the section of the E 65, CMK, railway line, Grodzisk Mazowiecki-Zawiercie**
	All will contribute to improvement bottleneck Warsaw-Katowice

Project nr.		*Type.*			
2010-PL-92245-S		Studies for modernization Katowice station and surroundings			
2006-PL-92608-S		Studies for modernization Warsaw junction			
2009-PL-60151-P		Project to modernize rail track with ETCS, leading to more capacity			
EU subsidy	€ 3.180.000	€ 4.900.000	€ 8.822.657		
% of total	50,00%	50,00%	50%		
				Old:	
Impact on bottleneck:		Warsaw-Katowice			0,25 hours
		100%			
New Bottleneck:		0 hours			

2009-SK-60108-P **ETCS deployment on Corridor VI: Zilina-Cadca-State Border SK/CZ**

Project nr.		*Type.*		
2009-SK-60108-P		Implementing ETCS and higher speeds around SK/CZ border		
EU subsidy	€ 2.025.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		Czech-Slovak border		0,333 hours
		100%		
New Bottleneck:		0 hours		

PP. 24 **Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerp** SUM: €

345.625.352

2007-DE-24040-P **Studies and works for the upgrading of the high speed railway line Duisburg-Emmerich**
2007-DE-60320-P **Equipment with ETCS of the railway section from Emmerich to Basel as part of the Corridor A Rotterdam-Genoa**
2009-DE-24070-E **Equipment with electronic interlocking of the railway line between Emmerich (Dutch-German border) and Basel**

Project nr.		***Type.***			
2007-DE-24040-P		Increasing capacity of this high traffic piece between NL-Duisburg			
2007-DE-60320-P		Implementing ETCS for Duisburg-Emmerich			
2009-DE-24070-E		New interlockings to facilitate interoperable rail service.			
EU subsidy	€ 46.981.302	€ 11.625.000	€ 39.732.000		
% of total	20,00%	50%	20%		
				Old:	
Impact on bottleneck:		Essen-Frankfurt			0,25 hours
		100% partially			
New Bottleneck:		0,0 hours			

2007-DE-24060-P **Works for construction and re-construction of the partially existing railway section between Karlsruhe and Basel**

Project nr.		***Type.***		
2007-DE-24060-P		Increase capacity between Karlsruhe and Basel		
EU subsidy	€ 46.656.550			
% of total	10,00%			
			Old:	
Impact on bottleneck:		Frankfurt-Zurich		0,32 hours
		100% partially		
New Bottleneck:		0 hours		

2007-EU-24090-S **"Iron Rhine"**

Project nr.		***Type.***			
2007-EU-24090-S		Studies for the creation of rail freight link from Antwerp towards Germany, relieving part Brussels-Germany			
EU subsidy	€ 2.630.500				
% of total	50,00%				
			Old:		Old:
Impact on bottleneck:		Antwerp-Brussels	0,25	Brussels-Germany	0,5
		10%		10%	
New Bottleneck:		0,225	hours	0,45	

2007-FR-24070-P Works for high speed line Rhine-Rhône - Eastern section

Influencing the Zurich-France Bottleneck

Project nr.		***Type.***			
2007-FR-24070-P		New track High Speed with freight possibilities			
EU subsidy	€ 198.000.000				
% of total	10,00%				
				Old:	
Impact on bottleneck:		Zurich-France		0,25	hours
		50%	partially		
New Bottleneck:		0,125	hours		
New track:		140	km		

PP26. **Railway/road axis Ireland/United Kingdom/continental Europe** SUM: € 9.234.000

2009-UK-26029-E Felixstowe-Nuneaton route work

Project nr.		***Type.***		
2009-UK-26029-E		Improve Rail section, higher capacity		
EU subsidy	€ 9.234.000			
% of total	20,00%			
			Old:	
Impact on bottleneck:		Tees-London		0,5 hours
		20% partially		
New Bottleneck:		0,4 hours		

PP27. **"Rail Baltica" axis: Warsaw-Kaunas-Riga-Tallinn-Helsinki** SUM: € 85.939.625

2006-LT-92401-S Preparation of territorial planning documents and technical designs for Rail Baltica link from Lithuanian/Polish border to Kaunas

Project nr.		***Type.***		
2006-LT-92401-S		Study on the relevant technical design of infrastructure Poland/Lithuania		
EU subsidy	€ 2.700.000			
% of total	20,00%			
			Old:	
Impact on bottleneck:		South-Lithuania		0,25 hours
		10% partially		
New Bottleneck:		0,225 hours		

