High Speed Rail in Greece: Methods for Evaluating Economic Impacts

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ABSTRACT

High Speed Rail is a mode that gains popularity every day. Many countries have such a network and others are on the way to adopting one. Greece, which is part of the European Union, is one of those countries that are looking forward to such a network. This thesis will investigate the transportation sector of Greece, its governance and funding issues. Moreover, it will go into depth regarding the mode of High Speed Rail. The projects and issues related to this mode will be presented.

Another issue of concern will be the evaluation of economic impacts of transportation investments and high speed rail specifically. A thorough literature review regarding the different methods and software packages that exist will be presented. Also, a method suitable to the Greek standards and characteristics will be proposed. Last, we create a screening model for High Speed Rail. This model aims to be used from countries similar to Greece, in order to realize whether it is worth it to start thinking of constructing such a network or not. HSR possibilities in Greece and Portugal are compared using the screening model.

Thesis Supervisor: Joseph Sussman

Title: JR East Professor, Professor of Civil & Environmental Engineering and Engineering Systems
DEDICATION

TO MY PARENTS,

WITHOUT THE GUIDANCE OF WHOM I WOULDN’T BE HERE TODAY
Aknowledgements

The thesis process is supposed to be an individual work. It is indeed a piece of work written by an individual, but many people contribute for the fulfillment of it. At this point I would like to thank all of those who helped me along this path.

First, I would like to thank my Professor at MIT, Joseph Sussman for his guidance, advice and help. Also, I am thanking my Professor at the Aristotle University of Thessaloniki, Pyrgidis Chistos, for the information that he provided me with.

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I should also thank my roommate, Constantina Georgaki for her advice and support. Also, you were very kind with me during the last week before the submission of the thesis. Thank you for your understanding.

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Chapter 1: Introduction

Rail is a mode very friendly to the environment in comparison with all other modes. It has advantages in relation to energy and sustainability issues. First of all, it is less intrusive to the environment. When compared to road and air transport, the levels of CO2 that are emitted are three to ten times lower. Regarding energy efficiency, rail is two to five times more efficient than other modes. Moreover, if the sources of energy that are being used for electric railways are renewable, then the emissions of CO2 could be reduced to zero.1

As far as safety is concerned, according to European Union studies, it is the safest mode since it generates the fewer fatalities per 100 million passenger kilometers.2 When service quality is good, it can compete with other modes at distances up to 500 kilometers and perhaps more. High Speed Rail (HSR) is a modernized and improved version of rail that operates at a higher speed than conventional rail. The quality of service and performance of HSR are great values that make it a very competitive mode.

In the European Union, actions are made in order to promote a coherent transportation system. Plans have been made regarding the rail network and HSR specifically. There some EU countries that already have a HSR network and constructions has already started in others. This thesis will explore the issue of HSR in Greece, which is part of the European Union since 1981.

1.1 High Speed Rail, the European Union and Greece

According to the EC Directive 96/58, High Speed Rail (HSR) is defined as “systems of rolling stock and infrastructure that regularly operate at or above 250km/hr on new tracks and at 200km/hr on existing tracks”.3 Nowadays, high speed rail is a mode that is very popular and even more countries are trying to adopt such a network. As a mode it is sustainable in actuality; further the high speed it achieves, makes it really attractive to passengers.

Energy is an issue that concerns the whole world, especially because of the climate change and the related disastrous phenomenon that happen from time to time (ex. intense storms). Global greenhouse gas emissions have increased dramatically in the last decade and have resulted in

---


the increase of the temperature and the sea level. CO2 is one pollutant that might affect global warming and climatic change the most, and the transportation sector is one of the most visible sectors for CO2 emissions it generates. Specifically, for the European Union, this sector causes about 27% of all EU CO2 emissions, and railways are responsible for only 1.6% of it (see figure 1-1). In general, trains have less environmental impact than any other mode. The idea of HSR is an attractive one. The fact that mode shift might possibly occur, and especially shifting from cars, which emit high levels of ozone and CO2, the result in the improvement of the air quality would be significant. The same positive attribute will result from the shift of airplanes to HSR.

In 2006, the European Union Commission reviewed and renewed the EU Sustainable Development Strategy, which was initially written in 2001 in Gothenburg. As far as transportation is concerned, the overall objective was “to ensure that the transport systems meet society’s [economic], social and environmental needs whilst minimizing their undesirable impacts on the economy, society and the environment”. The targets were to reduce the environmental impact, achieve levels of sustainable energy consumption and reduce the pollutants emitted. One mode that is significantly helping in the realization of those targets is HSR. Thus, the EU is supporting and promoting the development of high speed rail in its territories.

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Following the example of the EU, Greece published its own National Strategy towards energy sustainable development in 2002. The context of this publication regarding the transportation sector will be discussed in section 2.4.2 along with the transportation strategies of the country, which particularly emphasize on HSR.

1.2 Research questions

The EU has formed the Trans-European Transport Network agency, which has conducted studies for the more efficient and more environmentally friendly transportation systems in Europe. Some of the projects refer to Greece and to Greece's rail network specifically. Moreover, other research studies have also proposed different alternatives for HSR in Greece. This thesis will provide substantial informational background and will create a platform towards answering the following questions:

- Should Greece develop a HSR network? and,
- If so, what is the best way to do it?
These questions will be considered in the broader context of the Greek transportation sector. According to the situation of the sector and its needs, it is of great interest to understand whether HSR is the best way to go forward. The information provided will contribute into the research of HSR in the country of Greece. This thesis can constitute the start towards the answer to the following questions:

- Does HSR enhance the issues of sustainability and energy?
- Are there networks other than railways, where investments should be made for the better development of the country? Or does the rail network demand changes?

If the second is true then money will be allocated to this mode and another question is raised.

- Should this money be spent on the improvement of the whole network
- Or should part of the network be upgraded to high speed?

Furthermore, all suggested alternatives will be investigated from the point of view of feasibility and what will be the impacts on the economic development of Greece. It is definite that the linkage of the country to the rest of the EU will be of vital importance. One might ask,

- What are the greater plans of the EU and how can investment in Greece achieve the EU’s ultimate goal?

This raises further questions and issues. The funding originating from EU sources accounts for a large share of the total construction. That parameter is very important for Greece, since the financial support is significant.

- What if Greece did not have this support?
- Would HSR be able to be constructed within the country’s budget?
- Would it still be a priority?

As far as the economic development is concerned, the issue of evaluating the impact of transportation investments will be discussed.

- What kinds of methods are being used for evaluation?
- Are there specific pieces of software or special computer programs that ease the process?
- What method is used or should be used for the evaluation of the socioeconomic impacts of a HSR line?

Lastly, an attempt of creating a screening model for high speed rail will be made, including:

- What are the parameters that are relevant to the development of a HSR network?
• Are there specific indicators that can help in the decision of applying such a network?

The objective is for this model to be based on countries with similar characteristics to Greece, in order to understand whether it is worth it to start research for adopting high speed rail in those nations.

1.3 Methodology

Research will be conducted in order to gather general information about Greece and more specifically about its transportation sector. Specifically, there will be an attempt to find and learn about the Greek transportation strategies and acknowledge to what extent HSR systems are included in those. Also, information will be gathered about the plans that the European Union has in relation to HSR.

An extensive literature review will be carried out regarding the methods of evaluating transportation investment. When a decision is made about a new transportation project, it is supported with evidence that it will provide mostly positive impacts. There are many different methods of ex-ante evaluation and those will be presented in one chapter. Based on the background information of the Greek transportation sector and the review of evaluative methods of transportation investments, a method will be suggested for use in Greece.

On the basis of research currently being conducted about HSR in Portugal, there will be an attempt at comparing the situation of the two countries. Portugal and Greece are about the same size from the perspective of their population and geographical size. It would be of great interest to find similarities, since one can say that they are the on the southern periphery of the EU, Portugal in the West and Greece in the East. Also, both have two cities that are the most populated and dominant in each country accordingly (Lisbon and Porto in Portugal, Athens and Thessaloniki in Greece).

To close, a screening model for HSR will be formed. It will be a model to be used for understanding whether it is worth applying a HSR network. The countries of Greece and Portugal will constitute the basis for the formation of this model. The model will include parameters that are vital and relevant with HSR.

1.4 Structure of thesis

The thesis begins with the informational background about the country of Greece in Chapter 2 and the issue of HSR specifically in Chapter 3. Information is also given about the view of the European Union on HSR, the Executive Agency that has been formed on the EU’s behalf and the projects planned on this mode. Details about the European Union policies on the transportation sector are provided in appendix I. Chapter 4 includes the literature review of
methods for evaluating the economic impacts of transportation investment in general and HSR specifically. Appendix II includes a series of paper reviews that were made for the formation of chapter 4. This chapter ends with the suggestion of a method for use by Greece. A screening model for High Speed Rail is elaborated in Chapter 5. This model includes indicators that would lead to the decision to develop a HSR network. It is aimed to be used by countries with similar characteristics to Greece. Chapter 6 presents the conclusions of this thesis. It gives directions for further research as well.
Chapter 2: The Country of Greece

The overall goal of this thesis is to understand the role of HSR in Greece. This is interesting because of the participation of Greece in the European Union and the geographical position of the country, lying in the southeast border of the EU. Moreover, the author has particular interest in Greece, since it is the country of her origin.

To begin, this chapter focuses on the country of Greece and its demographical, economical and cultural characteristics. It is a country, which consists part of the European Union, thus part of a greater whole. Although small in size, it is interesting to investigate the role of the country in the rest of the Union through the perspective of the transportation sector and specifically High Speed Rail. Thus, emphasis will be given in the transportation system of Greece, the organization of the government regarding this sector and the Greek transportation systems in general. Serious question is whether Greece can be better integrated into the EU. This thesis lays a foundation for this kind of study.

2.1 Introduction

2.1.1 Overview

Located in southeastern Europe, Greece is the southernmost country of the Balkan Peninsula (see figure 2-1). The official name of the country is Hellenic Republic. Its peninsular mainland juts out into the Mediterranean Sea. The borders of the country are Albania, Republic of Macedonia (Former Yugoslav Republic of Macedonia) and Bulgaria on the north and Turkey to the east. The mainland lies between the Aegean (east) and Ionian (west) Seas. Many groups of islands, islets and rock islands on those seas are part of Greece. (see figure 2-2)

The country’s total area is 131,940 sq km (50,942 sq mi) and it has the tenth longest coastline in the world with 14,880 km (9,246 mi)6. The capital of the country is Athens, which is located on the mainland along the southeastern coast.

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Figure 2 - 1: Map of Europe (source: http://www.nationsonline.org/maps/countries_europe_map.jpg)

Figure 2 - 2: Map of Greece (source: http://www.greek-islands.us/map-greece/)
Greece is one of the most mountainous countries of Europe with 80% of the country consisting of mountains and hills. The highest mountain, Mount Olympus, culminates at Mytikas peak at 2,917m (9,570ft). This mountain has a great history going back to the ancient times of Greece, and it was considered to be the throne of the Gods. The western part of the country contains many lakes and wetlands and is dominated by the mountains of the Pindus range. Most of the islands are peaks of underwater mountains that in the past were part of the country’s mainland.⁶

Greece is a country with a rich history, dating its start in the Paleolithic era (11000 – 3000 BCE). It is the first location in Europe where advanced early civilizations emerged, beginning with the Minoan civilization on the island of Crete and then the Mycenaean civilization on the mainland. It is also the cradle of democracy, Western philosophy, the Olympic Games, Western literature and historiography, political science and Western drama. The modern history and development of the country starts after recognition of its independence from the Ottoman rule (duration 400 years).⁶

Greece is a developed country, which entered the European Union in 1981. It is also member of the Economic and Monetary Union of the European Union since 2001, North Atlantic Treaty Organization since 1952, the Organization for Economic Co-operation and Development since 1961, the Western European Union since 1995, a founding member of the Black Sea Economic Cooperation and a member of European Space Agency since 2005.⁶

2.1.2 Demographics

According to the census of 2001, which is conducted every 10 years by the official statistical agency of Greece (National Statistical Service of Greece, NSSG), the Greek population is 10,964,020. The same census has estimated that the distribution between male and female is half and half. The population estimation for 2009 is 11,260,402.⁷

From an administrative point of view, Greece consists of 13 regions (see figure 2-3) subdivided into 51 prefectures, which are further subdivided into municipalities. Mount Athos is an autonomous area situated in the north part of the country, being the third peninsula on the east of region three.⁶ Table 2-1 includes demographical details of each region.

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Table 2-1: Greek Peripheries – Area – Population (source: http://en.wikipedia.org/wiki/Greece)

<table>
<thead>
<tr>
<th>Periphery</th>
<th>Capital</th>
<th>Area</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attica</td>
<td>Athens</td>
<td>3,808 km²</td>
<td>3,761,810</td>
</tr>
<tr>
<td>Central Greece</td>
<td>Lamia</td>
<td>15,549 km²</td>
<td>605,329</td>
</tr>
<tr>
<td>Central Macedonia</td>
<td>Thessaloniki</td>
<td>18,811 km²</td>
<td>1,871,952</td>
</tr>
<tr>
<td>Crete</td>
<td>Heraklion</td>
<td>8,259 km²</td>
<td>601,131</td>
</tr>
<tr>
<td>East Macedonia and Thrace</td>
<td>Komotini</td>
<td>14,157 km²</td>
<td>611,067</td>
</tr>
<tr>
<td>Epirus</td>
<td>Ioannina</td>
<td>9,203 km²</td>
<td>353,820</td>
</tr>
<tr>
<td>Ionian Islands</td>
<td>Corfu</td>
<td>2,307 km²</td>
<td>212,984</td>
</tr>
<tr>
<td>North Aegean</td>
<td>Mytilene</td>
<td>3,836 km²</td>
<td>206,121</td>
</tr>
<tr>
<td>Peloponnesse</td>
<td>Kalamata</td>
<td>15,490 km²</td>
<td>638,942</td>
</tr>
<tr>
<td>South Aegean</td>
<td>Ermoupoli</td>
<td>5,286 km²</td>
<td>302,686</td>
</tr>
<tr>
<td>Thessaly</td>
<td>Larissa</td>
<td>14,037 km²</td>
<td>753,888</td>
</tr>
<tr>
<td>West Greece</td>
<td>Patras</td>
<td>11,350 km²</td>
<td>740,506</td>
</tr>
<tr>
<td>West Macedonia</td>
<td>Kozani</td>
<td>9,451 km²</td>
<td>301,522</td>
</tr>
<tr>
<td>Mount Athos (Autonomous)</td>
<td>Karyes</td>
<td>390 km²</td>
<td>2,262</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>131,934 km²</td>
<td>10,964,020</td>
</tr>
</tbody>
</table>
2.1.3 Economy

The Greek GDP was measured at $357.548 billion in 2008 by the International Monetary Fund, surpassing the respective levels of many of the EU members and placing the country in the 27th place of the global list.\(^8\) It corresponds to $32,105 per capita (which is close to the EU average GDP of $33,700 per capita).\(^9\) The major sources of revenues are tourism, which is also the major source of foreign exchange earnings, and the shipping industry.

The tourism industry accounts for 15% of the country’s total GDP (in comparison, in Portugal tourism accounts for 5% of the country’s GDP and in Germany it accounts for 3.5% of the country’s GDP\(^10\)) and employs 16.5% of the total workforce. The shipping industry has been a key element in the Greek economy since ancient times. Nowadays, it is one of the most important industries for the country. “It accounts for 4.5% of the national Gross Domestic Product and employs about 160,000 people”\(^6\). About 26% of the world’s merchant fleet is Greek-owned; the Greek fleet is the largest in the world.\(^6\)

Overall, Greece has a service-based economy which accounts for over 73% of GDP. Apart from the tourism and shipping industries, other important sectors include food processing, tobacco, textiles, chemicals, pharmaceuticals, cement, glass, telecommunications and transport equipment.\(^11\)

Greece adopted the euro and started using it as its common currency in January 2002. Prior to that the country had a high inflation risk, and the adoption of the euro gave Greece the opportunity to access competitive loans and low-interest rates in the Eurobond market. This action stimulated an increase in consumer spending, thus boosting economic growth.

In the decade 1997-2007 Greece had 4% average GDP growth, almost twice the EU average. Because of the economic crisis of 2007, Greece’s growth rate fell to 2.9% in 2009.\(^12\) The

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\(^12\) Index Mundi, 2009, Greece – Country – Profile, retrieve October 15th 2009 from http://www.indexmundi.com/greece/gdp_real_growth_rate.html
government is currently dealing with the burgeoning deficit, 12.7% of GDP in 2008\textsuperscript{13}, and the increasing total public debt, 97.4% of GDP in 2008\textsuperscript{11}. The EU recently placed Greece under its Excessive Deficit Procedure and requires the Greek government officials to bring its deficit back to the 3% EU ceiling by 2010. When a Member State is under the above procedure, there is a deadline set by the Council in order for the country to decrease the existing deficit. If the deadline passes and the country has failed to achieve decrease, then there is the possibility of “financial sanctions”.\textsuperscript{14}

2.1.4 Labor

The Greek labor force totals 4.96 million.\textsuperscript{11} A poll conducted over the 1995-2005 decade by the Groningen Growth & Development Center revealed that Greece was the country with the highest work/hour (productivity) ratio among European members; Greeks worked an average of 1,900 hours per year.\textsuperscript{15}

The estimated proportion of the labor force in the agricultural sector declined from 56% in 1970 to 20% in 2000, while the proportion of the workforce in manufacturing increased to 21% and services to 59% from 24%, in the same period. In 2007, the average worker made around $20 per hour, while immigrants make up nearly one-fifth of the work force, occupied mainly in agricultural and construction work.

The estimated Gini coefficient of Greece, which represents income distribution equality, was estimated at 33\textsuperscript{2}, a figure low by European standards\textsuperscript{16} (a low Gini coefficient indicates to a more equal distribution\textsuperscript{17}). The country’s Human Development Index, which is used to rank


\textsuperscript{14} Excessive deficit procedure, European Commission-Economic and Financial Affairs, retrieved January 22\textsuperscript{nd} 2010 from http://ec.europa.eu/economy_finance/sgp/deficit/index_en.htm

\textsuperscript{15} Antoniou et al 2008, Οι αργίες των Ελλήνων-ειδήσεις, κοινωνία, ειδικές δημοσιεύσεις, Ethnos online, retrieved on November 20\textsuperscript{th} 2009 from http://www.ethnos.gr/article.asp?catid=12128&subid=2&tag=8784&pubid=1114536


\textsuperscript{17} Wikipedia, “Gini coefficient”, retrieved January 26\textsuperscript{th} 2010 from http://en.wikipedia.org/wiki/Gini_coefficient
countries according to their human development and also to distinguish between developed and undeveloped countries, is 0.942 (relatively high), placing Greece in 25th place worldwide\textsuperscript{18}.

The strong growth rates noted in recent years have helped in the relief of unemployment, which declined to 7.5% in 2008 from 10.4% in 2004. Unfortunately, unemployment is still high among women and people under 27 years old and constitutes a significant problem for the country. Moreover, the economic recession has also decreased the amount of foreign direct investment flows to the country, but currently attempts are being made in order to revive them.\textsuperscript{7}

\section*{2.1.5 Culture}

The culture of Greeks is something that makes them very proud, because it has evolved through the years and it is also among the oldest cultures on earth. It is very rich in many different aspects such as philosophy, literature, science, arts, cuisine and more. It would be an omission if it wasn’t mentioned in this thesis, but the analysis of it isn’t of our concern at the moment. What is relevant is the current opinion of Greeks about their country and its future.

The Olympic Games of 2004, which were held in the ‘home’ of the Olympic Games, Greece, was of great importance to the Greek people. It wasn’t just the coming back of the Olympic Games to their origin, but it was a way of thrusting Greece forward. It was a chance for the country to show its capability of organizing such a big event and also to show its beauties to the rest of the world and attract more tourists. They are aware of their great history and culture and they are trying to promote it in order to increase the tourism sector and thus boost the economy.

Currently, the Greek people are very dissatisfied with the country’s economy. In general, there is the fear that the country might default. In general, Greeks desire a country that is safe to live and with no corruption in the public sector. Unfortunately, during the past years, incidents of no control have occurred and this has frightened the Greeks. Marches of protest have ended up in vandalism, thus Greeks are looking for safety. Regarding the public sector, a lot of corruption has been noted leading the country to many problems, and this has to come to an end.

\section*{2.2 Government Structure}

The political constitution of Greece is a presidential parliamentary republic. The head of State is the President of the Republic, who is elected every five years by the Parliament. The current political system was adopted by the Fifth Revisionary Parliament of the Hellenes after the fall of the military junta in 1974. The Constitution, which consists of 120 articles, leads to the separation of powers in executive, legislative and judicial branches and grants specific

guarantees of civil liberties and social rights. Greek women gained suffrage with Constitutional amendment in 1952.19

The two dominant parties in Greece are the liberal conservative New Democracy and the social democratic Panhellenic Socialist Movement (PASOK). There are three more parties, which are popular in the country and those are the Communist Party of Greece (KKE), the Coalition of the Radical Left (SYRIZA), and the Popular Orthodox Rally (LAOS).

Executive power is exercised by the President of the Republic and the Government, with the main power lying in the hands of the Prime Minister (head of the government). The position of the Prime Minister belongs to the leader of the political party that has gained the greatest share of votes in the national elections. Elections are held almost every four years, and every Greek citizen who is eighteen years old and older, has the right to vote. Voting is not mandatory but optional. Legislative power is exercised by a 300-member elective unicameral Parliament. The Judiciary is comprised of three different courts; the Court of Cassation, the Council of State and the Court of Auditors.19

The “administrative hierarchy” of the country is separated into four levels of authorities:

1. “Central Government”20, which is “responsible for the overall national policy in all areas, including planning legislation”.

2. “Regional Authorities” (Greek word peripheries), which are 13 in total. Each Regional Authorities, which includes a number of prefectures, is directed by a Regional Governor appointed by the Minister of the Interior, Public Administration and Decentralization.

3. “Prefectures” (Greek word nomoi), which are 51 in total. Each prefecture is directed by a prefect, who along with the board members of each prefecture, are elected by the Greek citizens, during the national elections every 4 years.

4. “Municipalities”, which are 900 in total, are the authorities of the lowest level. After the devolution of public administrative, new municipalities were formed from the integration of some communities.20

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2.3 The Transportation Sector

2.3.1 Overview

Greece is known worldwide for its ocean fleet size (merchant fleet of 1,405\textsuperscript{21}). The geographical location of the country encouraged the development of shipping from ancient times. The coastline of the country along with the large number of islands have made sea transport the basic means of linking localities within the country and foreign countries as well. The major ports are located in the five largest cities: Athens-Piraeus, Thessaloniki, Patra, Heraklion on the island of Crete, and Volos.

Greece has a total of 123 ports, which are large enough to handle both passenger and freight vessels. In addition to the five major ports, the port of Igoumenitsa, located in the northwest, and the port of Kavala, located in the northeast, serve a great number of routes destined to Italy from Igoumenitsa and the Middle East and Balkan countries from Kavala.\textsuperscript{11}

In the last 20 years, the road and rail network of Greece have been significantly modernized. Large scale projects including the Egnatia highway that connects the north-west with the north-east following the ancient Via Egnatia and the Rio-Antirion Bridge that connects Peloponnesus (Rio) with the mainland (Antirion) have helped in that.

The majority of overland transport needs are primarily covered by road and railroad. The road network of Greece covers 117,533 km in total (mainland and islands), of which 107,895 km are paved roads and 880 kilometers were classified as expressways. Nevertheless, Greece is planning on investing more on the road network with an ultimate goal of upgrading the current system as well as expanding it.\textsuperscript{11}

The Greek rail system is managed by the Greek Railroads Organization (OSE), which was established in 1971. Former Prime Minister, Charilaos Trikoupis, is credited with the evolvement of Greek railways\textsuperscript{6}, because he was the first to invest in railways back in 1882. He had a political vision, seeing railways as a way of stimulating the internal growth of the country. Nowadays, the network covers 2,548 km, of which 764 km are electrified.\textsuperscript{11}

Domestic air travel is served mainly by private airline companies like Olympic Air, Aegean Airlines and Sky Express. Olympic Air started operating in September 2009 with a fleet of 24 aircraft.\textsuperscript{22} Greece has a total of 44 airports and 9 heliports.\textsuperscript{11} Eleftherios Venizelos International Airport in Spata, Athens and Macedonian Airport in Thessaloniki are the two largest airports

\textsuperscript{21} Δύναμη Ελληνικής Εμπορικής Ναυπλιας, 2009, Ministry of Economy, Competitiveness and Marine, retrieved on October 17\textsuperscript{th} 2009 from http://www.yen.gr/wide/yen.chtm?pnbr=25164

\textsuperscript{22} Our fleet, 2009, Olympic, retried November 12\textsuperscript{th} 2009 from http://www.olympicair.com/Default.aspx?a_id=568
and host the majority of international air traffic. The airport of Spata, in Athens, is the one that serves international flights (New York, Dubai, Yerevan, Cairo, Tel Aviv, Bahrain etc). From Thessaloniki though, people can travel to many destination in the European Union directly (London, Rome, Prague, Vienna etc.) and also to some international destinations, such as cities in Russia and Georgia.

2.3.2 Transportation Authorities

The governmental authorities that are involved in transportation are the following:

1. Ministry of Transportation and Communications
2. Ministry of National Economy and Finance

In general, the Ministry of Transportation and Communications is responsible for the mapping out of national policy and the creation of a suitable institutional framework for the implementation of public works. It also monitors all construction activities around the country and secures their funding.

Under the supervision of the Minister of Transportation and Communications are the General Administrations of Transport Works, Co-financed Transport Works and Transportation. The first two administrations are responsible for the transportation infrastructure, the supervision of its construction and its maintenance. The General Administration of Transportation is further subdivided into the administrations of freight and passenger transport. This administration coordinates the operation of freight and passenger transportation. It plans their administrative activities and evaluates the quality of the service. Moreover, it administers the configuration of means of communication and collaboration with the following entities:

- Public enterprises and organizations overseen by the Ministry
- Administrative services of other services that exercise relevant policies
- Institutions of the public sector that exercise relevant policies

The objective is to guarantee the harmonized, effective and qualitative operation of transport.

To close, under the supervision of the administration of passenger transport are the administrations of urban and inter-urban transport. (see Figure 2-4)
2.3.3 Urban, Suburban and Intercity Transportation Systems

The structure of the Urban and Intercity Land Transportation Systems in Greece at urban, suburban and regional levels can be "characterized as a closed market"\textsuperscript{20}, where the public operators are fully supported by government authorities. Currently, the two main system features share the different regime of the two biggest Greek cities, Athens and Thessaloniki, in comparison to the rest of the country, and the major role of the Ministry of Transport in the regulatory and financing levels.\textsuperscript{20}
The Greek Public and Intercity System can be divided into four categories, thinking in "spatial terms":

1. "The metropolitan area of Athens–Piraeus
2. The metropolitan area of Thessaloniki
3. Some municipalities that offer public transportation services through public management
4. The rest of the country" 20

Figure 2-5: Simplified graphical representation of the Urban Public Transport System in Greece (source: Taxiltaris C. and Spandou M. 2005)

2.3.3.1 Urban Transportation Systems

Athens

Athens is the capital of Greece and is the biggest city of the country. The demographic characteristics of the metropolitan area of Athens are as follows. The population is 3,686,371 and
represents the 26% of the total Greek population and the area equals 2,928sq km. Many different services of transportation are offered in Athens and those are discussed here.

OASA (Athens Urban Transportation Organization) is a company owned by the Greek government, applies the “principles of private enterprise”, and operates “under the supervision of the Ministry of Transportation and Communication”. OASA has been assigned responsibilities, such as “planning, programming organizing, coordinating, monitoring and providing transportation in Athens-Piraeus and the Suburbs”. “OASA has been given the legal ability to establish subsidiary companies in the form of Anonymous Enterprises (S.A.)”. This is applicable only if OASA “approves and grants permission to the municipal plans” and if the sub-network created by the subsidiary companies consists of feeder lines to the network of OASA. The subsidiary companies that OASA has established are under the group name of EFSE and they are ETHEL S.A. (thermal buses - buses that operate with compressed natural gas), ILPAP S.A. (trolley buses) and ISAP S.A. (operates metro line 1). The administrative bodies of OASA are the Administrative Board, which is the superior body, the Managing Director, and the Board of Directors. The Managing Director is specified by the Minister of National Economy and Finance and the Minister of Transportation and Communications and is “responsible for suggesting and directing services, plans, and decisions”.

ATTIKO METRO S.A. is a company in which the “only shareholder” is the Greek government. This company aims to “supervise the design, construction, organization, administration operation, and development” of the Underground Rail Network (see figure 2-6) in the metropolitan area of Athens. The responsibility of its construction lies in the authority of the Ministry of the Environment, Physical Planning, and Public Works and currently is under the supervision of the Ministry of Transportation and Communications. The administrative bodies of ATTIKO METRO S.A. are the administrative board and a legal services department.

AMEL S.A. is the Attiko Metro Operations Company, and it is a subsidiary company of ATTIKO METRO S.A. AMEL S.A. is responsible for the Metro lines 2 and 3. The company is managed by an administrative board.

TRAM S.A. is a subsidiary company of ATTIKO METRO S.A. and aims “at the development and operation of the tram network” in Athens.

PROASTIAKOS S.A. is the Suburban Railway System of Athens and is a subsidiary company of OSE S.A. the National Railway Operator. This company handles the suburban and regional railway services.

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Thessaloniki

Thessaloniki is the second biggest city of the country and concentrates 10% of the total Greek population. To be more specific, its area is 1,089sq km and its population 947,904.24

OASTH S.A. is the Thessaloniki Urban Transportation Organization and is the exclusive public transport bus operator of the city, having concluded a contract with the Greek government. SASTH is the Thessaloniki Urban Transportation Council and it is an independent regulatory body that directs the “optimal organization and supervision of urban public transportation services” in the city. This council is “supervised by the Ministry of Transportation and

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Communications”. The only supervised operator that SASTH has is OASTH. SASTH is identified with the operating area of OASTH and “its operational costs” are covered by the income of OASTH. Lastly, there are plans of implementing other public transportation services to the city, such as tram, suburban rail and short-distance sea transport, with the aim of enhancing the existing public transport services and improving the overall performance of the public transport network.20

Other Greek cities

All bus operations in cities in the rest of the country are provided by a company which is called KTEL. As far as the organization and the characteristics of KTEL are concerned, those are as follows.

KTEL S.A. is the name of the Bus Owner’s Associations that provide public transport services in the rest of the country. It includes companies that are categorized according to the area in which they operate. “KTEL operators constitute associations of private property, where the shareholders are also owners of the buses”. KTEL S.A. is supervised by the Ministry of Transportation and Communication, and the form of funding that it receives from the State is intended to “cover the expenses” for converting KTEL companies into Anonymous Companies. KTEL companies are established by the merging of smaller companies that possessed one or two buses and incorporated at local or prefectural level. The funds given for the change of the companies into Anonymous, aim to “renew the fleet, improve their infrastructure, and automatize/computerize their operational procedures”,20

2.3.3.2 Intercity Transportation Systems

BUSES

Intercity traveling by bus is provided by the company of KTEL which is analyzed in the previous section (section 2.3.3.1).

TRAIN

OSE S.A. is the Hellenic Railway Organization that serves suburban, regional, and long distance passenger and freight railway transportation. The company is publicly owned and is “under the supervision of the Ministry of Transportation and Communications”. OSE S.A. owns and operates all the railway lines in Greece. Train services on these lines are run by TrainOSE S.A., and the infrastructure of the lines is managed by the company of EDISY S.A. ERGOSE S.A. is a subsidiary company of OSE S.A., which is responsible for the implementation of railway projects, such as planning, studying, expropriating, bidding, constructing, providing materials, health and safety, controlling quality, and delivering the completed projects to OSE S.A. for operation.20 More about the Hellenic Railway Organization is going to be discussed in section 3.2.1.
2.4 Transportation Strategies

In 2002, the National Strategy towards energy and sustainable development was published by the Greek government (back then, the party of New Democracy was in power). Since, then it hasn’t changed and the same guidelines are followed. Regarding the transportation sector, the following were included. The transportation demand kept on increasing and the amount of energy spent on that sector at the time accounted 40% of the total energy demand of the country. Greece had 40% lower transportation demand than the average transportation demand of the EU members and the level of total energy consumption, greenhouse gas emissions and noise levels were also lower, although the need to face the problem was and is major. In Greece, the objective was to follow the directions of the EU regarding this sector and achieve the goals set (the directions of the EU will be analyzed in section 3.1.2 and appendix I, where the European Transportation Policy will be presented and discussed). Thus, some of the actions intended to be followed in Greece, set by the Ministry of Environment were:

1. “Develop and extend the public transport infrastructure with greater emphasis on the modules of train, metro and tram
2. Upgrade and extend the road network in order to decrease the traffic congestion and increase the safety on roads
3. Promote more environmentally friendly fuels and technologies
4. Promote rail and sea transport
5. Enhance traffic flows by introducing more bus lanes, one-way streets and increase the use of telematics
6. Introduce measures to regulate the use of private cars and long-term change of behavioral and consumption patterns of drivers”

On October 4th 2009, national Greek elections were held. Although, no elections were required to be held until September 2011, the former Prime-Minister, Kostas Karamanlis, announced that he would request of the President to dissolve Parliament and call an election. On the day of the elections a big change took place in the country. For the previous six years the centre-right party of New Democracy had been in power. The results of the last elections gave power to the opposition Socialist Party of PASOK, which won with a difference of 10% (almost 44% of the votes were won by PASOK, and almost 34% by New Democracy. Almost 70% of the electorate voted in these elections). The new party in power earned 160 seats in the Parliament, whereas

New Democracy now has 91 seats. The victory was characterized as decisive, since PASOK increased its share of votes by 5.8% and New Democracy’s share decreased by 8.38%.\textsuperscript{26}

\textbf{2.4.1 Previous government}

The transportation strategies that the previous government (New Democracy) was following are described here. As far as the national policy of transport is concerned, the completion of the national transportation network (all modes: road, rail, air, and sea) was a basic priority in order to ensure the rapid and safe transportation of passengers and freight. The success of the above would contribute to the increase of competitiveness, in regional growth and in improvement of accessibility.

In greater detail, providing effective, flexible, and safe infrastructures was thought to be essential for economic growth. Developing transportation networks that are more efficient contributes to increasing the possibilities of commercial transactions, domestic and international, as well as the effectiveness of enterprising activities. At the same time, the growth of trans-European infrastructures was of great importance in order to achieve unification of national markets, especially under the framework of the extended European Union.

The strategies that the government followed aimed at improving the road and rail networks, ports, airports, promoting urban transportation, ensuring safety for roads, rail lines, sea and air, increasing research and application of rescue plans in the event of maritime accidents, as well as in promoting technical support for the application of all the above.

The following goals were set:

1. The improvement of accessibility for all regions of the country, via the construction of the Trans-European Road Network that included connections with the main “gateways” of the country like ports and airports. Moreover, there were plans to improve the rest of the National and Regional Road Network, while pursuing measures for the environmental protection of the country.

2. The development and modernization of the railway network, giving priority to the construction of the Trans-European High Speed Rail Network. Furthermore, growth of combined transport, supporting the development of infrastructures that have no negative effects on the environment.

3. The improvement of marine transportation systems and the construction of appropriate infrastructure at ports that will serve the demand and the needs for transporting freight.

\textsuperscript{26} Wikipedia, “Greek legislative election 2009”, retrieved December 7\textsuperscript{th} 2009 from http://en.wikipedia.org/wiki/Greek_legislative_election_2009
4. The improvement of air transportation regulatory policies, in order to minimize the negative effects on urban areas (like emission and noise pollution), the improvement of service quality, and the optimization of air transportation safety.

5. The development of the urban transportation network and the public transportation systems of the metropolitan areas, in order to improve the urban transports and also increase the attractiveness of urban public transportation systems. By serving the above, reduction of travel times and globally emitted gas volumes would be achieved and viable urban mobility would be strengthened.27

2.4.2 Current government

The current government is in power for the past three months. It has just begun its duty and the three-month period doesn’t allow us to fully understand what their plans are going to be for the future of the country and the transportation sector specifically. However, the initial statements of the new Minister are discussed here.

The Ministry of Transportation and Communications is to be renamed the Ministry of Infrastructure, Transportation, and Networks. In his first speech in the Parliament the new Minister in charge, Dimitris Reppas, presented the transportation strategies that the new government plans to follow. After presenting the current situation of the country’s transportation networks and infrastructure, he talked about the goals that the new government has set.

The government is primarily concerned with the reduction of the cost, the reduction of time, the guaranteed quality, and environmental protection. The quality of the system is the main objective, and, along with many other factors, reconstruction of the evaluating system of different proposals is currently being considered. The final decision on which proposal should actually be implemented will also be based on criteria such as cost savings. This action refers to the corruption of the Public Private Partnership’s procedure. According to this procedure, the project with the lowest cost was supposed to be funded under this scheme. The current minister accuses the previous government of not following the legal procedures and directions. Thus, he is declaring that from now on transparency is guaranteed.28

Furthermore, changes are proposed concerning the Law of Technical Specification Studies. This law refers to the bidding and development of a project. Part of this law requires the Ministry of Environment, Physical Planning, and Public Works to compose a pool of specialists, so that


28 Speeches, 2009, Ministry of Transport and Communication, retrieved October 25th 2009 from http://www.yme.gr/index.php?getwhat=7&tid=23&aid=2045&id= (this document is in Greek and the translation has been done by the author)
whenever a project is chosen to be constructed, there will be a list of people that can be called on to be involved. The qualification requirements for these specialists will be revised, determining reliable terms and conditions for registration and classification of the corresponding group of people. The objectives of each category of study will be set precisely and will be matched with the most appropriate specialists. Lastly, in order to conduct trustworthy bidding for each project, a file with the description, actions, and all other aspects of the project will be kept.

Changes in the area of road development are required, because the construction of large road networks, with the application of Concessions has resulted in big delays. The erroneous conventional terms have to be redefined and the technical planning of such projects has to be improved. Moreover, the tolls charges for road use must be reduced, in order for prices to be rational, according to the new plans, although this will decrease Greece's income.

The new government is keen on creating better conditions for the Viable Green Growth of the whole Greek region, not only focusing on the large cities and the most popular tourist destinations. Thus, there will be an extensive revision of the regional funding, with the ultimate goal of determining new hierarchies of actions. There will be a major collaboration between the Government and the Regional Authorities and Municipalities, for the application of Public Works that will benefit the further development of each region. The new Government will support and promote the implementation of small and mid-size projects.

Another strategy of the new Government concerns the underground rail systems of Athens and Thessaloniki. The goal is to convert these systems into the “backbone” of transportation in the two cities, which will cover the high density urban areas. Therefore, studies on connecting these networks with all other urban and public transportation systems of each city will be held. Additionally, attempts at reducing the use of cars will be made consequently reducing the pollution and improving the quality of life. The construction of the underground system in Thessaloniki started when the previous government was in power. The new government has undertaken the responsibility of finishing the project and desires to go one step forward by studying the connection of it with the rest of the urban and public transportation systems of each city accordingly.

At the moment Egnatia Odos, the longest road through the northern part of the country connecting the east with the west, is the biggest public project of the country. The goal set for this project is to complete the main road and also construct the traversal ones, which will connect Egnatia Odos with the neighboring countries in the north. Equally important is the connection of this project with the regions of Epirus, Thessaly, Macedonia and Thrace and especially with the “gateways” of these areas, like airports, harbors, and railway stations.

Another goal set is the configuration of a new modern framework of operation and organization that ensures public transportation as a public good for all citizens in the whole country. The main points of this policy are the application of integrated interventions in the
transportation infrastructure, vehicles, and the means with Right Of Way, aiming toward the reduction of pollution and also the reduction of road accidents.\textsuperscript{28}

Regarding the rail network, the government's choice is to rescue it from collapse and revitalize the Greek Railway, so that it can support modern development for Greece and also secure the rail's public and social nature. Greater detail about the rail network and its characteristics will be presented in the chapter 3.\textsuperscript{28}

For air transportation and the airports, the following policies have been set:

1. Accelerated completion of new infrastructures and instant application of the maintenance program.

2. Explicitly determining the necessary air and coastal lines for public service that will also serve the areas that currently have either none or infrequent connections with other parts of the country.

3. Changes in the institutional frame in order to upgrade the Service of Civil Aviation. The goal is to have the Service operate independently, with increased prestige and responsibility.

Finally, the regulation of Marine Transport will be reconstituted. The application of special policies for the coastal transport is set as a priority. Priority is also given to the security of the safe transport of the citizens, along with a high level of frequency, stability, and quality of service from and to all islands.\textsuperscript{28}

All of the above plans that were presented by the new Minister of Transport and Communication cannot be judged, since the new government is in power only for the past three months. So, no criticism can be made at the moment regarding the transportation-related actions of PASOK. Nor can we state whether differences of substance between the transportation ideas of the two parties will emerge.
2.5 National budget

2.5.1 Overview

The basic objectives of the economic policy that the Greek government is following at the moment are the continuation of further economic growth and the intensification of social cohesion. Specifically, the following goals have been set by the Ministry of Economy and Finance:

1. Further reduction of the country's deficit as a percentage of GDP
2. Further reduction of public debt
3. Support of minority groups - The main minority groups that exist in Greece are Albanians, Muslims and Armenians
4. Confrontation of tax evasion
5. Regional development
6. Reforming the previously inefficient public insurance and healthcare system

The 2007 economic crisis, which began with the US sub-prime loan market, is currently progressing and is influencing not only Europe, but the whole world. Because of the structural forms that were promoted in previous years and the dynamic that has developed, the Greek economy is closely monitored lately, because there are fears that the country might default. It has turned out that Greece is a weak financial member of the European Union at the moment and need help in order for the default of the country to be prevented. The deficit of Greece reaches 12.7% of 2009 output and the debt equals 113% of the Greek GDP.