2007-EE-27010-S **Studies for a European gauge line for Rail Baltica (Estonian section)**
2007-LT-27040-S **Studies for Rail Baltica, Lithuanian part**
2007-LV-27050-S **Studies for a European gauge line (Latvian studies)**

All should contribute to EU gauge in future

Project nr.		***Type.***					
2007-EE-27010-S 2007-LT-27040-S 2007-LV-27050-S		Studies on feasibility and technical measurements to implement European gauge in the Baltic Area.					
EU subsidy	€ 1.000.000,00		€ 16.070.000	€ 1.100.000			
% of total	50,00%		50%	50%			
			Old:			Old:	
Impact on bottleneck:		Poland-Lithuania		0,333	Klaipeda		0,5
			10%		10%		
New Bottleneck:			0,3		0,45		

2007-EE-27020-P **Cross-border section Tartu-Valga railway reconstruction / upgrading**

Project nr.		***Type.***				
2007-EE-27020-P		Upgrading single rail track in Estonia				
EU subsidy	€ 9.300.479					
% of total	27,00%					
				Old:		
Impact on bottleneck:		Estonia			0,5	hours
			50%	partially		
New Bottleneck:			0,25	hours		

2007-LT-27030-P

1) Upgrading of existing railway line on the cross-border section PL/LT state border-Marijampole
2) Cross-border section Siauliai - LV border. Reconstruction/upgrading

Project nr.		***Type.***				
2007-LT-27030-P		Construction of new cross border sections with Latvia and Poland				
EU subsidy	€ 45.703.402					
% of total	27,00%					
			Old:		Old:	
Impact on bottleneck:		South-Lithuania		0,225 North-Lithuania		0,5
		100%			100%	
New Bottleneck:		0			0	

2007-LV-27060-P

1) Reconstruction/upgrading: cross-border section north Valmiera-Valka and cross-border section south Jelgava-LT border
2) Reconstruction/upgrading Sigulda-Valmiera

Project nr.		***Type.***			
2007-LV-27060-P		Upgrading single rail track in Latvia of 152km			
EU subsidy	€ 10.065.744				
% of total	23,00%				
				Old:	
Impact on bottleneck:		Latvia-Northern			0,25 hours
		100%	partially		
New Bottleneck:		0	hours		

PP28. **EuroCap-Rail on the Brussels-Luxembourg-Strasbourg railway axis**

Only Passenger Hi-speed connections.

PP29. **Railway axis of the Ionian/Adriatic intermodal corridor**

Only design phase with some studies.

TOTAL RAIL: € 3.588.546.767

9.13 List of Priority Projects and the impact on bottlenecks, ROAD:

PP7. **Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest**

SUM: € 7.510.000

2006-HU-92201-S **Studies for M8 Motorway, Section I Lepsény-Dunaújváros and Section II Dunavecse-Kecskemét**

Project nr.		***Type.***	
2006-HU-92201-S		Study to approve and tender out new motorway, relieves Budapest.	
EU subsidy	€ 5.160.000		
% of total	50,00%		
			Old:
Impact on bottleneck:		Budapest	0,1666 hours
		Decreased by 10%	
New Bottleneck:		0,15 hours	

2007-EL-07020-S **Studies for the vertical access Thessaloniki-Serres-Promachonas**

Project nr.		***Type.***	
2007-EL-07020-S		It concerns studies for re-aligning/upgrading two road sections on the vertical axis Thessaloniki-Serres-Promachonas over a length of +/-17.6 km	
EU subsidy	€ 2.350.000		
% of total	50,00%		
			Old:
Impact on bottleneck:		Thessaloniki	0,1666 hours
		Decreased by 10%	
New Bottleneck:		0,15 hours	

PP12.	Nordic Triangle railway/road axis	SUM:	€ 76.920.000

2007-SE-12090-P Works for construction of the road section Norra Lanken

Project nr.		***Type.***	
2007-SE-12090-P		Better and efficient transport across the ring road of Stockholm	
EU subsidy	€ 56.150.000		
% of total	5,69%		
			Old:
Impact on bottleneck:		Stockholm	0,166 hours
		Decreased by 100%	
New Bottleneck:		0 hours	

2008-FI-90800-P Works for the construction of Road E18 Muurla-Lohja

Project nr.		***Type.***	
2008-FI-90800-P		New 51 km highway between Turku and Helsinki and infrastructure	
EU subsidy	€ 7.790.000		
% of total	10,00%		
			Old:
Impact on bottleneck:		Helsinki	0,166 hours
		Decreased by 30%	
New Bottleneck:		0,116 hours	

2008-FI-90801-S Studies for upgrading Road E18

Project nr.		***Type.***	
2008-FI-90801-S		Studies for completion of three important road links, including Helsinki ring road	
EU subsidy	€ 5.500.000		
% of total	50,00%		
			Old:

Impact on bottleneck:	Helsinki	0,116	hours
	Decreased by 10%		
New Bottleneck:	0,105 hours		

2008-SE-92607-P **Works for the upgrading of the Road E6 Trelleborg-Vellinge**

Project nr.		***Type.***	
2008-SE-92607-P		Partly new 10km motorway between Trelleborg and Vellinge	
EU subsidy	€ 5.340.000		
% of total	20,00%		
		Old:	
Impact on bottleneck:		none	- hours
New Bottleneck:		- hours	
Added km		10 km	

2009-SE-92600-S **E 6.21 Marieholm Tunnel**

Project nr.		***Type.***	
2009-SE-92600-S		Studies for New tunnel to relieve traffic from Gothenburg	
EU subsidy	€ 2.140.000		
% of total	50,00%		
		Old:	
Impact on bottleneck:		Goteborg	0,166 hours
		10%	
New Bottleneck:		0,15 hours	

PP.13	Road axis United Kingdom/Ireland/Benelux	SUM:	€ 37.832.440

2007-UK-13010-P **Package for improvements and upgrade of road infrastructure on Priority Project 13: sections of A14, M6 and A1**

Project nr.		***Type.***					
2007-UK-13010-P		3 schemes of Motorway upgrades					
EU subsidy	€ 23.997.440						
% of total	8,60%						
			Old:			Old:	
Impact on bottleneck:		London	0,333	hours	Belfast	0,166	
		10%			20%		
New Bottleneck:		0,3	hours		0,133		

2009-UK-13027-E **A14 Corridor traffic management scheme**

Project nr.		***Type.***		
2009-UK-13027-E		Traffic management to reduce congestion between Felixstowe and Birmingham		
EU subsidy	€ 11.670.000			
% of total	20,00%			
			Old:	
Impact on bottleneck:		Birmingham	0,166	hours
		80%		
New Bottleneck:		0,033	hours	

2009-UK-92708-S **A8 Belfast to Larne**

Project nr.	Type.
2009-UK-92708-S	Doubling capacity between Belfast and Larne port, study

EU subsidy	€ 2.165.000		
% of total	50,00%		
		Old:	
Impact on bottleneck:	Belfast	0,133	hours
	10%		
New Bottleneck:	0,119 hours		

PP25. **Motorway axis Gdańsk–Brno/Bratislava-Vienna** SUM: € 13.722.575

2009-PL-92005-S **Elaboration of the project documentation for reconstruction of the national road n°1 to an expressway on the section Podwarpie-Drąbrowa Gómicza**

2009-PL-92004-S **Elaboration of the technical documentation for S1 Expressway construction on the section from Kosztowy II Interchange in Myslowice to Suchy Potok Interchange in Bielsko-Biala**

2005-PL-92603-S **Feasibility studies for S-1 expressway section from Kosztowy II interchange in Myslowice to Suchy Potok interchange in Bielsko-Biala**

All Studies should impact in future the motorway area of Katowice.

Project nr.		***Type.***		
2009-PL-92005-S 2009-PL-92004-S 2005-PL-92603-S		Three studies towards upgrading the motorways around Katowice		
EU subsidy	€ 315.000	€ 707.575	€ 1.700.000	
% of total	50,00%	50%	50%	
			Old:	
Impact on bottleneck:		Katowice	0,1666	hours
		10%		
New Bottleneck:		0,15 hours		

2005-PL-92604-S **Design study for construction and tender documents for motorway A1 – section Toruñ-Stryków**

Project nr.	***Type.***
2005-PL-92604-S	Study for construction of new highway West of Warsaw

EU subsidy	€ 11.000.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		Warsaw	0,333	hours
		10%		
New Bottleneck:		0,3 hours		

TOTAL ROAD: € 135.985.015

9.14 List of Priority Projects and the impact on Bottlenecks, IWW:

PP 18. **Waterway axis Rhine/Meuse-Main-Danube**

SUM: € 49.930.501

2007-AT-18020-P **Implementation integrated river engineering project Danube East of Vienna**

Project nr.		***Type.***		
2007-AT-18020-P		Improvement of the river bed, enabling sufficient draught at this section		
EU subsidy	€ 22.420.501			
% of total	20,00%			
			Old:	
Impact on bottleneck:		Wachau-Slovakia	0,83	hours
		Decreased by 100%		
New Bottleneck:		0 hours		

2007-DE-18030-P **New construction of the rail bridge above the Danube at Deggendorf**

2007-DE-18050-S **Independent variant research on the development of the Danube between Straubing and Vilshofen**