The national income originates from many different sources (see figure 2-7), which are the following:

1. Regular incomes
   1.1 Direct taxes (revenue tax, tax on belongings and other taxes)
   1.2 Indirect taxes (taxes from transactions, consumption taxes, and other)

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1.3 European Union funding

1.4 Incomes from other than taxes

2. Non regular incomes

![Percentage Structure of Greek National Incomings for 2009](http://www.mof-glk.gr/proypologismos/2009/books/proyp/PDFProyp/1.5.pdf)

Figure 2-7: Percentage Structure of Greek National Incomings for 2009 (source: http://www.mof-glk.gr/proypologismos/2009/books/proyp/PDFProyp/1.5.pdf)

The expenditures of the country are divided into the following categories and subcategories:

1. **Salaries and pension**
   - 1.1 Government
   - 1.2 Hospitals
   - 1.3 Employment

2. **Health insurance and social care**
   - 2.1 Expenditures on health insurances
   - 2.2 Subsidy on health insurance agencies
   - 2.3 Social welfare
3. Operational and other

3.1 Subsidies of agents (transportation agents, other agents)

3.2 Consumers’ (traveling, operation, supplies)

3.3 Reimbursement to EU

4. Creditable assets

Each year, according to the needs of each part of the country, the total incomes are divided and distributed between the Presidency of Democracy, the Greek Parliament, the Ministries and the General Secretaries of Communication and Information and the Program of Public Investments. The Program of Public Investments is managed by the Ministry of Economy and Finance, which divides this amount of money further and distributes it to the Regional Authorities and Ministries. The money from this program is used for investments, which will contribute to the country’s development and the greater good of the Greek citizens.

2.5.2 Transportation Funding

The Ministry of Environment, Physical Planning, and Public Works (a Ministry that has been abolished by the new government) spent a great amount of money on transportation and specifically on new transport infrastructure systems, maintenance of the current systems, and research and development. In the budget of 2009 (the fiscal year for Greece is the same as the calendar year) the Ministry has dedicated an amount equal to 73% of its total budget to transportation.31

As far as the Ministry of Transportation and Communications is concerned, it is very interesting to note that it divides its budget in the subcategories of Communications, Transportation (generally), and the Rail System. Although there is no money allocated for the Rail System in 2009, 70% of the total budget was spent in this category in 2008. Moreover, in all the government’s official documents on incomes and expenditures, the Rail System is always separated from the rest of the transportation systems. This likely shows the government’s great interest in investing and upgrading the current rail network.32


As mentioned above, the Program of Public Investments includes actions that endorse transportation improvement and, specifically, the support of safety of air transport and further investigation of the causes of accidents. It also includes planning, programming, organizing, and controlling the transportation network. The ultimate goal is both to maintain and improve the existing transportation network and all other elements included, from constructing new depots to improving Greece's main ports.\textsuperscript{29}

The Ministry of Transportation and Communications has the option of funding transportation investment with the scheme of Public Private Partnerships (PPP). This can be applied if the PPP application is approved by the Ministry of National Economy and Finance. The procedure of applying for a PPP scheme is the same for all Ministries. When a Ministry wants to support a project with the use of a PPP, first it has to make an application to the Ministry of National Economy and Finance. The application is not just simple paperwork. A folder with many documents has to be submitted, and, if it is accepted, then the project is enlisted in the Program of Public Investments.\textsuperscript{33} The choice among similar projects is made according to the lowest costs.

2.6 Greece and the European Union

Greece was making efforts to be linked with the European Community long before its admission to the Union. The first step to integration was made in June 1959, when Greece applied for accession to the newly established European Economic Community. Two years later (June 1961), the Association Agreement was signed between the country and the Community. Unfortunately, the progress of this process was "frozen" during the Greek dictatorship, from April 1967 until July 1974. On July 12th, 1975, when democracy was restored, the Greek Government and Constantinos Caramanlis (the Prime Minister at the time) applied to the EU in order to be accepted as a full member. This first attempt was not successful, but after a long series of negotiations, Greece entered the EU in 1981.\textsuperscript{34}

In the beginning, Greece's participation was doubtful regarding serious aspects of European integration. The country was really reserved and concerned about its efforts and plans that aimed at the integration of institutions, politics, and defense throughout the EU. This situation lasted until around 1988, when the country begun to support the "federal" integration model, the development of joint policy in departments like education, health and environment, the strengthening of supra-national institutions, and the development of a joint foreign and security

\textsuperscript{33} Διαδικασίες Συμπράξεων Δημόσιου και Ιδιωτικού Τομέα, retrieved December 24th 2009 from http://www.sdit.mnec.gr/en/infopoint/procedures/

policy across the Union. However, some doubts regarding the economics of the country and its politics still existed. In 1987, Greece started attempting to secure the accession of Cyprus into the European Community, and its efforts led to the submission of Cyprus in 1990. After that, Greece started further supporting the idea and process of European integration. The country made many efforts to fulfill the “convergence criteria”, which were set by the Maastricht Treaty, and that led to the start of its participation in the Economic and Monetary Union in 2002.34

Greece has been greatly benefited by its participation in the European Union. The “dream” of integration has improved the economy of the country and the monetary flows of the market. Moreover, numerous public works have been financially supported with EU funds, and this has led to further development. In general, Greece’s progress has been accelerated with the help of the Community.

2.7 Summary

This chapter has presented the current geographical, political, and economic background to funding and programs for recent transportation development in Greece. Chapter 3 will refer specifically to high speed rail and its contribution to Greek economic development. Details about projects planned by the EU and Greece will be discussed.
Chapter 3: High Speed Rail in Greece

This chapter will focus on the perspective of the EU regarding the development of the HSR network across the whole Union and the Greek perspective as well. The agencies that have been formed and the entities responsible for the Greek rail network as well as all projects planned for Greece will be presented. The chapter will close with a discussion about the economic impacts that HSR can have and the barriers and obstacles that Greece is facing towards its implementation.

Several European Union (EU) programs have been outlined and funded to integrate and promote efficient modes of transport in order to attain the more efficient flow of goods, services and people throughout the Union and to promote further integration among the member states (countries that are part of the Union; those are Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom) as well as across its external borders throughout the region. Greece has been awarded funds and has had projects approved regarding its transportation networks.

Among the EU priorities, High Speed Rail (HSR) in Greece offers the promise of regional development, increased integration of the various modes of transport and economic advantages. Moreover, EU helps in facing challenges face in the rail network such as poor existing infrastructure, budgetary limitations and topographical features.

3.1 European Union Perspective

3.1.1 Overview

The European Union is particularly interested in the efficient transportation of passengers and freight within its territories, since well-functioning links are considered to be vital for European citizens. The aim set by the European Union is to provide “clean, safe, and efficient” travel of both goods and people throughout the EU. The policy areas that concern the European Union are discussed in detail in Appendix I. Regarding the rail sector, which this thesis is concerned with, the European Union has set the following goal:

• “Rail” – Efforts are being made to restructure the European rail network and strengthen its position among other modes of transport. The goals set for rail are to promote competition in the rail market, improve “the interoperability and safety of the network”, and develop the rail infrastructure.  

3.1.2 European Transportation Policy

In 2001, the Commission of the European Communities published the White Paper “European transport policy for 2010: time to decide”. The White Paper analyzed the condition of the transportation networks of all EU members and set out an ambitious action program up to 2010. The paper supports economic growth and the right to mobility and proposes to improve sustainability of transport through restoring the balance between road, rail, waterway, and shipping, developing intermodal transport, combating congestion and putting safety and service quality at the heart of the transportation policy. According to the “White Paper,” four main action priorities were set. Those are discussed in detail in appendix I. As far as rail is concerned, the actions that are relevant are the following:

1. “Revitalizing the railways

2. Linking up sea, inland waterways and rail”

A “growing imbalance” was noticed between transport modes in the EU, with the increased success of road and air traveling resulting in great congestion. This situation is blocking the exploitation of the full potential of rail and short sea shipping; thus the Commission decided to solve the problem with investing in all mode networks.  

With an interoperable trans-European network (regarding all modes) gradually being put together and traffic growth expected to rise, it was necessary to look at how networks are organized and how they can be better integrated. Specifically for high speed rail, it seemed that the market had great potential of growth for longer distance trips. The construction of high speed rail aims to help attain the following objective: “the new high speed rail lines brought into service will absorb some of the traffic from conventional lines, which currently carry all the traffic”. The increased distances between centers at opposite ends of the Union as it expanded meant that high speed rail network was required.  

Such a network comprised the high-speed lines, including upgraded lines, connections, and systems that would allow the integration of air and rail transport services and airports. On routes where it was impossible to construct new lines the upgrading of existing tracks for high-speed trains was seen to be the solution to offer an adequate level of comfort and service. Lastly,

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investment geared to integrating the high-speed train network with air transport was encouraged. The network planning sought to take advantage of the ability of high-speed trains to replace air transport and encourage rail companies, airlines, and airport managers not only to compete but also cooperate.\textsuperscript{36}

In 2005, a mid-term assessment of the 2001 White Paper was planned in order to check whether the targets and objectives were being attained or whether adjustments were needed. The discussion about this paper is included in Appendix I, along with the review that Nash (2009) did of this paper.

\textbf{3.1.3 Trans-European Transport Network Executive Agency}

"The mission of the Agency is to provide an efficient and effective service in realizing the technical and financial implementation" of the whole program. The TEN-T Network, which is referring to all modes and to both passengers and freight, is a project which will benefit the whole European population by providing a more "efficient and environmentally friendly" transportation system. It will also reinforce the "economic and social cohesion" across the whole Union. By funding such a network, the ultimate goal is to achieve "European competitiveness, job creation and cohesion".\textsuperscript{37}

The TEN-T Executive Agency was founded by the European Commission in 2006 and has its base in Brussels, Belgium. It is in charge of all transportation projects under the 2000-2006 and 2007-2013 funding schemes. The Agency is independent, but closely related with its parent, the Directorate - General Energy and Transport (DG TREN). The DG TREN "deals with all the policy-making issues" in the TEN-T program and the Agency is "executing the program's specific tasks" (see table 3-1), through the end of 2015. The stakeholders of the TEN-T Agency are the Member States, who are also benefited by the funding that the Agency provides.\textsuperscript{37}

The Agency is divided into four units and is directed by the executive director (see figure 3-1).

Figure 3-1: TEN-T organization (source: http://tentea.ec.europa.eu/en/about_us/organisation/)
The Road and Rail Transport unit is responsible for the operational follow-up and project management of road and rail projects. This unit is involved in feasibility studies, design and infrastructure like tunneling, railway lines, and electrifications etc.38

The European Commission's TEN-T Program is one of the most important Community financing means for European transport infrastructure projects that totals €8 billion for the period 2007-2013.39 The program includes projects located in every EU Member State and refers to all modes of transport (road, rail, maritime, inland waterways, air, logistics and co-modality, see figures 3-2 and 3-3). The number of projects exceeds four hundred.

Figure 3 - 2: TEN – T network map (source: tentea.ec.europa.eu)


As mentioned above, the EU has allocated €8 billion for the TEN-T program for the period 2007-2013. In greater detail, the above amount of money includes €500 million “for the Loan Guarantee Instrument”. This is “an innovative financial instrument”, which has been set up and developed by the European Commission and the European Investment Bank (EIB), in order to facilitate a greater proportion of “the private sector in the financing of the TEN-T” projects.

The aim of this funding is to improve the European transport network and to increase mobility. In order for a Member State to benefit from this funding, a sequence of activities has to be followed. Those are presented in Appendix I.

At the moment, 30 Priority Projects (Axis) exist, which concentrate on pan-European integration and development. Those were identified according to the value added to Europe in general and their contribution to the sustainable development of transport in the Union. Upon completion (planned for 2020), economic efficiency of the European transport system will be improved and direct benefits will be provided to European citizens.

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From the 30 Priority projects, 18 are railway projects, 4 of which are HSR, 3 are mixed rail-road projects, 2 are inland waterway transport projects and one refers to Motorways of the Sea. A list of the projects follows; a map of the whole European rail network is also provided in figure 3-4:

3. High speed railway axis of south – west Europe (rail connection between Spain and Portugal)
4. High speed railway axis east (connection of the HSR networks of France and Germany)
5. Betuwe line (Netherlands) COMPLETED
7. Motorway axis Igoumenitsa / Patra-Athens-Sofia-Budapest (connection of Greece – Bulgaria – Hungary)
8. Multimodal axis Portugal / Spain-rest of Europe
9. Railway axis Cork-Dublin-Belfast-Stranraer (Ireland) COMPLETED
10. Malpensa airport (Italy) COMPLETED 2001
11. The Øresund bridge (connection between Denmark and Sweden) COMPLETE 2000
12. Nordic Triangle railway / road axis (refers to the countries of Sweden and Finland)
13. Road axis United Kingdom / Ireland / Benelux
14. West coast main line (rail connection of south-east and north-west UK)
15. Galileo (European initiative for creating a global navigation satellite system)
16. Freight railway axis Sines / Algeciras-Madrid-Paris (connection of Portugal and Spain)
17. Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava (connection of France – Germany – Austria – Hungary)
18. Waterway axis Rhine/Meuse-Main-Danube (a waterway that crosses the Union from west [Strait of Dover] to east [Black Sea] and specifically from Netherlands – Germany – Austria – Hungary – Serbia [not in the EU] – Bulgaria)
19. High-speed rail interoperability in the Iberian Peninsula (Spain)
20. Railway axis Fehmarn belt (connects Germany – Denmark)
21. Motorways of the Sea (refers to motorways around the whole Union)
23. Railway axis Gdansk-Warszawa-Brno/Bratislava-Wien (connects Austria – Czech Republic – Poland and Hungary – Slovakia – Poland)
24. Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerp (connects France – Germany – Belgium – Netherlands with Switzerland and Italy)
25. Motorway axis Gdansk-Brno/Bratislava-Vienna (connects Austria – Czech Republic)
26. Railway/road axis Ireland/United Kingdom/continental Europe
28. “Eurocaprail” on the Brussels-Luxembourg-Strasbourg railway axis”(connects Belgium - Luxembourg - France - Germany)
29. Railway axis of the Ionian/ Adriatic intermodal corridor (within Greece)
30. Inland Waterway Seine-Scheldt (connects France with Brussels)”

Figure 3 - 4: European rail map (source: http://api.ning.com/files/f0-IMD2IHtyJdYQ*bUTDSocemc-

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**3.1.4 Rail Plans for Greece**

The TEN-T Agent has planned two rail projects that concern Greece. Both of them are in the list of the priority projects (Priority Projects 22 and 29), reflecting the weight of importance. It is quite surprising that 6% of the priority projects refer to Greece, if we take into consideration the small size of the country. Probably the fact that it is on the eastern boundary of the Union and
serves as part of the borders of the Union increases its importance and the Commission’s attention. Also, it is the crossroad between Asia, Europe and Africa. Moreover, it is a Mediterranean country with many ports that serve both passengers and freight. Thus, with the upgrade of the existing railway network, the goal of co-modality will be achieved. The efficiency of accommodating intra-EU and international flows towards the central European markets will increase significantly.

HIGH SPEED RAIL

The first project (#22, see figure 3-5) is the railway axis of Athens - Sofia - Budapest - Wien - Prague - Nuremberg / Dresden. This project will link the eastern Member States (Greece - Bulgaria - Romania - Austria - Czech Republic - Germany) with a major rail corridor. Sections of this project have already been completed, but there are parts of it that will start being constructed after 2013.41

The subprojects set for this railway axis are the following:

1. “Geotechnical and design studies for the construction of new rail connection Prague-Broun (€29,000,000million)
2. Reconstruction of the Olomouc Railway Station (€3,294,000million)
3. Studies for the development of the Railway Priority Project 22 (€13,000,000million)
4. Preparation of design for approval for the railway line section Biatorbagy (included)-Tata (excluded) (€2,500,000million)
5. Optimization of Railway section Prague Hostivar - Prague main railway station detailed design (€10,000,000million)”41

The funding contribution of the European Commission to each country will be 50% of the total cost of each subproject. The beneficiary bodies will be the Ministries of Transportation of each Member State and in the case of Greece the Hellenic Railway Organization and ERGOSE (the company responsible for the investment programs) companies as well (details about the Greek companies will be provided in the next section of this chapter, 3.2.1 Railway stakeholders).

The implementing bodies from each country involved are the Hellenic Railway Organization and ERGOSE in Greece, the National Railway Infrastructure Company in Bulgaria, the National Railway Company in Romania and the MAV Company in Hungary. From the above subproject, number three is the one referring to Greece, but not exclusively. In subproject 3 all countries are involved, since it concerns the study of this corridor.
CONVENTIONAL RAIL

The second project planned from the TEN-T Agent comprises the Priority Project 29 and refers to the Ionian/Adriatic intermodal corridor. This project has been planned for Greece specifically, because of its important “geographical position at the crossroads between Europe, Africa and Asia”. The capacity of intermodal links between sea and rail is believed to increase with the implementation of this plan. It will complete a major part of the network that is currently absent in that part of Greece, and it will improve the connections between Greece and the rest of the Balkan countries. Moreover, this corridor will result in significant time and cost savings of cargo transit. 42

The subprojects set for this Priority Project are:

1. "Railway line between Antirrio and Ioannina, studies for designing the new line Antirrio – Ioannina" 42 (see figure 3-6)

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This corridor consists of two interlinked routes (a. Kozani - Kalambaka - Igoumenitsa, b. Ioannina - Antirrio - Rio - Kalamata). The goal is to connect the major Greek ports with each other and with the main rail routes of the EU. The total cost of this plan is €43,000,000, 50% of which will be granted by the European Commission. The start of the project has been set for December 2008 and it will be completed in April 2013.

2. Studies for standardization and upgrading design for the existing Patra - Pyrgos - Kalamata railway"⁴² (see figure 3-7)

This project involves the improvement and upgrading of the existing railway roadbed and the "change of its gauge from 1m to 1.435m"⁴². The cost will be €15,500,000 in total and 50% will
again be granted by the European Commission. The start for this project has been set for January 2009 and it is planned to be completed in December 2013.43

3.2 Greek Perspective

3.2.1 Railway Stakeholders

HISTORY44

The Hellenic Railway Organization (OSE: Greek initials) was founded in the beginning of 1970, and its aim was to operate and develop the railway transport system. OSE replaced the Hellenic State Railways, an entity owned by the Greek government, “which was established in 1920”.45 On December 4th 1972 all services of the Hellenic Railways were brought to their new “house”, which was placed in 1st Karolou Str. in Athens. This period is characterized by a rapid development of the railway services. Diesel trains and railcars were exclusively used and the steam-driven trains became obsolete.

New, comfortable INTERCITY trains started daily service on regular routes between the major cities of the country, Athens – Thessaloniki (approximately 500 km apart) in October 1981. A new era seemed to begin for the Hellenic Railways, since the layout of the network started improving, the lines were maintained regularly, and the signaling of the routes started to be in service. Furthermore, the line between Athens and Thessaloniki was being electrified and doubled in width in some sections.

1. OSE restuctured its operations after the application of the Presidential Decree 41/2005 and the European Directives 12, 13 and 14 of 2001 and created the following subsidiary state-owned companies:46

2. EDISY, a company responsible for the management of the railway infrastructure, further infrastructure investments, and its maintenance


44 History, Hellenic Railways (OSE), retrieved October 12th from http://www.ose.gr/ose/content/Folder.aspx?d=39&rd=16685622&f=1663&rf=1372328207&m=-1&rm=-1&l=1


3. TRAINOSE, which is responsible for the transport services of passengers and freight in the suburban, urban, and long distance level

4. ERGOSE S.A., which is a company responsible for the investment programs, conducting necessary studies, and supplying the materials needed for the decided investments

5. GAIA OSE S.A., which is a company responsible for the utilization of the holdings of the organization (real estate)

During the past three years, OSE Company has recorded large financial deficits and much technical damage. During the year 2007, the company’s total sales were €103.7 million from which 65% was the share from the transport of passengers. The salaries and expenditures for the employees were over €385 million and the interest payment was almost €362 million.⁴⁷

The situation kept on worsening with the amount of debts increasing. Thus, changes were decided and took effect during the summer of 2009. The company of EDISY was incorporated with OSE Company and the same happened with GAIOSE and ERGOSE. As far as TRAINOSE Company is concerned, it became independent (not included in the OSE companies as it used to be and like ERGOSE and EDISY) according to the European standards.⁴⁸

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CURRENT SITUATION

The aim of the Hellenic Railway Organization is to develop, plan and operate the railway transport for goods and passengers and combined transport in the suburban, interurban, and international level. Along with the collaboration of the supervising Ministries, the main goal is to follow the national policies with the respective guidelines of the European Commission. Lastly, it aids in the completion of the construction works in progress and in the timely delivery of the planned sections.49

The mission of OSE is to provide high quality rail services to both passengers and freight, "maximize the social-economic effectiveness" of sources used, and cooperate harmoniously with the carriers of "economic, enterprising, and social life of the country". The main values that guide the mission of OSE are consistency, honesty, meritocracy, integrity, transparency, and high quality. OSE’s mission includes the effective management of its human and economic resources. Moreover, OSE aims to plan and apply an integrated transport policy that will provide a technologically advanced and qualitatively upgraded railway service. Finally, OSE intends to secure the safety of railway transportation.50

The vision of the company is to create a modern system of railway transport services that will be a substantial part of the Trans-European network and will serve the needs of the citizens. OSE places great emphasis on the rapid, secure, comfortable, and economic transport of passengers and freight with respect to the environment and the economic and social development of the country.51

EDISY S.A. was founded in order to manage the National Rail Infrastructure. Although it has been incorporated with OSE, under the framework of its responsibilities the company is obliged to provide the following:

- Maintenance of the National Railway Infrastructure
- Care for the improvement and extension of the network; management of the relative investments


• Calculation, pricing, imposing and collecting usage fees from the rail enterprises that use the rail infrastructure.

TRAINOSE, which currently is an independent company, is responsible for the provision of rail services both to passengers and freight. Specifically for the connection of Athens and Thessaloniki (500 km), a depiction of the linkage follows in Figure 3-9. Depending on the number of stops that each train makes, the duration of the trip varies between 4 hours 15 minutes and 6 hours 15 minutes. The cost of the trip varies according to the number of stops and the seating class. A roundtrip costs between $108 and $157.

ERGOSE S.A. was formed in 1996 as a subsidiary company of OSE with the responsibility of managing the Organization Investment Program projects. This company is co-funded by the European Union Programs. A Project Manager was recruited at the company’s outset with the role of transferring the know-how to the company’s employees and helping them in the launching of ERGOSE. The company is responsible for managing all activities that are related to programming, procurement, design, quality control, expropriations, tendering, and construction.

The mission that ERGOSE has set is two-sided. First, the company has to maximize the absorption of Greek and EU funds channeled to OSE for the upgrade and modernization of the Greek Railway Network and its infrastructure. Second, the company handles the responsibility of delivering the “approved Investment Programs” to OSE “on time” and at the cost and quality agreed before its construction. Furthermore, the company aims to “complete each project in the most technically and economically sound manner”, because it is trying to develop the “necessary know-how” and “become a marketable and reliable” company that will provide services to other countries (such as the Balkans) as well in the future.


53 TRAINOSE S.A., retrieved 22nd October 2009 from www.trainose.gr


In the meantime, both OSE as a company and the Greek economy have to be benefited, if OSE is able to raise its income and stop running large deficits. The Greek economy will be boosted with the faster trips offered. If the attraction of the rail mode becomes greater (rail mode share is 4% of the total transportation demand\textsuperscript{56}), demand will increase and numerous positive economic and environmental impacts will occur (further discussion regarding the economic impacts of transportation investments and HSR particularly will follow in chapter 4).

3.2.2 Current Railway Network

According to the Hellenic Railway Organization report published in 2007, the total length of the railroad is 2,746 km, 2,551 km on which trains operate. The operating network can be broken down as follows:

*Regular track network* - 1,778 km (1,190 km double line not electrified, 389 km single line not electrified, 199 km single and double electrified line)

*Metric track network* - 700 km

*Mixed track network* - 30 km

*Track network (width 0.75m)* - 22 km

*Track network (width 0.60M)* - 21 km

Figure 3 - 10: Greek rail map (source: http://www.alleuroperrail.com/eurorailway-maps/greece-map.htm)
The main rail corridors which are supplemented by many branches are:

1. Patra – Athens – Thessaloniki – Idomeni: serves the greatest share of the total demand
2. Thessaloniki – Alexandroupoli: located in northern Greece and connects the country with Turkey and Bulgaria
3. SKA (rail station in the greater Metropolitan area of Athens) – Athens International airport “Eleftherios Venizelos” 57

The speeds that the current trains reach vary from 20 km/hr to 160 km/hr depending on the type of tracks they are operating on. The slower speeds are reached in the branches that supplement the main rail corridors and the faster speed in the main corridors.58 The train categories that are offered in the Greek territories in order of growing speed are regular, intercity, and intercity express. Great time reduction is achieved on the intercity express train offered between Athens – Thessaloniki: the regular travel time is reduced by 2 hours (from 5hrs to 3 hrs).

The weaknesses from which the network is suffering are numerous. First, the topography of the country with the steep gradients and sharp curves does not allow for high speeds to be reached. A great part of the country is left without rail service. The main rail corridor is not connected with the major commercial ports; this discourages the evolution of intermodal transportation. From the technical point of view, the disadvantages are several as well. There are many lines that are single-track and rail electrification remains at a low level. Lastly, rail transport plays a very modest role in Greece. In general, the attractiveness of the network is poor (rail mode share: 4%).59

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3.2.3 Existing projects

The competitive transport market has led the Hellenic Railway Organization to set the following goals:

1. Modernization of the organization and transformation into a company that provides competition to other modes

2. Upgrading of the main railway corridor Patra – Athens – Thessaloniki – Idomeni into high speed rail and modernization of the rest of the network

3. Upgrading of the suburban rail in the areas of greater Athens and Thessaloniki

For the achievement of the above goals, a number of projects have been planned. The projects that ERGOSE S.A. is responsible for can be divided either by geographical region or by project categories. In addition, there is a series of new technologies implemented in the modernized Greek railway network.

Regarding the environment, ERGOSE is aware of the fact that the environmental impact from the construction and operation of a train line is unavoidable, but the goal of the company is to minimize it in order to achieve a viable development. In all projects, Environmental Impact Designs are studied and activities are planned both in the phase of design and construction. In cases that it is feasible and possible, environmentally friendly methods, such as cut and cover, are preferred and followed.

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61 The Projects, 2009, ERGOSE, retrieved October 22nd from http://www.ergose.gr

1. “Geographical region
   1.1. Main corridor” (see figure 3-11)

![Figure 3-11: Map of the main corridor of the Greek railway network (source: http://www.ergose.gr/ergosesite/innerFlashbase.asp?CONTAINERID=7&REFCI=22&LANGUAGE=2)](http://www.ergose.gr/ergosesite/innerFlashbase.asp?CONTAINERID=7&REFCI=22&LANGUAGE=2)

Part of this corridor constitutes part of the Priority Project 22 of the TEN-T Agency. To be more specific, the connection of Athens – Thessaloniki and Thessaloniki – Idomeni will be part of the rail path between Greece – Bulgaria and the “heart” of the Union. The TEN-T funding has sponsored 50% for the study of this part of the main corridor. This part of the Greek rail network is the one that will be upgraded to High Speed Rail and speeds up to 200 km/hr.

The total amount of money needed for the upgrading and modernization of the main corridor is €6,481,709,390. This contribution of the European Union and the Greek national funds for the payment of this cost is 65% and 35% accordingly. In detail, the percent of the funding sources varies from link to link, but if we consider the main corridor as one project, then the above shares hold.

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1.2. “Regional” (see figure 3-12)

The total amount of money for the scheduled projects of the network depicted in Figure 3-12 is €130,785,920 from which 68% is funded by European Union sources and the rest 32% comes from Greek funds. Regarding the share of funding between the EU and Greece, the same as with the main corridor holds. For each link and according to the type of the project, the share might vary, but if we consider the regional network as a whole, then share of funding is split as just mentioned, (68% from the EU and 32% from Greek funds).
1.3. “Suburban rail (PROASTIAKOS, in the metropolitan area of Athens)” (see figure 3-13)

The total amount of money needed for the projects that refer to this network is €753,000,000, 50% of which is going to be funded by European Union sources and the rest will be Greek money.63

2. “Project category
   2.1. Electrification
       While modernizing the Greek railways, electrification will be provided with an alternating current of 25 KV/50Hz.
   2.2. Signaling
       Modern signaling systems are needed in order to secure safe train traffic. The Greek signaling system is required to change and upgrade, in order to accommodate and manage the increased needs. The following installations are planned:
       2.2.1 Main light signals in the entrance and exit of all stations and stops
       2.2.2 Electrically operated rail point machines
       2.2.3 Track circuits for the detection of trains
       2.2.4 Solid State Interlocking (SSI) system
2.2.5 Block light signaling, in order to reduce the headway of the trains
2.2.6 Two-way signaling along the entire network
2.2.7 Automatic Train Protection, which is based on the trans-European ETCS / ERTMS system for the interoperability between EU railway networks.

Furthermore, six Centralized Traffic Control Centers are going to be introduced in strategic places for Train Traffic Management. The aim is to optimize the control of train traffic and minimize the operational cost.

2.3. Telecommunication

A data transmission network via fiber optic cables will be installed and operated in the main corridor.

2.4. Station

The vision of modernizing the network needs to be endorsed by the construction of modern, high quality stations that will be equipped with new technologies. A list of stations are planned to be maintained and renovated in order to offer the passengers all the comforts and safety suitable for a modern European network.

2.5. Bridges

2.6. Tunnels

Because of the complex terrain of Greece and the mountainous regions that the railway has to pass through, a substantial part of the structures that ERGOSE S.A. has planned are tunnels. The projects are approximately 60, the total length of which is about 90km.

2.7. Infrastructure

Each railway line cross-section includes the Infrastructure, which consists of the base and the formation layer, and to which the train loads are transferred; these loads are already distributed and reduced inside the superstructure layer. During the renovation of the superstructure, no interventions can be implemented to the infrastructure.

2.8. Superstructure

Apart from the infrastructure, the superstructure, which consists of the rail, the sleepers, with their fastening, the ballast, and the sub layer, is also needed.

3. New technologies

3.1. Slab track

This new technology is currently being used in a part of the main corridor, and it will offer passenger greater comfort due to its accurate geometry and the very low maintenance requirement.

3.2. ERTMS / ETCS system

The European Rail Traffic Management System / European Traffic Control System aims to achieve the interoperability of the Trans-European network.

3.3. Wireless network GSMR

GSMR is a digital communication system based on the internationally widespread and reliable GSM mobile telephone system that ensures safe communications at all levels.
3.2.4 Greek Rail Funding

During the two last programming periods (2000-2006 and 2007-2013), one of the main national development objectives was the modernization of the Hellenic Railway Network. The goal has been set for developing an upgraded system, combined with proper rolling stock that will reinforce the company's competitiveness, in terms of quality to its users.60

The funding for implementing the appropriate projects originates from the following sources:

- Greek Public funds
- 3rd Community Support Framework (EU funds)
- Cohesion Funds 2000-2006 (EU funds)
- National Strategic Reference Framework 2007-2013 (EU funds)64

A series of projects have been planned for the modernization of the Greek network. The completion of the Athens - Thessaloniki rail corridor, however, remains the first priority. This project includes the construction of a “double-track, high-speed railway line”, which will be constructed according to the “European specifications and standards, and equipped with modern signaling, telecommunication and electrification systems”. This is the only rail line that is currently planned to operate in high speed in Greece. Emphasis is also given in the construction of the new double-track high-speed railway line between Athens and Patras.57

The Greek government has to ensure the national public expenditure of the co-financed programs. In general, although the EU funding has been awarded for investment in the rail network since 2000 the progress of the projects is moderate. There are projects that were achieved to finish on time, but on the other hand there are others that should have been finished years ago and still haven’t. An approximate percentage of the amount of work that has been completed is 30% of the projects that have been planned.

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64 The Project-Funding-Funding Sources, 2009, ERGOSE, retrieved 22nd October from http://www.ergose.gr/ergosesite/inner.asp?CONTAINERID=3&REFCI=198&LANGUAGE=2
The money that the European Union grants is coming from the following sources:

- **European Regional Development Fund (ERDF)**
  The funding under this program is directed at the development of all regions of the Union and the reduction of the gap between development levels and living standards.

- **Cohesion Fund**
  This program is directed at the reduction of social and economic disparities among EU citizens. It grants projects directed to the environment and the trans-European transport network to those members of the Union that have GDP less than 90% than the community’s average.

- **Trans-European Transport Networks**
  The agency formed specifically for the development of the trans-European transportation network financially supports corresponding projects. This source provides funds in order for the HSR line to be studied in Greece.

### 3.3 Barriers and Obstacles to Implementation of HSR

There are two main obstacles that exist for implementing High Speed Rail in Greece. As mentioned above, one of them is physical. It is the terrain and the general topography of the country. Greece is quite mountainous and the gradients are very steep. Thus, it is very difficult for trains to reach high speeds. Moreover, because of this topography it is very expensive to construct appropriate infrastructure. This brings us to the second obstacle of HSR.

In general, the amount of money needed for the construction of a HSR network is large. The fact that the terrain of the county is rugged does not help the situation. On the contrary, it makes it even worse. More money has to be spent for clearing the path, the opening up of tunnels and the construction of bridges. All these are needed in order for a complete HSR network to be developed in the country. The share of money that is already given by the EU is large (discussed in section 3.2.3), and it seems that the Greek government cannot dedicate more than it already does. Other priorities have been set (the improvement of the whole rail network), limiting the construction of HSR between Athens - Thessaloniki - Idomeni. It is hoped that this will change in the future and money will be allocated for the upgrading of the entire Greek rail network, or most of it, to high speed.

### 3.4 Economic Impact of High Speed Rail in Greece

The Council of the European Union has defined a number of guidelines under the scheme of the Member States’ cohesion. One of those guidelines is to “Make Europe and its regions more attractive places in which to invest and work”. The implication of the rail plans, analyzed in the previous section, will contribute to the above guideline, since not only will it upgrade the
current network, but it will also improve the linkages of Greece with the rest of the European Union. The strategic position of the country along with the upgraded network will ease and increase the flows of passengers and freight not only within the country, but also to the whole Union.

The Priority Project 22 (railway connection of Greece - Bulgaria - Romania - Hungary - Austria - Germany) of the TEN-T Agency will help in the integration of the rail networks of the involved counties; thus, helping to face the problem of discontinuity in the inter-European transportation infrastructure. This construction will bolster the importance of Northern Greece and especially the city of Thessaloniki, one of its largest ports, with respect to the Greek economy and the geopolitical role of the country. The same holds for Priority Project 29. When this project is actually implemented, another major port of the country will be connected with the rail network. This port is located in the city of Igoumenitsa, in the northwestern part of the mainland of Greece. Even now, it is a very important connector of Greece and Italy. Unfortunately, from the Greek perspective, no plans seem to be scheduled on this specific project.

At the domestic level, there will be an improvement in the connection of the railway with other means of transport, such as sea ports and airports, resulting in the development and expansion of the urban transportation network. Both sea ports and airports that are placed in Thessaloniki and Athens are of great importance to the country. Actually, they are the biggest and most busy ones. Thus, mobility and level of accessibility will be enhanced. Furthermore, the upgraded quality of the system (referring to the connection of Athens-Thessaloniki) will increasingly attract passengers from other modes, who will benefit from time and cost savings.

Moreover, HSR might lead to the formation of a megalopolis (definition: a very large urban complex, usually involving several cities and towns\(^{65}\)) between Athens and Thessaloniki. Both of those cities are monocentric (definition: a form of spatial organization in regional sciences in which single city dominates the landscape and is centered at a single point in space\(^{66}\)) and all services are located mostly in the downtown areas of those two cities. Also, the greatest percentage of the population is also located in Athens and Thessaloniki (24% and 10% of the total population respectively\(^{56,57}\)). Through HSR, the time to travel between the two cities will be shortened. The cooperation of the two cities in areas like trade and business is great and this speedy mode will bring the cities closer.


Another possible positive effect is the triggering of local economies of the areas along the corridor. Currently, most areas between Athens and Thessaloniki are not lively and energetic, since most Greeks prefer to live nearer to the metropolitan areas. More specifically, half of the population and almost all main public services like Ministries are located in the capital of Greece, Athens. This is possible to change with HSR. Other cities will have the opportunity of livening up and developing. Since HSR will be there to allow people to commute faster, business and population relocation is very likely.

According to Banister and Berechman (2000), the economic effects of a transportation investment in developed countries are not that drastic, but economic redistribution is what happens. We would agree with them in general, but for the case of Greece, we believe that the boosting of the economy especially in places that currently are not easily accessed will be substantial. Relocation of businesses and population is also probable. To continue, they claim that for economic growth to occur there are other factors that need to co-exist, such as political support. It is true that the political support through corresponding policies is needed for supporting the new investment, but also for securing equilibrium among mode shares and people’s preferences.

At the moment, cars, airplanes and even busses are more preferable to Greeks. Depending on the economic status of the individual, one of those modes is usually chosen for travelling. This situation has resulted in the pollution of the environment especially in the downtown areas of the larger cities. The problem of congestion that many cities are facing is also quite serious. These issues will definitely be alleviated when high speed rail is available in Greece. Many people will shift to HSR, and when they reach the city it will be more likely that they continue to use public transportation. Thus, congestion within cities might decrease. Generally speaking, trains are environmentally friendly, causing the least pollution to the environment. The increase of the speed will contribute in the shifting of the mode used and that will result in partially solving the problem of pollution and congestion. Other actions are also needed to confront those issues, but high speed rail is a way for their relief.

To close, it is said that HSR can constitute as a good substitute to airplanes. In the case of Thessaloniki and Athens specifically, this might be true. Nowadays, a business trip between the two cities takes four hours of total travel. One needs almost an hour to reach the airport of Athens, has to be one hour earlier to the airport than the flight time, the flight then lasts about 45 minutes and if we take into consideration that a business traveler does not wait for luggage but has just a carry-on, about 40 minutes are needed to reach the centre of Thessaloniki. So, although the flight is short, the door-to-door travel time is quite long. This would definitely change when HSR is introduced in the transportation network. Station locations are closer to the city-centers than the airports, and one does not need to check in a hour before the journey. Thus, HSR will most probably constitute a good substitute to airplanes for travel between Thessaloniki and Athens.
3.5 Summary

This chapter presented various aspects of High Speed Rail in Greece, including the EU position, the Greek perspective, the recent history of the Greek rail network and the challenges faced in the implementation of HSR and the projects planned. The next chapter presents a literature review on the topic of socio-economic impacts of transportation investments and methods of evaluating them, and a method of measuring such impacts in Greece will be proposed.
Chapter 4: Methods for evaluating socio-economic impacts of transportation investments

The decision regarding implementing a major investment is very difficult and carries numerous responsibilities. When this investment concerns the transportation system, the responsibilities are even greater. Those kinds of decisions are taken by the government and the fact that the public has to be pleased and satisfied enlarges the burden. Many different parameters have to be considered before the final decision is taken, and the process is often quite time-consuming. On the one hand all the benefits and costs of a specific investment should be calculated, and on the other hand many different scenarios should be investigated. For example, should an investment be made in the highway network or the railway network? And if there are needs in the network of one mode, what is the best way to fulfill them?

In order to answer the questions that are generated in the decision phase and also to facilitate the complicated process of evaluating an investment before actually making it, many different methods have been developed. Different methods for evaluating socio-economic impacts of transportation investments and specifically of HSR investments will be analyzed in this chapter. Before advancing the analysis of different methods of evaluation, the benefits of HSR and the contribution of this modern technology to economic growth will be discussed. The impacts of transportation investments in general will also be presented.

4.1 High Speed Rail and transportation investments' benefits and economic growth

High speed rail is a mode that has gained great popularity over the last decade. Although it has been applied in Japan since 1964, which was the first country to develop HSR technology, with Germany and France to follow, nowadays a large boom is observed and a new trend is starting to be developed. Extensive research has been undertaken for the verification of the effects of HSR on economic development, and many papers have been published in order to present findings on the topic. The question of how transport investment affects the economy and growth of a region has also been of great interest to many researchers.

According to Pickton et al.(2007), who prepared a report for the Colorado State with the title “Statewide Economic Benefits of Transportation Investment”, they divide the benefits into two categories; the quantifiable benefits and the non-quantifiable benefits.
“Quantifiable benefits
  o Travel time savings
  o Reduced vehicle operating costs
  o Reduced congestion
  o Better pavement quality
  o Safety condition improvements
  o General system improvements
  o Shorter travel times
  o Reduced vehicle operating costs
  o Fewer accidents and injuries
  o Business expansion and attraction
  o Air quality changes

Non quantifiable benefits
  o Economic competitiveness
    - Increased access to labor and other inputs
    - Expanded market reach
    - Depends on level of investments in other states
  o Benefits to the tourism (finding from the I-70 Programmatic Environmental Impact Statement)
    - Increased visitor days
    - Increased out-of-state visitor spending
  o Quality of life
    - Local air quality improvements
    - Access to jobs and services
    - Improved public transportation in metropolitan areas
    - Increased leisure time
  o Short-term construction benefits
  o Efficient transportation investment”

Bruinsma and Rietveld (1993) believe that transportation infrastructure constitutes an “economic determinant of urban agglomeration”. Pol (2003) supports an idea that can be categorized together with the one of Bruinsma and Rietveld, that “urban actors” are the ones that “determine the level of impact of new transport infrastructure”. Everything is dependent on their reaction and on the strategies they develop. The question is whether there are certain preconditions to be fulfilled in order to promote the improvement of external accessibility.