Project nr.		***Type.***		
2007-DE-18030-P		Uplifting the currently low rail bridge up to 8m.		
2007-DE-18050-S		Research to improve the draught at Straubing		
EU subsidy	€ 7.010.000	€ 16.500.000		
% of total	20,00%	50%		
			Old:	
Impact on bottleneck:		Straubing	0,57	hours
		Decreased by 100%		
New Bottleneck:		0 hours		

2007-HU-18090-S **Improvement of the navigability on the Danube**

Project nr.		***Type.***		
2007-HU-18090-S		Elimination of draught restrictions on the Hungarian part of the Danube.		
EU subsidy	€ 4.000.000			
% of total	50,00%			
			Old:	
Impact on bottleneck:		Gabcikovo-Budapest	1,67	hours
		Decreased by 20%		
New Bottleneck:		1,34 hours		

PP30. **Inland Waterway Seine-Scheldt** SUM: € 420.190.000

2007-EU-30010-P **The Seine-Scheldt inland waterway network - cross-border section between Compiègne and Ghent**

Project nr.		***Type.***		
2007-EU-30010-P		Connection of Seine with Scheldt including eliminating bottlenecks		
EU subsidy	€ 420.190.000			
% of total	10,00%			
			Old:	
Impact on bottleneck:		Seine-Scheldt	1.67	hours
		100%		
New Bottleneck:		0 hours		

TOTAL IWW: € 470.120.501

9.15 List of Priority Projects and impact on Bottlenecks, Other modes or already completed

PP8. **Multimodal axis Portugal/Spain-rest of Europe**

Most of the funds not from TEN-T budget, some overlap with PP 19. Faro airport not relevant.

PP10. **Malpensa airport**

Already Completed in 2001

PP11. **Øresund bridge**

Already Completed in 2000

PP15. **Galileo**

Galileo is Europe's initiative for a state-of-the-art global navigation satellite system, providing a highly accurate, global positioning service under civilian control.
Through 2007-2013 period, 190.000.000 euro was awarded for studies.
However, the impact of this amount is not possible to estimate on the modes of transport, therefore not taken into consideration.

PP21. **Motorways of the sea**

Amounts for 122 million Euro's to shift cargo from land to sea. However, not possible to estimate the impact on land infrastructure bottlenecks.

PP22. **Railway axis Athina–Sofia–Budapest–Wien–Praha–Nürnberg/Dresden**

This Axis has much potential and great plans are there. But in the current financing period, not many is awarded only on studies.
Further must work is planned after 2013.

9.16 Considered Core Network sections relevant for scenario 2

Table A12. Relevant sections of the Core Network and their impact on bottlenecks

Baltic -Adriatic Corridor					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Tallinn - Riga - Kaunas - Warszawa	Rail	(detailed) studies for new UIC gauge fully interoperable line; works for new line to start before 2020; rail – airports/ports interconnections	Single track: Estonia,	-0.025	0.225
			Single Track: Latvia Southern	-0.025	0.225
			Single Track: Lithuania Klaipeda	-0.045	0.405
			Electrification: Klaipeda-Vilnius	-0.075	0.675
Gdynia - Katowice, Warszawa - Katowice	Rail	upgrading, port interconnections	Slot: Gdansk-Warsaw	-0.5	0
			Slot: Warsaw- Katowice	-0.25	0
Warszawa – Berlin – Amsterdam/Rotterdam – Felixstowe – Midlands					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
PL Border - Berlin - Hannover - Amsterdam/Rotterdam	Rail	upgrading of several sections (Amsterdam – Utrecht – Arnhem; Hannover – Berlin)	Slot: Osnabruck-Poland	-0.4	0.1
Felixstowe – Midlands	Rail, port,	interconnections port and multimodal platforms	Slot: Tees-London	-0.2	0.2
Mediterranean Corridor					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Barcelona	Rail	interconnections rail with port and airport	Slot: Barcelona	-0.25	0
Hamburg – Rostock – Burgas/TR border – Piraeus – Lefkosia					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Hamburg - Dresden - Praha - Pardubice	IWW	Elbe upgrading	Draught Elbe:Lauenburg-Chech	-6.94	0