According to Pol (2003) urban actors are all inhabitants, companies and governmental actors. The spatial behavior is different for each of these, and it is believed to be driven by the maximization of their welfare. In order to maximize welfare, people either change their transportation behavior or their location behavior. Moreover, he says that spatial behavior is connected with the “maximum acceptable transportation distance” (MATD) of the individual,
and in order to predict whether HSR will cause changes either in urban actors' transportation behavior or location behavior, it is necessary to explore the way they value transport costs. The MATD of each individual is closely related to his/her income, mobility and purpose of travel. The issue of time, which is also very important when studying the transportation behavior of individuals, is considered in the cost of traveling. In detail, Pol explains that the "generalized transportation costs" (GTC) of an individual include the money spent for traveling, the traveling and waiting times and also the effort required, such as discomfort and risk of delays. Lastly, he explains that infrastructure investment does not occur simultaneously in all regions, thus leading to the increase of prosperity of those who are benefited by the application of new technologies.

Banister and Berechman (2000, 2002) are also concerned with the relationship of transport infrastructure and economic development and question the effects of the former on the latter. They believe that in developing countries and cities, the relationship does exist and is quite clear, but in developed countries those links are unclear. Specifically, for developed countries, they argue that additional transportation investment has little impact on the overall accessibility and results in a change of business patterns and mode trends and not economic growth. Moreover, they claim that further investment in a well-connected, transport infrastructure network of high quality, does not result in economic growth on its own. Their opinion is that positive economic externalities, investment factors, and political factors have to co-exist in order for a transportation investment to result in economic growth (figure 4-1).

Priemus (in Bruinsma et al. (2008) is concerned with "the synergy between urban development and the development of transportation networks in Europe" and what is the role of various policies in this. The hypothesis is that this relationship has weakened since cars and airplanes have been widely preferred. Typical examples of good synergy, he explains, are monocentric cities like London and Paris, where the underground rail system is extensively developed and ease the access to downtown and on the other hand, have "intensified the interaction between city centre, suburbs and region". This relationship can be reinforced in European cities with the development of the HSR network. The areas where the stations are and/or are going to be built, will cope with an increased flow of passengers, thus increasing the purchasing power of the station itself and the surrounding area.
Blum et al. (1997) believe that high-speed trains can solve two problems of accessibility: first, HSR constitutes a good substitute to air travel and, second, it triggers the creation of a new economic corridor with high interregional accessibility. Sasaki et al. (1997) are interested in evaluating the impact of high speed rail transit on spatial dispersion of economic activities and population.

Givoni (2006) recognizes the following benefits of High Speed Trains (HST) as modes:

1. Increase of capacity

2. Travel time reduction and increase of level of service that changes the mode shares and generates new demand. Diverted passengers are mostly coming from the air share and not from the car share.

3. Ability of achieving very high operating speeds (above 120km/h)

4. Dense and dominant cities are more attractive for HST

He emphasizes the fact that HST can constitute a good substitute to air travel and observes the possibility that HST can result in positive spatial and socio-economic impacts.
Knox (2006) shows interest about the wider economic effects of HSR. He tries to find out whether relocation of businesses will occur by investigating which businesses are more attracted to the time saving that HSR offers. He also analyzes the belief that time on HSR is really productive, since there is the possibility of video conferencing and mobile broadband internet. He mentions that there were "suggestions that travel time on rail is so productive that the benefits from travel time savings should be reduced". The truth is that comfort can also be added as an advantage of rail in comparison with airplanes, since the seats and space area per traveler are much bigger than those offered on air. The influence of HSR on London and its huge agglomeration economies is also discussed in his paper. It seems that HSR will help in the expansion of agglomeration economies and relocation away from the center of London, without losing the connection with the markets and suppliers located downtown, in spite of the distance from the centre of the city.

He also claims that HSR will contribute positively to the connectivity of cities. It is possible that stronger bonds will be formed between cities, and HSR will help in the linkage of their economies. Economic benefits will arise from the increase of the capacity of the total network. He continues that HSR will cause a large number of inter-city trains to use those tracks instead of the conventional lines, allowing slower trains and freight trains alone on the existing lines. This will lead to the strengthening of local and commuter rail and the increase of freight services as well, since the lines will only be used from such trains. Finally, he believes that substantial agglomeration benefits will occur.

According to Pol (2003), HSR will affect the development of cities, reinforcing the existing hierarchical position of cities in different ways. The "growth-pole effect", which is defined by unbalanced economic growth across the region, might be marked. Then, the spread effect might be illustrated, as a result of the growth-pole effect, where economic activities are not center-located but are spread in the periphery. There is also the possibility of "backwash-effects". Those will occur in regions that lack accessibility to HSR, where businesses will relocate to areas that have HSR stations. Lastly, Pol believes that new surface networks within cities that are connected with HSR will be formed, and the "interaction among such cities will be enlivened". HSR will bring cities closer but also increase the competition between them, resulting in the further development of the cities themselves. The net impact of HSR is depicted in figure 4-2.
Depending on:

- Connection to the HST-network
- Lower generalised transport costs (GTC)
- Longer maximum communication distance
- Economic potential of an urban region

Influence on the urban economy:

- Catalysing role
- Facilitating role

Figure 4 - 2: Influence of the HSR on urban areas (source: Pol, 2003)

Regarding the lower level of the flow of HSR influence depicted in Figure 4-2, Pol explains that the regional economy of the city could be affected in two ways. Either HSR can have a “catalyzing or a facilitating role”, according to Pol. The first occurs when “new activities” are attracted and the economy grows. The latter is noted when the city is already prosperous and the new network facilitates economic growth.

Vickerman (2006) is concerned with the wider economic impacts of High Speed Rail in the European Union. He believes that HSR has the potential to be recognized as an instrument that enhances competitiveness and cohesion. The changes of accessibility and regional economic activities in areas benefited by HSR services are studied. He is concerned with “the relationship between HSR networks, regional and local transport networks and the role of accompanying policies”.

The wider effects defined by Vickerman are:

1. “Greater speeds
2. Reduced generalized travel costs
3. Reduced impedance of distance
4. Rise in accessibility
5. Rise in economic potential of major centers”
He discusses two ways of viewing wider economic impacts. One is the increase of total welfare, and the other is the increase in GDP.

Bertolini (in Bruinsma et al. 2008) claims that transport innovation triggers new development in the station area. Station areas constitute both “nodes” and “places” in transport and non-transport networks. They constitute a “dense and diverse conglomeration of uses”, he says, and the dynamic that is developed is very important. The increase of accessibility creates favorable conditions for further development. The strategy formed for the paths and station locations is critical to development.

The question that arises is what kind of method someone uses in order to appraise all of the benefits discussed above. Not all of them can be quantified, since some cannot be measured in monetary values, but still there are parameters that should be taken into consideration in the evaluation process.

As discussed in the Transit Cooperative Research Program Report 35 (1998), there is a variety of different methods for evaluating the economic impacts of transportation infrastructure investments and according to the nature and characteristics of each project, and the most appropriate can be applied. They can be categorized into predictive (ex ante) and evaluative (ex post). The first attempts to forecast the economic impacts of a possible transportation investment, whereas the second aims to gauge the effects of a transportation investment after its implementation. A discussion of the most-used methods will be presented in the following sections.

It should be noted here that most economic impact analyses are comparing different scenarios, each of which constitutes an alternative project (see a schematic imaginary example on Figures 4-3 to 4-6). For example, the comparison can include the alternatives of investing in the light rail network, the highway network or HSR. Projects about the same mode but with different characteristics, such as different routes, are considered as different scenarios. In the series of alternatives, usually the no-project scenario is also included, in order to investigate the option of not applying any investment.
Figure 4 - 3: Investment on highway connection of Thessaloniki and Athens

Figure 4 - 4: No investment in any network between Thessaloniki and Athens

Figure 4 - 5: Alternative 1 of HSR connection between Thessaloniki and Athens

Figure 4 - 6: Alternative 2 of HSR connection between Thessaloniki and Athens
With the analysis of each scenario, each link to be built is studied. Different criteria are being investigated. Aside from the economic impacts that each alternative presents and the level to which each helps economic growth, the economic condition of the country plays an important role as well. Depending on the amount of money that is available, an alternative might directly be rejected. Moreover, the time that each alternative needs to actually be implemented is critical. The need to improve a network or construct a new one might be urgent and can lead to the choice of the quickest alternative.

Specifically for HSR, the following criteria are usually taken into consideration when alternatives are built, as the Atkins Company (2004) has done when they studied the feasibility of HSR in the United Kingdom:

1. “Environmental constraints and habitation
2. Synergy with land use and transport policy
3. Technical constraints and affordability
4. Stakeholder concerns
5. Different High Speed Line routes
6. Station access
7. Costs including construction, land acquisition, rolling stock purchase etc
8. Investigation of HSR capabilities from the time savings point of view”

4.2 Benefit-Cost Analysis

Economic growth is an objective that most governments are aiming for when they set strategies and decide where to allocate money. As Riley (2006) states, economic growth has the benefits of higher levels of employment and the increase of the GDP of the country. These lead to the boosting of the economy and increase of inflows of money. On the other hand, if it occurs quickly, then it might result in negative impacts, such as an increase in inflation or uneven distribution of welfare.

When different projects are considered for implementation, the contribution to economic growth is an important aspect that is studied. The Benefit-Cost analysis (BCA) is a method that can help in the above concern. It is a way to weigh the benefits that a project has against the costs that it requires if it is implemented. The advantages and disadvantages of economic growth can also be studied with the use of BCA.
4.2.1 Description

Benefit Cost analysis (BCA) is a method that is used in order to assess a project and help in the decision process of deploying it or not. In general, this process involves the calculation of total expected costs compared to the total expected benefits. Those are usually expressed in monetary values adjusted at the time of the study, so that everything is expressed on a common basis. It is a method used in the private and/or public sectors. According to the country and the sector applying the method, differences can be noted, such as the types of benefits and costs appraised and discount rates. The most common set of benefit-cost indicators are:

- "Present Value of Benefits (PVB)
- Present Value of Costs (PVC)
- Net Present Value (NPV = PVB – PVC)
- Benefit Cost Ratio (BCR = PVB/PVC) – whenever this indicator is greater than one then that means that benefits of the project outweigh its costs" 67

According to Rietveld (in Bruinsma et al., 2008), BCA is the most widely-used method for ex ante evaluation of railway system investments. In the Transit Cooperative Research Program Report 35 (1998) the procedure of BCA is described as follows:

1. “Definition of the economic project life” – it is usually set between twenty and thirty years in order to allow a long period of time for the full range of impacts to occur and be realized

2. “Choosing discount rate” – this is usually ranging from 12 to 14 percent

3. “Measurement of benefits” – the most important ones are the travel time savings that result from the implementation of the new transportation investment.

4. “Measurement of costs”

5. “Calculation of the benefit-cost ratio”

The total social costs for building and operating a HSR line can be divided into the following categories according to de Rus Gines (2008):

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1. **User costs** – Regarding this category, the interest is focused on the difference of this kind of costs between the situation before and after the HSR line.
   a. Total time costs
      i. Access time
      ii. Egress time
      iii. Waiting time
      iv. Travel time
   b. Reliability
   c. Probability of accident
   d. Level of comfort

2. **Producer costs**
   a. Infrastructure cost
      i. Planning and land (land expropriations are quite costly)
      ii. Infrastructure building (ex. Terrain preparation and platform building)
      iii. Superstructure (this is the cost for the rail specific elements such as tracks and signaling system)
   b. Operating costs
      i. Infrastructure maintenance (ex. Cost of labor and energy consumed)
      ii. Operating costs (ex. Train operations, sales and administration)

3. **External costs**
   a. Construction costs (ex. Barrier effect and visual intrusion)
   b. Environmental costs (ex. Noise and air pollution, global warming effects)

Thus, in order to perform a BCA analysis, it is necessary to gather specific data sets. Since the procedure involves the measurement of benefits and costs associated with the investment, those are the data that need to be found. The costs of a HSR line in particular were presented above. Regarding the benefits of a HSR line and transportation investment in general, those were discussed in section 4.1. In summary, the *benefits* were categorized as the generative impacts, the redistributive impacts, and the financial transfer impacts.

As far as the measurement of benefits and costs is concerned, according to Ashford (1997) a matrix is usually formed of benefits and costs. This matrix describes benefits and costs and when those occur during the life of the project. Then, all of the above are transformed into monetary terms and discounted to the present value using the discount rate chosen. Finally, the net effect of the project, either benefit or loss, is calculated.

The popularity of BCA is due to several reasons, but there are also some disadvantages that should not be overlooked.
4.2.2 Advantages and disadvantages

BCA is among the best tools available in order to evaluate economic impacts and understand whether society will be better off economically with or without the considered project. It is highly desirable that all political considerations are put aside, as stated in the Transit Cooperative Research Program Report 35 (1998). In the same report, it is stated that when transportation demand models are used for forecasting cost changes, then travel-time based benefits are easy to measure.

Rietveld (in Bruinsma et al., 2008) notes that investment, maintenance, and operations costs can be easily found from data of analysis of previous similar projects. For “travel-time savings”, he says, it is not difficult to compare the times with and without the implication of the transport investment. Models are used to forecast demand of passengers and volumes of freight. He adds that the Value of Time for expressing “the value of shorter travel-times” into monetary values is very useful. “VOT differs according to modes, income classes, and other characteristics of travel and travelers”.

In general, with BCA the decision process of implementing a project is eased. The fact that everything is expressed in monetary values can help in finding large costs that can lead to the prevention of making “expensive mistakes”.68 On the other hand, there are some issues that have to be taken into consideration when a BCA is performed.

According to Ashford (1981), costs are easier to calculate than benefits, but the fact that they can be quantified does not mean that they are more certain. Also, he says that BCA needs assumptions to be made, and that leads to the “deceptive” belief that BCA is neutral, because the assumptions are made by the one who performs the analysis. In general, he believes that it is not a good evaluative method, since it does not tell explicitly who is benefiting and who is losing.

As mentioned in the Transit Cooperative Research Program Report 35 (1998), there is danger of misusing BCA. To be more specific, there is the possibility of “overstating benefits associated with a transit investment.” Redistributive impacts, which refers to spatial shifts of economic activities do not add to economic growth and might lead to “double-counting.” However, direct benefits, such travel time savings and reduced congestion, are “capitalized into land values” and cannot be omitted from BCA. There must be caution when measuring such benefits not to include them twice.69

Spatial boundaries should not be that tight, since impacts might occur outside the area of study. In addition, the opening year is very important, because only after that will benefits occur, and


also the time horizon should be long (20-30 years), because there are some long-term benefits that need time to be realized. Also, there are impacts and inequalities that cannot be measured in monetary values and thus cannot be captured by this kind of analysis. Lastly, CBA has to be accompanied with a transportation network model that will forecast travel-time savings. The use of such models is complicated and requires experience and technical skills.69

To close, the aim of performing BCA is to understand whether society is going to benefit from the actual project that is being studied. The question is whether the new infrastructure will contribute to economic growth and if the new service is going to be profitable for the managing entity, whether this is the government or a private company.

4.3 Multi-criteria analysis

As Vreeker (in Bruinsma et al., 2008) says, multi-criteria decision analysis (MCDA) is a family of methods that includes more than 100 ways of evaluating projects. They are mostly used to help decision makers to choose from a set of “different alternatives”. The advantage of MCDA is that it does not require all effects to be expressed in monetary units, as BCA does. In general, MCDA uses a set of criteria with a set of weights in order to reflect the preferences of the decision maker. Such methods are used in order to include multiple views of the problem and evaluate the influence of multiple criteria, both qualitative and quantitative. Vreeker says that there is no formal procedure for choosing criteria, but a long list of criteria and indicators can be formed so that the decision-maker can choose which are relevant and to what extent (decide the weights on each indicator and at the end express each of those in the same unit).

A positive aspect of MCDA is that it gives the decision-maker the freedom to choose between objectives and criteria and estimate the weights and contribution of each indicator. On the other hand, this introduces subjectivity to the process, and that can lead to questioning the final decision. Moreover, MCDA is incapable of showing whether a scenario is adding or not adding to welfare, unlike BCA.

The procedure of an MCDA is as follows:

1. "Identify the problem
2. Identify the alternatives
3. Identify the criteria
4. Score the alternatives in relation to each criterion
5. Weight the scores according to the weight
6. Evaluate alternatives
7. Produce a ranking of alternatives on which to make a recommendation.\textsuperscript{70}

It seems that BCA and MCDA complement each other. BCA takes into consideration all aspects that can be expressed in monetary values and shows whether the project will be profitable or not. MCDA introduces other parameters that are of the same importance. It considers aspects that cannot be expressed in money values and inserts them in the analysis, in order to help in the decision process. Moreover, it gives the freedom to the decision-maker to set the weights of each criterion, giving him/her the option of laying emphasis on specific issues whenever that is needed. For example, if the environmental impact is of great concern, then in MCDA, it can have a greater weight than other effects, helping the decision-maker to concentrate on this specific issue at the time he/she decides to.

4.4 Methods for evaluating regional and urban effects

Researchers have narrowed down their question about the effects of transportation investment and different models have been formulated. Most of those models, which are called travel demand models, are predictive and can be used to compare alternatives or measure the regional impact of a project. They can measure the change in the transportation system’s performance and/or predict changes in travel behavior, traffic volumes and travel-times.\textsuperscript{69}

One example is Elhorst and Oostehaven (2003), who have developed a commuter location model. Their model has been created to simulate residential location changes of commuters that are affected by transport improvements. Their results have an estimation error of 7%, justifying the accuracy of their model. Six rail connections between Amsterdam and Groningen were used to test the model. While developing their model, the objective was to accurately predict the actual spatial distribution of the working population. The assumption of the model is that all municipalities studied have the same commuting time distribution. The data they needed as input were:

1. Number of jobs per employment zone
2. Commuting times per mode
3. Zoning pattern and variance in travel times
4. Number of modes
5. Residential attractiveness

Elhorst and Oosterhaven suggest that this model could be used for any transportation improvement, both in the private and public sectors. It is not so data-intensive; thus it can be used more easily than other models in which the database needed might not always be available.

\textsuperscript{70} Methods of assessing the effectiveness of policies/measures, 2010, United Nations ESCAP, retrieved on January 19th 2010 from http://www.unescap.org/DRPAD/VC/orientation/M5_10.htm
Bruinsma and Rietveld (1993) have formulated a *simple gravity model*, with travel-time being the main parameter, which measures the accessibility of urban agglomerations (as mentioned above, they believe that transportation infrastructure constitutes an economic determinant of urban agglomeration). For that reason, they have studied the positioning of 42 European cities according to the rail, air, and road network that they have. The model is first applied to air traffic, then to rail, and then to road. According to the ranking of the cities, suggestions are made for the improvement of the existing networks. Specifically, for the rail network, a discussion of the scenario of HSR in the European Union is presented. Moreover, research was conducted on the aspect of the national borders as barriers to the road network. One of the main conclusions is that the level of rail inaccessibility is the highest and the level of road inaccessibility the lowest. Also, it is realized that the impacts of HSR will be greater in the issue of accessibility, in comparison to road and air improvements. Lastly, they discovered that the national borders will mostly serve as obstacles to agglomeration in smaller countries, thus the European Commission should consider this when deciding the transportation policies of the Union.

Specifically, for high speed rail urban and regional impacts, Sasaki et al. (1997) have formulated a *supply-oriented regional econometric model* in order to study the contribution of HSR to spatial dispersion of economic activities and population. Their research was focused on the Shinkansen network in Japan, for which five hypothetical scenarios were built. Their aim was to prove that HSR would contribute positively to the efficiency and attraction of the regions and would result in the allocation of private investment and population. The main idea of the model is that the regional investment function is based on a two-stage process as proposed by Crow (1979), in which national investment is initially determined and then is distributed among regions according to their relative efficiency and requirement for investment. The outline of their model is depicted in figure 4-7.
According to the model suggested by Sasaki et al. (1997), first accessibility of each region is calculated according to the length of the HSR line in each region. Then the distance between the centroids of the region and the rail line, and, last, the number of passengers using the line are calculated. Then several formulas were tested based on the data collected. The data referred to the period 1975-1986 and were:

a. Prefectural incomes
b. Private investments
c. Private capital stocks

Their conclusion is that if the Japanese network becomes denser, then some regional dispersion will occur, but this cannot “resolve the problem of agglomeration”. Also, they suggest that other factors, such as wage differences and the housing market that affect regional dispersion or concentration of population, should also be included, in order for the model to be more realistic.
Schneekloth and Broecker (2003), who are working in the IASON project that deals with the economic impacts of the TEN European transport investments and policies, have used the following models in order to evaluate the regional impacts of the infrastructure (referring to all modes) and the pricing policies:

1. "SASI model: a quasi production function model (developed in the SASI project for the 4th framework program of the European Union)

2. CGEurope model: a spatial computable general equilibrium model" (developed by Johann Broecker)

CGEurope is a “comparative static non-monetary spatial computable equilibrium model” in which the world is divided into 1373 regions. “Static” means that the comparison is performed with respect to the transport cost only, while keeping everything else constant. Each region is allocated with a number of households that try to maximize their utility and firms which produce and trade goods and are maximizing their profit.\(^7\)

The data needed are GDP, population, area characteristics, and trade flows in nominal values in Euros, which have been collected for the sake of this study from reliable European resources. Transport costs include specific characteristics of speed limit and likelihood of congestion and are composed of costs related to geographic distance (functions related to time and distance) and costs for overcoming impediments to international trade. The transfer costs of goods include both costs of freight and of personal contact for exchanging business information.\(^7\)

The way users choose a mode is calculated with a logit choice model. The scenarios were developed by the Institute of Spatial Planning of the University of Dortmund and were implemented with the use of GIS-based database available at the same Institute. Those assume a “with-world” version, in which the applied infrastructure or policy is applied and a “without-world” version.\(^7\)

The CGEurope model was also used by Vickerman (2006) in order to assess the wider economic impacts of HSR in the EU. He concluded that this model is very strong for measuring the impact of HSR links in the development of a complete network, but it is unable to capture the possible dynamic impacts which might result from the implementation of this network.\(^7\)

4.5 Input – output models

The Transit Cooperative Research Program Report 35 (1998) notes that input – output (I-O) models are used in order to enumerate inter-industry production and linkages that occur due to increased demand and consumption within a specific sector. I-O models are matrices, in which

\(^7\)Schneekloth and Broecker (2003)
the rows and the columns represent different industries. The cells describe the production-consumption relationship that exists between industries. Such models use regression equations in order to associate purchases of goods or services between industries. The inputs to these models are the amount of money spent in each industry in order “to construct, operate and maintain a new transit line.” The outputs of the model are estimations of the “direct, indirect and induced production” of each industry that results.

According to Lynch (2000), the three mostly used I-O models are:

1. Regional Input-Output Modeling System (RIMS II)

This model was developed by the U.S. Department of Commerce. It is used both for public and private sector projects and at all levels of analysis (national, state and local). For each industry, an I-O table shows the industrial distribution of inputs purchased and outputs sold. The advantages of this model are that multipliers can be estimated for any region and that the cost of calculating multipliers is relatively low. As far as its accuracy is concerned, it has been proved that the results produced aren’t greatly different in magnitude from the results of expensive surveys. Moreover, the model helps in avoiding aggregate errors and also has the ability of comparing results across areas. Last, multipliers are consistently updated in order to reflect the most recent local-area wage and salary and personal income data. The data input are industry category, year of expenditure and location and the output given are earnings, output (change in the dollar value of production) and jobs.

As Oster et al (1997) point out, the disadvantages of this model are the following:

- There is no estimation of the duration of the effects
- The aggregation of industries limits precision
- There are dimensions of economy that can’t be examined
- It is incapable of capturing effects of substantive changes that result in structural shifts of the regional economy

2. IMPLAN

This model was developed by the Minnesota IMPLAN Group, Inc. IMPLAN isn’t expensive and is more complex than RIMS II. The data in this model is build from top to bottom. National data serve as control totals to state data, who serve county data. The resources of employment and earnings data are County Business Patterns data and U.S. Bureau of Economic Analysis (BEA).

3. Regional Economic Modeling, Inc (REMI)

REMI is the most sophisticated and expensive model of the three. It is an integrated output-econometric model developed by Regional Economic Modeling, Inc. One can say
that this model is more than an econometric model. It is a tool that combines an input-output model with an econometric model and whenever the second is suppressed then REMI downgrades to an I-O model. The description of the model is really complex. In short, it consists of five basic blocks:

- Output
- Labor and capital demands
- Population and labor supply
- Wages, prices and profits
- Market shares

As far as input data is concerned, employment, income and output data is of greater importance. The sources that this model is using are BEA, ES-2 and County Business Patterns data published by the Bureau of the Census.

The produced output of the model is the relationships between industries and all characteristics related with them, such as production, wage rate changes, etc.

4.6 Banister and Berechman's method

Banister and Berechman (2008) suggest a twin approach for the appraisal of a transportation infrastructure project as follows:

a. "Traditional cost benefit analysis
   i. User transport benefits
   ii. Costs of investment
b. Complementary economic development analysis
   i. Network effects – accessibility analysis
   ii. Value added from project – changes in employment, factor productivity, environmental quality
   iii. Priority – spatial impacts in terms of location, social impact in terms of distribution"

The framework of their methodology is depicted in figure 4-8 and the scheme for evaluating the economic benefits of transportation investments in figure 4-9.

Two types of models are developed by Banister and Berechman; "production function" and "cost function" models. The main assumptions for the building of the models are that:

- Infrastructure capital expansions helps in the increase of efficiency and profitability of businesses
- The increase of efficiency of businesses stimulates investment in private capital
The problems faced with the use of the above models are numerous. First, they perform statistical analysis. Second, they assume that the level of capital stock is already efficient and that growth can occur only with additional investment. Third, they also assume that investment in stock leads to greater output and that is questionable. Specifically, for production function models, they omit input prices and place restrictions. The conclusion is that while using such models, attention should be paid to statistical misspecifications that might occur.

Figure 4 - 8: The basic causality paradigm of the relationships between transport infrastructure investment and economic development (source: Banister and Berechman (2000))
4.7 Available software packages in the market

There is a variety of software packages for evaluating the economic impact of transportation investments in the market. Some of those are discussed by Iacono and Levinson (2008) and are the following:

- "MicroBENCOST is a sketch planning tool that estimates basic benefits and costs for highway improvement projects and capacity additions"

- Sketch Planning Analysis Spreadsheets Model (SPASM) is a benefit-cost model designed for ‘screening’ level analysis. The outputs are project costs, cost-effectiveness, benefits and
energy and air quality impacts. It also allows the comparison of multiple modes and non-modal alternatives.

- **Surface Transportation Efficiency Analysis Model (STEAM)** is a planning-level extension of the SPASM software, which helps to design a fuller evaluation of cross-modal and demand management policies.

- **Spreadsheet Model for Induced Travel Estimation (SMITE)** is a sketch planning application which works with STEAM in order to account the effects of induced travel in traffic forecasting.

- **SCReening for ITS (SCRITS)** is a sketch planning tool used for rough estimates of ITS benefits.

- **Highway Economic Requirements System for states (HERS-ST)** is a model for economic impact evaluation of highway improvements.

- **Transportation Economic Development Impact System (TREDIS)** is a microeconomic simulation model that enables the economic development impact evaluation and benefit-cost analysis for a transportation investment (applicable for all modes). It can also be used for examining different scenarios. 

Those software tools are unable to capture the full range of impacts. To be more specific, none of those can be used by itself and assure that the whole range of impacts are studied. Depending on the package, different impacts are not considered.

The main conclusion of Iacono and Levinson is that although there is a variety of methods and models to be used, none of them should be used by itself, since all of them lack the ability to model all the effects of transportation investments. Thus, the solution is to choose, compare, and combine one or more methods according to the nature of the project that is to be evaluated.

### 4.8 Greek studies

In 1992, Tsamboulas et al. performed a study concerning the introduction of HSR services along the two main corridors (a. Athens-Thessaloniki, b. Athens-Patra) in Greece. The process they followed was threefold in order to assess the transport potential and the impacts, economic and others, of the investment. The analyses (figure 4-10) they performed were:

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72 Iacono and Levinson (2008)
1. "Financial, in order to assess the commercial viability at the level of the railway organization
2. Cost-benefit, in order to assess the merit of the project at the national economy level
3. Multi-criteria, in order to assess other aspects of the project"

Alternative scenarios were considered while performing this study. The scenarios, which all had different rate of flow for investment funds, were built according to:

a. The construction period (6 years, 9 years and 15 years)
b. Different pricing schemes (constant fares, double fares and triple fares)

For the forecasting process, many different econometric models were tested, but finally one was used for passengers and one for freight. The first assumed the relationship between passenger-kilometers and GDP and the second between ton-kilometers and GDP.
The general conclusion of the analysis was that rail-line traffic volumes would increase in the following decade and the share of the railways would expand. As far as HSR was concerned, they resulted in the conclusion that it would be commercially viable and would help in the alleviation of the deficits that the Greek railway had.

In addition, Profillidis and Bontzoris (2005) have developed three econometric models for forecasting passenger demand in Greece. One is for estimating the total demand, the second for rail, and the third for private car demand. Before developing the models, analysis of the market share of each transport mode was done. The parameters that were found to be crucial were the car ownership and cost of fuel for the market share of private cars and the car ownership, GDP, rail fares, fares of competitive modes, and travel-time for the market share of railways and buses. The dependent variable was the number of passenger-kilometers. The independent variables for each model were:

**Model 1** (total demand): GDP and cost of fuel ($C_{fuel}$)

**Model 2** (demand for private cars): Private car ownership index ($I_{co}$) and cost of fuel

**Model 3** (demand for rail):  Cost of fuel, private car ownership index, rail use cost per pass.-km ($C_r$), competition expressed as the cost of using bus instead of rail ($C_{br}$) and a time lag dependent variable that represents habitual inertia and constrains on supply ($D_{rail(-1)}$)

The final models were tested with eleven statistical and diagnostic tests and were finalized with the study of elasticities of independent variables. The final models are:

1. \( \ln D_{tot} = 1,667 \times \ln GDP - 0,877 \times \ln C_{fuel} + 0,991 \)
2. \( \ln D_{car} = 0,691 \times \ln I_{co} - 0,066 \times \ln C_{fuel} + 1,723 \)
3. \( \ln D_{rail} = -0,192 \times \ln C_r - 0,078 \times \ln I_{co} + 0,111 \times \ln C_{br} + 0,109 \times \ln GDP + 0,766 \times \ln D_{rail(-1)} + 1,273 \)

The most recent study that was carried out in Greece was by the consulting firm of GLOBAL VIEW S.A. The Intermediate Managing Authority of the Ministry of Transportation and Telecommunications signed a contract with this company for consultation for the execution of the Cost-Benefit Analysis of the major railway projects that are going to be included in the 4th Programming Period 2007-2013. The scope of this analysis includes the following parts of the major railway line:

- “Tirothea-Domokos
- Piraeus-Three Bridges
- SKA (Athens railway station)-Aigio”
4.9 Suggested method for Greece

After reviewing the Greek context and the literature on evaluating impacts of transportation investments, the following step-by-step methodology (see figure 4-11) is proposed to be used in Greece for assessing the socio-economic impacts of a transportation project:

1. Current situation assessment:

Before applying any ex ante method for studying the possible positive and/or negative aspects of a transportation investment, analysis of the current situation should be done. This first analysis should refer to the whole transportation network and not only to the network of study. Thus, a general view of the situation at the moment will be acquired and it would help into realizing whether investment on a specific network is needed. After observing the needs of each network, then the network of interest should be analyzed in more depth. It should be examined whether an improvement or expansion is required. Both of the above analysis will help into understanding the actual needs of each network, guide to the area of focus and contribute in preventing unnecessary spending of money.

The above analysis could be done by evaluating the condition of the networks and the level of services offered. Also, it is important to perform an analysis of the mode shares in order to examine the current trends. Last, it would be very helpful to find whether the capacity of the network covers the demand and if not what is the essential need. This kind of data should be kept both from the Ministry of Transport and Communication and the responsible agencies in charge. Some of the data can also be found in the National Statistical Service of Greece.

At this point, it would be very helpful to assess the situation of the economy of the country regarding economic growth and public debts. It is important to know the course of the country’s economy during the last years and understand whether the government is able to support a transportation investment or not.

2. Building of scenarios:

Alternatives should be tested when considering a transportation investment. In the previous step, the needs of each network will be realized. If this leads to the realization that improvements are needed to the rail network for example, then the different scenarios should consider different paths of lines or concentration on different existing links. If the previous step leads to the conclusion that there are needs in both the highway and railway networks, then the different scenarios should include different alternatives regarding both networks. A scenario might be investing on one network only; another could be to invest on both; another to concentrate on the rail link of two cities etc. The building of multiple scenarios will contribute in the evaluation process by
comparing the results from the analysis of each scenario and decide which will be the most beneficial for the country.

3. Benefit-Cost Analysis:

As performed in most cases of transportation investments around the world, the same should be done in Greece. The literature shows that this kind of analysis is pretty good for evaluating the benefits and costs of a project. All aspects that can be measured in monetary values should be included and evaluated. The data needed for this analysis are the benefits (presented in section 4.1) and costs (presented in section 4.2.1) associated with the investment. As far as the process of this analysis is concerned, it has been discussed in section 4.2.1.

4. Multi-Criteria Analysis:

The previous analysis can't capture all aspects affected by an investment. Thus, multi-criteria analysis should also be performed in order to capture non-monetary attributes. The main advantage of this method is that the analyst can decide the weight of each attribute. So, if there is an aspect on which greater emphasis should be given or needs special treatment, there is the option of assigning a greater weight to it. The process of this analysis is discussed in section 4.3.

5. CGEurope model:

Since Greece is part of the European Union, the aspect of cohesion and enhanced mobility in the Union should always be considered when deciding about investing on a transportation project. This model has been built according to the European characteristics, so it would be appropriate to use it for testing the project considered, in order to forecast the equilibrium that will result after its implementation. A small change that could be introduced to the model is addressed to passengers' mode. The equations produced by Profilidis and Bontzoris (2005), which were discussed in section 4.8, could be inserted for the mode choice within the state of Greece, since those were justified to be trustworthy for the Greek standards.

6. Banister and Berechman's approach

Greece is a developed country and according to Banister and Berechman, a transportation investment can't trigger economic growth by itself to such a country. As mentioned before, positive economic externalities and political factors should co-exist for greater economic development to occur. For that reason, while deciding about implementing an investment, policies that support it should also be studied.
4.10 Summary

The current chapter was concerned with the benefits that a transportation investment and specifically HSR have on the society and the economy. Many kinds of benefits were discussed at the outset as well as the opinions of different researchers on the subject. Then, different methods, approaches, and tools for evaluating the socio-economic impacts were analyzed. The advantages and disadvantages of most were also noted. An overview of the research conducted on the Greek framework followed.

All the above, led to the suggestion of a method that can be used in Greece. This method could be adopted for the ex ante evaluation of a project, with the objective of covering as many impacted aspects as possible.

In the next chapter, the country of Portugal will be presented including a comparison between Portugal and Greece. The two countries will be used as a basis for the formation of a screening model for High Speed Rail, which will follow. Details about this model will be provided in section 5.3.
Chapter 5: A Screening Model for High Speed Rail

This chapter includes the presentation of a screening model for High Speed Rail. The objective is to construct a model for understanding whether a country should start considering building a HSR network or not. The characteristics of the countries of Greece and Portugal will be used for the formation of this model. They will also serve as examples of its application. Thus, the reader will be able to understand the use of the model more easily.

Before exercising the model, the country of Portugal will be presented. The choice of Portugal for comparing and contrasting with Greece was not random. The fact that these countries constitute the two southern edges of Europe (Turkey not included) and the European Union, Greece on the east and Portugal on the west, along with their similar geographical size stimulated the interest of comparing them. Moreover, we are interested into seeing which of the two countries is ahead in the issue of HSR and if Portugal is, then what Greece can learn from the Portuguese experience in also to go forward as well.

5.1 The country of Portugal

The idea was born after a series of discussions between the author and her thesis advisor. A large incentive was the MIT Portugal project. This is a large research project about Portugal, part of which concerns the Portuguese transportation sector, including the plans for HSR.

5.1.1 Overview

Portugal is located in the southwestern part of Europe on the Iberian Peninsula. On the west the country borders the Atlantic Ocean and on the east with the country of Spain. Two blocks of islands in the Atlantic archipelagos, the Azores and Madeira are also part of Portugal, but they are autonomous regions. The area of the country is 92,090km² and the capital is Lisbon, which is the biggest city of the country and is located on the southwest coast.

"Portugal is a developed country" that entered the European Union in 1986 and is also a member of the Eurozone (this is the euro area that includes the EU countries, which are using the euro as their currency). Moreover, it is part of the Latin Union, the Organization of Ibero-American States, the Organization of Economic Co-operation and Development, NATO, the Community of Portuguese Language Countries and the Schengen accord. Portugal ranked 19th

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worldwide, with respect to the quality of life it offers, according to the Economist Intelligence Unit.

Figure 5-1: Map of Portugal (source: www.lonelyplanet.com)

DEMOGRAPHICS

According to the measures of the Instituto Nacional de Estatística (Portugal’s official bureau of statistics) of the 2001 census, the population was 10,355,824, 52% of which was female and 48% was male. In 2007, the population had increased to 10,617,575 with a total of 332,137 legal immigrants. The estimation for 2009 is that the population equals 10,707,924. This country is quite popular for immigrants and not only for Indians, Africans and Far East Asian people, but also Ukrainians, Brazilians and people from the former Portuguese colonies of Africa (those are Angola, Cape Verde, Guinea Bissau, Mozambique and Sao Tome and Principe). It is important to note that the British community is quite large, and it is composed mostly of retired pensioners who choose to live in the Algrave and Madeira after their retirement.

The most populated cities of the country are Lisbon, the capital, Porto, the second largest and Coimbra. Also, Portugal has seven large metropolitan areas, “Algarve, Aveiro, Coimbra, Lisbon, Minho, Porto and Viseu” (see table 5-1).

From the administrative point of view, Portugal is divided into 308 municipalities, which are subdivided into about 4,000 parishes (Portuguese word: frequesias). The municipalities are grouped into 18 districts (see table 5-2).
Figure 5 - 2: Map of districts of Portugal (source: http://en.wikipedia.org/wiki/Portugal)

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Subregion</th>
<th>Population</th>
<th>City name</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.M.A. of Lisbon</td>
<td>Grande Lisboa</td>
<td>2,003,580</td>
<td>Lisbon</td>
<td>564,657</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amadora</td>
<td>175,872</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Almada</td>
<td>101,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Setubal</td>
<td>89,303</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Agualva-Cacem</td>
<td>81,845</td>
</tr>
<tr>
<td>G.M.A. of Porto</td>
<td>Grande Porto</td>
<td>1,572,176</td>
<td>Porto</td>
<td>263,131</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amandora</td>
<td>175,872</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vila Nova de Gaia</td>
<td>178,255</td>
</tr>
<tr>
<td>G.M.A. of Minho</td>
<td>Cavado</td>
<td>404,681</td>
<td>Braga</td>
<td>109,460</td>
</tr>
<tr>
<td>G.M.A. of Coimbra</td>
<td>Baixo Mondego</td>
<td>340,342</td>
<td>Coimbra</td>
<td>101,069</td>
</tr>
</tbody>
</table>

Table 5 - 1: Characteristics of some of the Great Metropolitan Areas of Portugal (source: http://en.wikipedia.org/wiki/Portugal)
<table>
<thead>
<tr>
<th>District</th>
<th>Area (in km²)</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisbon</td>
<td>2,761</td>
<td>2,124,426</td>
</tr>
<tr>
<td>Leiria</td>
<td>3,517</td>
<td>477,967</td>
</tr>
<tr>
<td>Santarem</td>
<td>6,747</td>
<td>445,599</td>
</tr>
<tr>
<td>Setubal</td>
<td>5,064</td>
<td>815,858</td>
</tr>
<tr>
<td>Beja</td>
<td>10,225</td>
<td>154,325</td>
</tr>
<tr>
<td>Faro</td>
<td>4,960</td>
<td>421,528</td>
</tr>
<tr>
<td>Evora</td>
<td>7,393</td>
<td>170,535</td>
</tr>
<tr>
<td>Portalegre</td>
<td>6,065</td>
<td>119,543</td>
</tr>
<tr>
<td>Castelo Branco</td>
<td>6,675</td>
<td>208,069</td>
</tr>
<tr>
<td>Guarda</td>
<td>5,518</td>
<td>173,831</td>
</tr>
<tr>
<td>Coimbra</td>
<td>3,947</td>
<td>436,056</td>
</tr>
<tr>
<td>Aveiro</td>
<td>2,808</td>
<td>752,867</td>
</tr>
<tr>
<td>Viseu</td>
<td>5,007</td>
<td>394,844</td>
</tr>
<tr>
<td>Braganca</td>
<td>6,608</td>
<td>148,808</td>
</tr>
<tr>
<td>Vila Real</td>
<td>4,328</td>
<td>218,935</td>
</tr>
<tr>
<td>Porto</td>
<td>2,395</td>
<td>1,867,986</td>
</tr>
<tr>
<td>Braganca</td>
<td>2,673</td>
<td>879,918</td>
</tr>
<tr>
<td>Viana do Castelo</td>
<td>2,255</td>
<td>252,011</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autonomous regions</th>
<th>Area (in km²)</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azores</td>
<td>2,333</td>
<td>243,101</td>
</tr>
<tr>
<td>Madeira</td>
<td>801</td>
<td>244,098</td>
</tr>
<tr>
<td>Total</td>
<td>92,090</td>
<td>10,355,824</td>
</tr>
</tbody>
</table>

Table 5 - 2: Characteristics of Portuguese districts (source: http://en.wikipedia.org/wiki/Portugal)

ECONOMY

The Portuguese industry used to be quite traditional and produced textiles, clothing, cork, wood products and beverage. The economic model of the country was mostly focused on public investments. Currently this has changed and the economy is quite diversified and service-based; businesses have grown and the traditional industries have lost their power. The country’s economy is based on exports, private investment and the development of the high-tech sector. This change took place after the introduction of Portugal to the European Union. The EU contributed to the development and improvement of the infrastructure by providing the country with financial support.