Budapest - Arad - Timişoara - Calafat	Rail	upgrading in HU nearly completed, ongoing in RO	Single Track: RO border-Hungary	-0.5	0
Vidin - Sofia - Burgas/TR border, Sofia - Thessaloniki - Athens/Piraeus	Rail	studies and works Vidin – Sofia – Thessaloniki;	Single track: Bu border Rom	-0.5	0
		upgrading Sofia – Burgas/TR border	Single track: BU border Greece	-0.25	0
Helsinki – Valletta					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
RU border - Helsinki	Rail	works ongoing	Border stop: Fin-Russia	-0.1	0.233
Hamburg/Bremen - Hannover	Rail	works to be started before 2020	Slot: Hamburg-Munich	-0.1	0.3
Genova – Rotterdam					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Basel - Rotterdam/Amsterdam/Antwerpen	IWW	upgrading	Bridge: Rhine, Mainz	-0.152	0
Lisboa - Strasbourg					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
No relevant implications for current bottlenecks					
Dublin – London – Paris – Brussels/Bruxelles					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
No relevant implications for current bottlenecks					
Amsterdam – Basel/Lyon – Marseille					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Brussels/Bruxelles - Luxembourg - Strasbourg	Rail	Works ongoing	Slot: Brussels-Liege	-0.225	0

Strasbourg – Danube Corridor					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Nürnberg - Regensburg - Passau - Wels	Rail	studies; works partly ongoing	Frankfurt-Austria	-0.04	0.36
Main – Main-Donau-Canal – Danube	IWW	studies and works on several sections and bottlenecks; inland waterway ports: hinterland connections	Draught: Main, Bamberg	-0.333	0
Arad - Brašov - Bucurešti - Constanta	Rail	upgrading of specific sections	Slot: Constanta-Bucharest	-0.25	0
Other Sections on the Core Network					
Pre-identified sections	*Mode*	*Description*	*Influenced Bottleneck*	*Effect*	*New*
Nürnberg – Praha	Rail	Studies	Czech-Germany	-0.025	0.225
Graz – Maribor – Pragersko	Rail	Studies	Single Track: Slovenia-Austria	-0.025	0.225
North-West Spain and Portugal	Rail	works ongoing	Electrification: La Coruna	-0.75	0
			Single Track: La Coruna	-0.25	0
Sundsvall – Umea – Lulea	Rail	studies and works	Single track, Sweden: Inland	-0.4	0.6
Malmö - Göteborg	Rail	works	Single Track, Sweden: Goteborg	-0.5	0
Zilina – UA border	Rail	upgrading	Slot: Slovakia-Ukraine	-0.25	0
Ventspils – Riga – RU border	Rail	upgrading	Slot: Riga	-0.25	0
Klaipeda – Kaunas – Vilnius – BY border	Rail	upgrading	Electrification: Klaipeda-Vilnius	-0.675	0
			Single: Klaipeda	-0.405	0
Katowice – Wroclaw – DE border	Rail	upgrading	Slot: Wroclaw-Katowice	-0.25	0
Tampere – Oulu	Rail	upgrading of sections	Single: Finland inland	-0.5	0.5
			Total Time barrier hours reduced:	**-15.44**	
			Number of sections:	**25**	

Source: Compiled by author.

9.17 Infeasible modes of transport per port

Table A13. Ports with modes not available for transport from the port to EU27

Port	mode	Port	mode	Port	mode
Burgas	IWW	**Palma de Mallorca**	Road	**Riga**	IWW
Arhus	IWW		Rail	**Ventspils**	IWW
Copenhagen	IWW		IWW	**Klaipeda**	IWW
Luebeck	IWW	**Sevilla**	IWW	**Valetta**	Road
Tallinn	IWW	**Tarragona**	IWW		Rail
Cork	IWW	**Valencia**	IWW		IWW
Dublin	IWW	**Bordeaux**	IWW	**Porto**	IWW
Limerick	IWW	**Ancona**	IWW	**Lisbon**	IWW
Igoumenitsa	IWW	**Bari**	IWW	**Sines**	IWW
	Rail	**Genoa**	IWW	**Koper**	IWW
Patras	IWW	**Gioia Tauro**	IWW	**Helsinki**	IWW
Piraeus	IWW	**La Spezia**	IWW	**Kotka,Hamina**	IWW
Thessaloniki	IWW	**Livorno**	IWW	**Turku**	IWW
Algeciras	IWW	**Napoli**	IWW	**Goteborg**	IWW
Barcelona	IWW	**Palermo**	Road	**Lulea**	IWW
Bilbao	IWW		Rail	**Malmo**	IWW
Cartagena	IWW		IWW	**Stockholm**	IWW
Gijon	IWW	**Taranto**	IWW	**Trelleborg**	IWW
La Coruna	IWW	**Trieste**	IWW	**Belfast**	IWW
Las Palmas	Road	**Lemesos**	Rail	**Dover**	IWW
	Rail		IWW	**Southampton**	IWW
	IWW			**Tees and Hartlepool**	IWW

Source: Compiled by Author