Lisbon and Porto are the biggest economic centers of the country, with Aveiro, Braga, Coimbra and Leiria to follow. Portugal is a very popular destination for tourists, since it offers many different attractions. Thus, the tourism sector is quite important for the country’s economy. Moreover, because of the geographical position, Portugal has a strong tradition in the fisheries sector. It is one of the countries in the world with the highest fish consumption per capita.

The GDP of the country is $22,232 per capita, the lowest per capita GDP in Western Europe. When, the country joined the European Union, the economic stimulus was great but during the last years Portugal has fallen back. The biggest obstacle to growth is the poor education system. However, the current Prime Minister, Jose Socrates, is quite aggressive and makes a lot of effort in order to improve the educational sector of Portugal. There are many attempts for improving the higher educational level system (universities) and also for investing more in research programs (this can be justified with the collaboration that Portugal has with MIT and the existence of the MIT Portugal Program).

In spring 2007, Portugal’s economy was studied because of its very poor performance and it was characterized as “a new sick man of Europe of Europe” by The Economist. The long-term credit assessment of the country is “negative” and that shows the country’s weak economy and competitiveness. This bad situation is also due to the corruption of the economic sector, which is a big issue in Portugal. The government is making attempts for boosting the economy and also to keep the deficit within the EU limit of 3% of the GDP of the country.

LABOR

The unemployment of Portugal is 7.6% of the total labor force, which according to the estimation of 2008 it was 5.625 million. The level of unemployment is a 23-year record high. Almost 60,000 people with an academic degree, which accounts for the 8% of the total number of people with an academic degree, are unemployed. According to Portugal’s purchasing power (“this is the number of goods/services that can be purchased with a unit of currency”), the country has the 9th place in the list of the poorest countries of the European Union. Also, according to the last European survey of workers conducted in 2007 placed Portugal in the 5th place on the list with the lower quality of work. This shows the dissatisfaction of the people in relation with the working conditions they are facing daily.

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GOVERNMENT

Portugal is a democratic republic. The way to democracy started in April 1974, when a revolution was performed against the dictatorship of Antonio de Oliveira Salazar, who was leading the dictatorship of the country since 1926. Nowadays, the main components of the government are the President of the Republic, the Assembly of the Republic (the parliament), the Council of Ministers (the government), and the courts. The divisions of powers are divided into three branches, the legislative, the executive and the judicial.

The executive branch is comprised by the President, the Prime Minister and the Council of Ministers. The President is elected every five years and is also the chief of the army. His consulting body is the Council of State. The Prime Minister is the head of the government and is also the one that appoints the Council of Ministers.

5.1.2 Transportation

Transportation has been a priority for the Portuguese since the early 1970s. The country has 82,900km network of roads, of which 71,294km are paved and the rest are unpaved. From the paved part of the network, 2,300km have been categorized as expressways. Portugal was among the first counties that built expressways, with the first opening in 1944.

Brisa, a company founded in 1972, is an international transportation company based in Portugal. Brisa’s largest business is highway management and constitutes the largest concessionaire of the country. Brisa was the company to win the bid for the construction of the high speed rail line between Lisbon and Madrid.

The country has 65 airports, 43 of which are paved and 22 unpaved. The international ones are located in Lisbon, Porto and Faro. To continue, because of its big coastline and great history in the fishery sector, Portugal has many seaports, with the major ones being located in Leixoes, Aveiro, Figueira da Foz, Lisbon, Setubal, Sines and Faro.

As far as the rail network is concerned, it was introduced in Portugal over a century ago. Both big cities, Lisbon and Porto have subway systems; Lisbon Metro and Metro Sul do Tejo in the Greater Metropolitan Area of Lisbon and the Porto Metro in the Greater Metropolitan Area of Porto, both of which have more than 35km (22mi) of lines. A tram network is built in the city of Porto, as a tourist line on the shores of Douro (name of the shore line), since 1895. This was the first tram network in the Iberian Peninsula.

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The total length of the rail lines for both passengers and goods is 2,791km (1,734mi), of which 1,430km (889mi) are electrified and 900km (559mi) allow trains to reach high speeds (more details about High Speed Rail in Portugal are given in the next section, section 5.1.3) of greater than 120km/h (75mi/hr). The management company of the rail network is REFER and the responsibility of the operation has Caminhos de Ferro Portugueses (CP), both of which are publicly owned.73

The rail network is divided into four categories (see Appendix III for a rail map of Portugal):

1. The Alfa Pendular network which constitutes the current high speed rail network of the country and is 314km long
2. The inter-city network
3. The inter-regional network and
4. The regional network

5.1.3 High Speed Rail78

The companies that are involved with the network of High Speed Rail in Portugal are REFER, RAVE and AVEP. The first is responsible for the management of the infrastructure of the railway system of the country. The second has been created in order to control all issues related with the development of the High Speed Rail network. The involvement of REFER is indirect, first because of its mission, which is to manage the infrastructure of the railway of Portugal, and second, because it owns 40% of RAVE. The remaining share of the company, 60%, belongs to the state of Portugal. AVEP is a European Economic Interest Grouping company, which is comprised by RAVE and ADIF and is responsible for conducting the studies for the connection of Madrid-Lisbon-Porto and Porto-Vigo. ADIF is the Spanish organization responsible for the construction and maintenance of the Spanish High Speed Rail lines.

REFER is in charge of the development and co-ordination of all studies and projects that are related with the planning, financing, provision and operation of the HSR network in Portugal and the connection of it with the HSR network of Spain. The objectives of the creation of HSR in Portugal are the same as most transportation investments. These are the following:

- Reinforcement of integration of the country
- Acceleration of economic and technological development; creation of new employment
- Promotion of "a modern, sustainable and efficient transport system"78

- Expansion of mobility and increase of competitiveness of "the port, airport and logistics networks"\textsuperscript{78}
- Increase of rail attractiveness towards a balanced distribution of mode demand, both for passengers and goods
- Development of a competitive network

The network will be proposed by five routes (see figures 5-3, 5-4). Three of them, Lisbon-Madrid, Lisbon-Porto and Porto-Vigo have been studied and a schedule for their construction has already been set. The other two routes, Aveiro-Salamanca and Evora-Faro/Huelva, "are still being studied"\textsuperscript{78}.

All of the above are studies that have been performed and plans that are going to be followed in the future. To be more specific, from the planning point of view, Portugal is working hard and has made a lot of progress, but as far as construction is concerned, nothing has started yet. So, there more yet to be done.

![High Speed Rail map of Portugal](http://www.rave.pt/tabid/189/Default.aspx)
5.2 Comparison of Greece and Portugal

From the overview of the two countries that has already been presented, Greece in chapter 2 and Portugal in section 5.1, it seems that they have a lot in common. First, their geographical position is almost the same; great part of their perimeter borders on water. Greece juts into the Mediterranean Sea and the coastline of Portugal is on the Atlantic Ocean. This has led to the great development of the shipping sector in Greece and the fishery sector in Portugal.

The size of the two countries is also similar (Greece's area is 131,990 sq km and Portugal's is 92,090 sq km), with Greece being larger by about 40,000 sq km, which is almost equal to the size of Athens. Both countries have a number of islands as part of them, but the difference is that in Portugal the complexes of islands of Azores and Madeira are autonomous. The size of the population of the two countries is almost the same as well. Although, Greece is bigger by 40,000 sq km, its population exceeds the population of Portugal by 608,196, according to the census conducted in both countries in 2001 (Greek population: 10,964,020, Portuguese population: 10,355,824).

Another similarity is that both countries have two cities that most part of the population is living. In Greece there is Athens and Thessaloniki, where almost 44% of the total population is gathered, and in Portugal there is Lisbon and Porto, where almost 40% of the total population is gathers. Athens and Thessaloniki have a distance of 500 km and Lisbon and Porto 300 km. Regarding economic rivalry, it is true that in both cases competition exists. The two capitals of
the countries (Athens and Lisbon) are the cities on lead, but the second biggest cities (Thessaloniki and Porto) are making great efforts into performing better than the capitals.

As far as the administrative divisions of the two countries are concerned, those are almost the same as well. Portugal is divided into districts, municipalities and parishes and Greece is divided into regions, prefectures and municipalities. The same similarity exists in the political system. Greece has presidential parliamentary republic and Portugal has democratic republic. The authorities of the two countries are exactly the same with the President of the Republic being at the top of the hierarchy, who is governing along with the parliament and the Ministries. Moreover, it is quite astonishing that for both countries’ democratic constitution, the critical year was 1974. In Portugal that was when dictatorship fell after a great revolution and in Greece that was the year that the military junta fell.

Regarding the transportation systems of the two countries, there are some differences. First, the subway system is better developed in Portugal. Both big cities of the country, Lisbon and Porto, have a subway network, in contradiction to Greece, where only in Athens there is such a network developed. However, Lisbon’s underground rail network is much older than Athens’. The operation of the Athens Metro began in 2000, whereas in Lisbon it has been operating since 1955. The second biggest cities of the countries present the difference in this area. In Porto, the subway network operates since 2002, whereas in Thessaloniki it is currently under construction.

Second, difference exists regarding the High Speed Rail sector. It has to be noted that in Portugal the organization is much better and plans are much more advanced. The fact that there has been a company founded, in order to be fully responsible for all issues related with HSR, shows the difference. In Greece, the same company that manages the operation of the regular rail will also manage the HSR and the same holds for the company that handles the infrastructure investments.

To finish with the comparison, the two countries have many similarities and some differences. As far as the topic of this thesis is concerned, HSR, Portugal has given greater emphasis and has put more effort into this kind of mode. Greece is behind in comparison with Portugal, although it is true that there are attempts of improvement.

It would be really interesting to find out why Portugal is ahead of Greece on the area of HSR. This difference is quite strange if we take into consideration that the GDP of Portugal is lower than the one of Greece. That shows the importance of other factors that probably support the idea of HSR in a stronger way. But which are those factors?
First, it might be the economic situation of the neighboring countries. Portugal borders with Spain, the GDP of which is $30,588 per capita (higher than the GDP of Portugal).\(^7^9\) According to the World Bank, Spain has the fifth largest economy among EU members. Also, the HSR network is already developed in this country. On the other hand, Greece is bordering with Albania, F.Y.R.O.M., Bulgaria and Turkey. Besides Bulgaria, the other countries are not members of the European Union. This fact is vital, since the desire of integration between the non-EU countries doesn’t exist.

To continue, Bulgaria has a GDP of $11,760 per capita, which is much lower than the Greek GDP ($32,105) and shows the smaller power of the country in comparison to Greece. Regarding the HSR network in Bulgaria, it is currently being developed. The difference that Portugal is bordering with Spain, which is more powerful than Portugal and Greece is bordering with Bulgaria, which isn’t as powerful as Greece, is likely important for the development of HSR.

Second, the distance of the country from the core of the Union, where the strong economies exist, might be of great importance. Portugal is closer to France and Germany than Greece is. Maybe the fact that there are some countries between the major economies of Europe and Greece that are not part of the Union also contribute in the slowest development of the HSR network in the country.

The amount of money spent from the TEN-T Executive Agency can certainly justify why Portugal is in the lead. To begin, the financial support to the country of Portugal is much bigger than that to Greece. Portugal is funded with the amount of €616,286,000 and Greece with the amount of €58,420,000. It is also worth it to mention that from those totals, €608,110,000 is allocated to the development of the Portugal HSR network and €6,500,000 to the Greek one.\(^8^0\) This huge difference of financial support is definitely a reason that help Portugal be ahead of Greece. But, in addition to the relationship with the European Union, there are likely domestic factors that affect HSR development in the two countries.

The situation of the networks of the other modes contributes in the urgency and pace of the HSR network development. The level of congestion in each modal network and the competitiveness that exist with railways are important factors. There is the possibility that the highway, rail and air congestion in Portugal forces the development of HSR in order to alleviate

\(^7^9\) International Monetary Funds, 2009, *World Economic Outlook Database – October 2009*, retrieved on January 17th 2010 from http://www.imf.org/external/pubs/ft/weo/2009/02/weorept.aspx?sy=2006&ey=2009&sscsm=1&amp;ssd=1&amp;sort=country&amp;ds=.&amp;br=1&amp;c=184&amp;s=NGDPD,NGDPDPC,PPPGDP,PPPPC,LP&amp;grp=0&amp;a=&amp;r.x=33&amp;r.y=6

\(^8^0\) European Commission TEN-T Executive Agency, 2009, retrieved on January 17th 2009 from tentea.ec.europa.eu
the situation. The airport in Lisbon is the one that is very congested in Portugal, and maybe this problem has led to the progress that Portugal has made on the planning of the HSR network.

Last, it might be the different economic development models that the two countries have adopted. Portugal is changing rapidly. Great emphasis is given in the development of the high-tech sector and the MIT Portugal Project reveals the interests of the country. Greece on the other hand, focuses mostly on the shipping industry and the tourism. Those two industries are the major ones in the country. The Greek maritime fleet is the largest in the world and the tourism sector, not only accounts for a big share of the country’s GDP, but also employs big part of the total Greek workforce (16.5% of the total). Thus, HSR is further promoted in Portugal, than in Greece, where other sectors have priority for investment.

5.3 Screening model of High Speed Rail

In this section, a screening model of High Speed Rail is proposed. This model aims to be used in countries with similar size characteristics to Greece, in order to judge whether it is worth it to start thinking about constructing a HSR network or not. A number of parameters that are vital and related to the development of High Speed Rail according to the author’s judgement will be presented. The model will be in the form of a matrix and the countries that will serve as examples will be Greece and Portugal.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Greece</th>
<th>Portugal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Area size</td>
<td>131,934 sq km</td>
<td>92,090 sq km</td>
</tr>
<tr>
<td>2 Population</td>
<td>10,964,020</td>
<td>10,355,824</td>
</tr>
<tr>
<td>3 GDP per capita</td>
<td>$32,105</td>
<td>$22,232</td>
</tr>
<tr>
<td>4 Modal split of passenger transport&lt;sup&gt;61&lt;/sup&gt;</td>
<td>car-77%, bus-21%, rail-2%</td>
<td>car-84%, bus-11.5%, rail-4.5%</td>
</tr>
<tr>
<td>5 Rail network condition</td>
<td>poor</td>
<td>TBD</td>
</tr>
<tr>
<td>6 Rail attractiveness</td>
<td>poor</td>
<td>TBD</td>
</tr>
<tr>
<td>7 Monocentric cities</td>
<td>yes (2)</td>
<td>yes (2)</td>
</tr>
<tr>
<td>8 Distance between monocentric cities</td>
<td>504 km (Athens - Thessaloniki)</td>
<td>300km (Lisbon - Porto)</td>
</tr>
<tr>
<td>9 Percent of total population in monocentric cities</td>
<td>Athens-33% Thessaloniki-10%</td>
<td>Lisbon-26% Porto-16.5%</td>
</tr>
<tr>
<td>10 Percent of rail trips between monocentric cities</td>
<td>80%</td>
<td>TBD</td>
</tr>
<tr>
<td>11 Modal split of passenger transport between monocentric cities</td>
<td>car-TBD, bus-TBD, rail-13%</td>
<td>TBD</td>
</tr>
<tr>
<td>12 Percent of business traveling between monocentric cities</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>13 Percent of rail trips having either one of monocentric cities as an origin or destination</td>
<td>30.75%&lt;sup&gt;82&lt;/sup&gt;</td>
<td>TBD</td>
</tr>
<tr>
<td>14 Sources of funding</td>
<td>National and EU</td>
<td>National and EU</td>
</tr>
<tr>
<td>15 Amount of money coming from sources other than national</td>
<td>not much</td>
<td>a lot</td>
</tr>
<tr>
<td>16 Rail connection with neighboring countries</td>
<td>yes (Bulgaria and Turkey)</td>
<td>yes (Spain)</td>
</tr>
<tr>
<td>17 Economy of neighboring countries</td>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>18 Existence of HSR network in neighboring country</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>19 Share of rail trips that have international destinations</td>
<td>4%</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Table 5 - 3: Screening model of High Speed Rail

<sup>61</sup> Cells are filled according to 2007 data retrieved from the electronic database of European Commission on January 17<sup>th</sup> 2010, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

<sup>82</sup> Executive summary of BCA of parts of the main rail corridor, done by GLOBAL VIEW S.A., September 2009
The size, the population and GDP are used as indicators in order to show what kind of countries can use this screening model. As far as the modal split of passenger transport is concerned, it refers to the percentage of the each mode’s trips out of the total number of trips that are being done in the country. According to the percentage of its network, a bigger picture of the each network’s situation can be seen. These numbers can help into understanding the existing trends and preferences of the population. Regarding the rail mode percentage, if it is low, then the construction of HSR might increase it.

As far as the condition of the rail network is concerned, it is important to know which is the situation are the moment of the study. If it needs improvements, then HSR should be considered, since an investment will be made anyway. Also, if the attractiveness of the network is poor then it might be possible that an upgrade could boost it up. If the attractiveness is already high, then congestion might exist and the consideration of HSR could also help alleviate the problem.

The existence of monocentric cities, along with some parameters that will be explained here, might urge to the serious consideration of HSR. First, monocentric cities usually create a great number of business travelers who might be better served if HSR is offered. Thus, the percent of business traveling between those cities is important. The distance between monocentric cities is also critical because it shows whether it is worth it to consider constructing a high speed line. The distances that the monocentric cities have in the countries of Greece (504km) and Portugal (300km) are enough to justify the construction of a high speed line.

Moreover, the modal split of passenger transport between monocentric cities is critical in order to understand the current preference of business travelers, investigate whether there exist congestion problems and if HSR will contribute into improving the current situation. This parameter is referring to the mode shares for the origin-destination pairs of Athens-Thessaloniki for Greece and Lisbon-Porto for Portugal; thus from the total number of trips being held between those cities, which are the percentages of each mode. Last, the percent of the rail trips which either originate or have one of the monocentric cities of the country as destination is also a good parameter for HSR. This number might lead to the consideration of more HSR lines, other than the one between the monocentric cities.

Specifically for the rail mode share between monocentric cities, it is a good indicator for HSR connection between them, because if it is high, then why not increase it even more (the desire of increase the rail share originates from its benefit of being environmentally friendly when compared to the rest of the modes) and if it is low, then why not improve the situation and make rail attractive. Regarding the air mode shares between monocentric cities if it is higher than the rail share, then the construction of a HSR line might increase the mode share of rail.

The sources of funding is another important factor, since both the construction and maintenance of HSR is very expensive. If a country has many sources outside of the national ones, then the
construction of such an expensive network is more easily achievable. However, the amount of money from sources other than the national is very important. The financial support that a country has is crucial, because it is very helpful when the level of this support is high. In more detail, the fact that the European Union is giving €616,286,000 to Portugal for the construction of HSR specifically is vital for the realization of the project.

The data of whether there is already rail connection of the country with the neighboring ones is also vital, because if there is then along with the percent of the rail trips that have international destinations, HSR might increase this number, thus contributing to the increase of tourism and business relationships as well. On the other hand, if there isn't any rail connection with the neighboring countries, then depending on the relationship that exists, HSR might be a good idea. In the case of Greece, although the percent is small, the importance of integration of all Member States of the EU was a factor that triggered the development of HSR.

Last, the economies of the neighboring countries and the existence of HSR networks in those countries are useful parameters. In the case of Portugal, the bordering with Spain contributed in the development of the idea of HSR. Spain is a powerful economy and has HSR already. This has motivated Portugal to also work towards the application of such a network.

5.4 Summary

This chapter started with the presentation of the country of Portugal. Then, a comparison between Portugal and Greece was performed. The two countries were used as a basis for the formation of the screening model for High Speed Rail, which has been presented and explained in the previous section. The conclusions of this thesis will follow in the next chapter.
Chapter 6: Conclusions

6.1 Summary of findings

This thesis begins with an introduction to the mode of High Speed Rail, a mode that is environmentally-friendly and energy-efficient in comparison to other modes. Its great benefits result from the fact that it not only emits lower levels of pollutants, but also has caused a shifting of modes that is noted in countries that have such a network. As the proportion of more polluting modes decrease, so does the level of pollution.

A profile of Greece was then presented including a discussion of the history, characteristics, authorities, and the transportation sector of the country. Although the country is relatively small geographically, its history dates from Paleolithic times. Its geographical position has helped in the extensive development of the shipping industry, which accounts for 4.5% of the national Gross Domestic Product. In addition, the tourism industry is very important for the country and employs 16.5% of the total workforce. As far as its economy is concerned, Greece is facing problems with large debts and is closely monitored by the European Union because of its performance does not meet the EU benchmarks. However, attempts are being made in order to alleviate the problem, stimulate the economy, and reduce the budget deficit.

The development of the Greek Public Transportation (PT) systems shows the dominance of the two largest cities of Greece, Athens and Thessaloniki. The power and importance of the two cities is also reflected in the hierarchy of the governance of Greek Transportation: there are two separate agencies responsible for the transportation systems of Athens and Thessaloniki respectively, and the rest of the country is handled by a third. The development of PT systems in Athens, which is the capital, is much better than that of Thessaloniki. Athens is served by regular, thermal and trolley buses, tram and metro, whereas Thessaloniki is only served by regular buses. An underground rail network is currently under construction in Thessaloniki. Moreover, Athens is also connected with its suburbs via railway, a network that does not exist in the greater metropolitan area of Thessaloniki. Regarding the intercity urban transportation, two services are available, either buses, run by a company named KTEL, or trains, which are managed by OSE, the Hellenic Railways Organization.

In this context, it was noted that in early October 2009 elections were held, and the socialist party of PASOK came into power replacing the center-right party, New Democracy. Both parties have expressed support for the issues involved in investment in transportation and have promised actions in order to tackle them. Public-private partnerships are also very important, and although they have been used in the past, the new government desires to change the selection procedures for public works projects, since it claims that there was a great deal of corruption in the process. Moreover, PASOK plans to invest in projects that concern the whole
country and improve the accessibility of places that currently are difficult to reach. At present, PASOK is promising to connect all modes and to promote combined transportation.

The issue of High Speed Rail was then analyzed from the perspectives of the European Union and Greece. The EU is highly concerned in general with the transportation sector, proof of which is the fact that it has formed an agency responsible for transportation issues only. This agency, the so-called TEN-T Network Executive Agency, is responsible for planning, organizing and applying actions and projects regarding all transport modes. The ultimate objective is to integrate all member states of the Union and secure the safety of passengers. General and specific guidelines and projects have been planned. According to how they progress, they have been revised in order to meet the objectives that were initially set.

Specifically, for Greece, the European Commission shows its concern by including two projects concerning Greece in the Priority Projects list and also by helping the country with the issue of funding. The fact that two out of the thirty Priority Projects concern Greece can be regarded either as positive or negative, depending on the perspective of the judge. If one sees the glass as being half-full, then it would be positive. We also believe that it is positive, regarding the size of Greece. On the other hand, if one sees the glass as being half-empty, then perhaps Greece is under-respected. Perhaps one might assume that the current rail condition is in such bad condition that the EU is forced to fund Greece in order to improve it.

Both of these EU projects refer to the mode of rail, and one of them specifically concerns High Speed Rail. This fact demonstrates that the Greek rail network requires investment, and help is provided from the EU. Currently, the main rail corridor of Greece (from Athens to Thessaloniki and from Thessaloniki to Idomeni) is being modernized and upgraded into high speed. The truth is that the network needs to be expanded in order to cover more parts of the country. Also, it needs to be modernized and made more attractive. The plans from the EU perspective and the funding support have prompted those in charge to move into action, but still more could be done. The main obstacles that are faced, especially regarding the application of High Speed Rail, are two. First, is the issue of money: High Speed Rail is expensive both for construction and maintenance. Second, the mountainous terrain of the country and the steep slopes that the rail must follow present engineering challenges. Not only does this make construction more difficult, but it also increases the budgetary requirements.

Regarding the impacts that High Speed Rail has provoked, extensive research has been carried out. The numerous benefits observed lead us to the issue of the ways that are being used to evaluate the socioeconomic impacts of transportation investments. The literature on this topic is very extensive; many methods of evaluation exist. Also, many different software packages have been developed in order to help with the complicated procedure of evaluation. Depending on the nature of the project, its characteristics, and the place intended for construction, a method is chosen in order to predict the possible impacts. From the point of view of the author, the best
way to make an evaluation is to use a combination of the available methods. Since all options have advantages and disadvantages, none of them can cover all possible outcomes. Regarding Greece, a step-by-step method has been proposed in chapter 4. For other countries, this method might not apply, and another one should be formed. Aside from the details, the main conclusion is that a combination of methods provides a more accurate evaluation. This combination assures that many different aspects of impacts will be included in the ex-ante evaluation in order to take the most appropriate decision at the time of study.

Lastly, a comparison between Greece and Portugal was presented. The results show that the two countries have a great deal in common. However, as far as High Speed Rail is concerned, Portugal is better organized and more advanced than Greece. Although, HSR does not exist in Portugal yet, the planning process is on a very good track. Perhaps Greece should follow the example of Portugal in order to improve the current situation in this sector. The main lesson that can be learned from Portugal is that institutional changes are needed for HSR to become a reality. In Portugal, an organization that is responsible for solely HSR issues has been formed. If Greece can manage to develop such an organization, perhaps the implementation of HSR will be accelerated.

The experiences of the two countries help in appreciating indicators for the construction of High Speed Rail. Parameters that show the need for applying a HSR network do exist. One could say that those parameters can be used as “signs along the way” to the utilization of High Speed Rail. From this formation of the model, the main conclusion is that the GDP of the country does not play a major role in the construction of HSR. It is definitely a parameter that is vital, but the fact that the GDP is high does not mean that HSR will be built. If it was so, then Greece would be ahead of Portugal (Greece [$32,105 per capita] has a higher GDP than Portugal [$22,232 per capita]). The U.S.A ($47,440 per capita), in other words, one of the richest countries in the world would already have HSR (something that is not the case).

This thesis concludes by presenting informational background regarding High Speed Rail, the European Union, and Greece. It also provides two tools (a method for evaluating transportation investment in Greece and the screening model of HSR) that can be used as a platform to consider transportation investments in Greece and HSR in particular. Its review supports the development of an HSR plan and offers a way to deploy this plan.

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84 It is very interesting to note that at the time these words are written, the President of the United States of America, Barack Obama, has announced the allocation of “$8 billion to high-speed rail projects” in the country, retrieved on January 28th 2010 from http://www.nytimes.com/2010/01/29/us/politics/29obama.html?hp
6.2 Directions for further research

High Speed Rail is a modern and rapid means of transport which is gaining more popularity every day because of the benefits it provides. After considering this analysis, it would be very interesting to investigate if other paths of the Greek rail network could be upgraded into HSR. Moreover, research is needed into constructing new rail lines that will not only connect places that are currently not covered by the rail network, but also help to bring those areas closer to the rest of the country.

Drawing from the discussion presented in chapter 2, it seems that both governments (led by two different parties, New Democracy [previous] and PASOK [current]) hold the same view regarding the future of Greek transportation. Thus, the conclusion is that transportation issues are bipartisan, at least from the analysis that has been made regarding these last two governments. Further research might investigate whether this observation which is true in Greece, is also held in other countries. This investigation would require the analysis of the transportation strategies that were followed by previous governments.

Further research is also needed regarding the evaluation of the socioeconomic benefits of a transportation investment and particularly of High Speed Rail. A detailed evaluation is needed in order to assess all the benefits of HSR. Moreover, further investigation is needed to determine the disadvantages and negative aspects that might ensue from this construction. Such an analysis needs data and time, but it is something that can be done and is necessary in order to make correct decisions. As far as Greece is concerned, the decision regarding the upgrading of the main rail corridor (from Athens to Thessaloniki and from Thessaloniki to Idomeni) has been taken. Currently, it is being modernized in order to achieve the speed of 200km/hr. The proposed method in chapter 4 can be used and actually implemented for other transportation investments that are being considered in Greece and/or for the upgrading of the rest of the rail network.

6.3 A closing word

To close, this thesis can constitute a beginning towards the answers to the following questions:

1. Should Greece implement HSR?
2. Is there a better strategy to go forward?
3. If Greece does choose HSR, what is the best way to implement it?
4. How should Greece consider the impact of the EU funding?
5. If there were no support from the EU for HSR, should Greece go ahead anyway?
Finally, we would like to thank the reader for dedicating time to this thesis. We hope that this piece of work will indeed engage the interest of researchers and motivate them to continue the analysis that has been started.
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ΔΗΜΟΣΙΕΣ ΕΠΕΝΔΥΣΕΙΣ ΚΑΙ ΠΡΟΣΑΡΤΗΜΕΝΟΙ ΠΡΟΫΠΟΛΟΓΙΣΜΟΙ – Υπουργείο

ΔΗΜΟΣΙΕΣ ΕΠΕΝΔΥΣΕΙΣ ΚΑΙ ΠΡΟΣΑΡΤΗΜΕΝΟΙ ΠΡΟΫΠΟΛΟΓΙΣΜΟΙ – Υπουργείο


Appendix I - European Perspective in detail

The policy areas that concern the European Commission are the following:

1. "European strategies" - The European Commission is looking forward to a sustainable future of transport and follows actions towards an integrated, user-friendly network.

2. "Sustainable transport" - Demand for travel keeps on increasing on a daily basis and so does pollution and congestion. Thus, the EU is trying to enhance a form of mobility that is sustainable, efficient, and environmentally friendly. The goal is to promote co-modality and technical innovation and shift to modes that are energy efficient and less polluting.

3. "Air" - In the last thirty years air travel has tripled within Europe because of the policies promoting the formation of a "Single European Sky". This has been achieved by having no restriction to market access for the European Union Member States and with the application of harmonized airline traffic management. The challenges currently faced are the insurance of a strong performing industry, the achievement of highest standards of safety and security, the sustainable development in relation with environmentally friendly performance and the increase of opportunities of the European aviation to the international air market.85

4. "Road" - The objectives for road transport are to promote efficient road freight and passenger transport services and to create fair conditions for competition, to promote and harmonize safer and more environmentally friendly technical standards, and to ensure that the rules set will be effectively applied without discrimination.

5. "Road Safety" - Several activities concerning behavior, vehicles, and infrastructure issues are covered in order to minimize the risk of injury or death on the European roads.

6. "Rail" - Efforts are being made to restructure the European rail network and strengthen its position among other modes of transport. The goals set for rail are to promote competition in the rail market, improve the interoperability and safety of the network, and develop the rail infrastructure.

7. "Maritime" - The objective in this area is to insure safety within the Union by setting strict safety rules preventing sub-standard shipping, reducing the risk of accidents, and minimizing the environmental impact. Actions are also aimed against piracy and terrorist attacks. Moreover, there is great concern about the working conditions, health

and safety issues, and professional qualifications of seafarers. Lastly, emphasis is placed on the protection of citizens as users of maritime services, and attempts aim to ensure safe and secure conditions for them. The most recent update of the strategic goals regarding the EU maritime transport policy aims at the sustainability of this mode for the benefit of all economic sectors and the final consumer as well.

8. “Inland Waterways” – Inland waterway transport is an environmentally friendly way of traveling, and, since Europe has more than 37000km of inland waterways, the Commission is aiming to promote this mode and to strengthen its position in the intermodal logistic chain.

9. “Galileo” – This is an independent satellite navigation system, which will consist of 30 satellites and the associated ground infrastructure, in order to improve the global positioning service.

10. “EGNOS” - European Geostationary Navigation Overlay Service. This is the first attempt of the EU on satellite navigation and leads the way towards the application of Galileo. It is a service that works as an addition on the GPS system and improves the accuracy of data.

11. “Intelligent Transport Systems” – The European Commission plans to focus on innovation, except infrastructure. It is believed that only new infrastructure can’t help solve the transport problems. The goal is to integrate the existing technologies and create a new service.

12. “Clean Urban Transport” – With the promotion of mobility and environmentally friendly vehicles, the Commission is trying to improve the citizens’ quality of life while reducing congestion, accidents and pollution.

13. “Security and Safety” – Security and safety is a sensitive issue that constitutes a priority for all transport modes.

14. “Transport Infrastructure” – In addition to the upgrade of several modes’ networks, new transport infrastructure is being built with the vision of a single, multimodal network. The ultimate goal is to integrate land, sea, and air transport throughout the Union, so that both freight and people will be able to travel fast and easily between the Member States.

15. “Passenger Rights” – The Commission is very concerned with the protection of passengers’ rights on the different modes of public transport, and thus they are aiming at ensuring basic standards of treatment.
16. "State Aid" – The European General Directorate for Energy and Transport deals with State aid actions for transport and coal. Moreover, it co-operates with other directories with the goal of enhancing competition in the market.

17. "International Relations" – Nowadays, globalization is a worldwide phenomenon that cannot be overlooked. Transportation is a key to ensure smooth movement of people not only within the EU but also with the rest of the world.

18. "Research" – The main objective of the Commission in this area is to make the EU the leading knowledge-based economy. The goal is to achieve the best coordination between European and national policies, with integrated transportation networks, free movement of people, and ideas can be stimulated. 86

The above policies create the general guidelines that the European Union is setting for its Member States. Those actions and general objectives should be followed by all EU countries when considering any transportation investment. On the other hand, if a country desires to make a transportation related investment that isn’t included in the definition of the above policies, but aims on the same issues, then the country is free to do so.

***

According to the “White Paper,” the action priorities that were set were the following:

1. “Shifting the balance between modes of transport by:

   a. Objective 1 – Regulated competition

      i. Improving quality in the road sector

      ii. Revitalizing the railways

      iii. Controlling the growth in air transport

   b. Objective 2 – Linking up the modes of transport

      i. Linking up sea, inland waterways and rail

      ii. Helping to start up intermodal services: the new Marco Polo program

      iii. Creating favorable technical solutions”

A growing imbalance was noticed between transport modes in the EU, with the increased success of road and air traveling resulting in great congestion. This situation was blocking the exploitation of the full potential of rail and short sea shipping, thus the Commission decided to solve the problem with investing in all mode networks evenly. The two priority objectives of this Action were to regulate competition between modes and also, to link up the modes towards successful inter-modality.

2. “Eliminating bottlenecks by:

   a. Unblocking the major routes
   
   b. Solving the problem of funding”

The bottlenecks that existed in Europe didn’t allow the physical movement of goods and persons, and this barrier had to be overcome in order for the internal market and the territorial cohesion of the Union to be fully realized.

3. “Placing users at the heart of transport policy”: The Commission proposed a directive on harmonization of the means of payment for certain infrastructure, particularly for motorway tolls and another directive on safety standards in tunnels.

4. “Managing the effect of globalization”: The Commission planned to propose the reinforcement of the position of the community in international organizations, in particular the International Maritime Organization, the International Civil Aviation Organization and the Danube Commission, in order to safeguard Europe’s interest at world level. The goal is for the Union to be able to manage the effects of globalization and contribute to international solutions to combat problems such as abuse of flags of convenience.87

****

In 2005, a mid-term assessment of the 2001 White Paper was planned in order to check whether the targets and objectives were being attained or whether adjustments were needed. The advancement of implementation activities up until the year of 2005 are shown in table I-1.

---

At the European Union level, the legislative activities were well advanced. At the Member State level, though, they were much lower. This is not surprising, because the Member States needed about three years to translate the new European legislation into their own national legislation and the new Member States had even less time to do so. The Member States in 2001 were 15 (the so-called EU15) and to be more specific, those were Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden and the United Kingdom. By 2005 more countries were added in the Union, the so called new Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia.
and Slovenia), and those were the ones who had less time to translate the European legislation into their own language.

As far as implementation is concerned, the EU15 is the result of a five-year-period, while the new Member States were assessed for a one-year period, since they joined the EU in 2004. During the assessment, it was realized that the implementation of the planned activities would not be completed in 2010, but good progress was noted. The political schemes of the Member States were changing, and new countries that were added to the Union needed time to adjust and reach the EU standards. No changes in the transport policy were believed to be needed; on the contrary efforts at overcoming political and financial barriers by building in incentives were decided. 88 (Table 1-2 shows the progress of all measures applied specifically for the action of revitalizing the railways.)

---

### Policy 
**Revitalizing the railways**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Advancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separated management of infrastructure and services, opening international services in rail freight TENs</td>
<td>Low</td>
</tr>
<tr>
<td>Opening up the national and international freight market</td>
<td>Low</td>
</tr>
<tr>
<td>Ensuring a high level safety for the railway network</td>
<td>Medium</td>
</tr>
<tr>
<td>Updating the interoperability directives on high-speed and conventional railway networks (ERTMS)</td>
<td>High</td>
</tr>
<tr>
<td>European Railway Agency</td>
<td>Low</td>
</tr>
<tr>
<td>Certification of train crews and trains on the Community rail network</td>
<td>Medium</td>
</tr>
<tr>
<td>Gradual opening-up of international passenger services</td>
<td>Medium</td>
</tr>
<tr>
<td>Quality of rail passenger services and users' rights for international services</td>
<td>Medium</td>
</tr>
<tr>
<td>Improving quality of the rail freight services (3rd)</td>
<td>Medium</td>
</tr>
<tr>
<td>Enter the dialogue with the rail industries in the context of a voluntary agreement to reduce adverse environmental impacts</td>
<td>High</td>
</tr>
<tr>
<td>Support the creation of new infrastructure and in particular rail freight freeways</td>
<td>High</td>
</tr>
</tbody>
</table>

*Table 1-2: Advancement of the White Paper implementation at the Commission, June 2005 (source: Assessment of the White Paper- Final Report, 2005)*

In September 2009, Professor Chris Nash and his team from the Institute for Transport Studies from the University of Leeds composed a report, “European Transport Policy: Progress and Prospects” about the European Transport Policy, which was written and published in 2001. The aim of this report is to cite the progress that the European Commission had made, according to the goals that were set in 2001 and to detect the impact of the initiated policy. Since the core of this thesis is High Speed Rail, we will only discuss their findings about the rail sector.

He sites that in the past decade the rail sector has dramatically changed, although there are some commentators that express great dissatisfaction with the rate of change in the rail industry. Reorganization has occurred and usually infrastructure is different for passenger and freight operations. In some EU countries, the railway ownership has shifted to the private sector, and in others rail has been introduced for the first time. Competition has emerged in the
freight sector and especially in the north – south corridor of the Alps. A study done by the consulting firm of NERA has proved that efficiency has risen and the cost coverage among European railways has improved, but still there are a number of rail organizations that are in poor financial condition particularly in terms of debt.

The negative side that Nash (2009) discusses about is that problems still exist in parts of the new policies, specifically those that concern infrastructure charges. To be more specific, in many EU countries, the infrastructure manager has failed in their obligations leading the manager to borrowing in order to provide the service that is responsible for. Moreover, problems arise in the practical application of the provisions on regulation and access to ancillary facilities. The problem of the financial scheme is even worse, especially in the new Member States. Unfortunately, it is pretty difficult for the hoped-for results to occur in the time limit set (initially the goal was that all activities were to be implemented by the year 2010). Many parts of the legislation were late to be applied, thus the desired results will need more time to be achieved. There are countries that are facing problems in implementation, and the Commission should put priority into identifying and solving such very important issues.

Next, the railway infrastructure charges were studied by Nash (2009), from the point of view of the second pillar set by the Commission, which aimed at intermodal competition. Unfortunately, little progress has been achieved. According to the policies set by the Commission, charges must be based on “costs directly incurred as a result of operating the train service”. Although, considerable activity has been noted in order to adopt the above policy, the different interpretation and approaches to implement it has led to diversified results. Unfortunately, great differences in prices are noted and those are probably damaging the rail sector and the whole transportation system in general. Priority should be given for setting guidelines about how to implement the corresponding policies, in order to provide common definitions, consistent interpretations and approaches.

As far as funding is concerned, it seems that problems are also faced in this area, according to Nash (2009). For the TEN-T projects (explanation of the TEN-T agent has been provided in section 3.1.3), the EU’s budget is limited. To be more specific, 50% of the amount needed for studies is given by the EU and for construction 10-20%. The alleviation of funding is supported with favorable lending terms from the European Investment Bank (EIB). Table 1-3 shows the sources and the amount of funds for the TEN - T projects.
Table I-3: Expected sources of finance for TEN-T projects for 2007-2013 (source: European Transport Policy: Progress and Prospects by the University of Leeds)

<table>
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<th>Source of funding</th>
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<td>TEN program</td>
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</tr>
<tr>
<td>Regional Funds</td>
<td>8</td>
</tr>
<tr>
<td>Cohesion Funds</td>
<td>35</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>51</strong></td>
</tr>
<tr>
<td>European Investment Bank</td>
<td>54</td>
</tr>
<tr>
<td>Other resources (mainly national governments)</td>
<td>284</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>389</strong></td>
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Although the Commission is providing funding for research and construction, it is not enough for the Member States to actually adopt and apply the guidelines, as Nash (2009) reports. In countries where the private sector has undertaken the ownership and management of the rail network, the results were encouraging. Thus, it is believed that another way to finance support should be followed. Emphasis is given to the fact that poorer countries should have high priority and that contributions should be limited in projects with spillover benefits to only a few countries. Moreover, concerns are discussed about the way that the Commission is deciding about which projects to implement, and it is suggested that great emphasis should be given to traffic demand, market needs, business cases, and alternatives.

In conclusion, it is foreseen that in the next decade strong groups will be formed in the rail sector in order to compete in international freight and/or passenger markets. Thus, alliances with operators in each country and/or collaborations will most probably emerge. National markets will continue to be important to smaller operators, who specialize in niche markets. This means that pricing of competing modes is as important as improvement of the quality and efficiency of rail systems. If prices of other modes remain cheaper than rail prices, then rail will not be able to play its full role. Moreover, development should be monitored by the full implementation of the corresponding policies. This includes the “provision regarding compensation for social obligations and financial equilibrium of infrastructure managers as well as non discriminatory access to the market.”


The procedure of applying for funding to the TEN-T Agency is as follows:

First, a Member State has to apply to the Agency for funding. All EU countries are eligible to make an application. Each year, calls for proposals are announced. Calls for proposal are divided into Multi-Annual Call and Annual Call. The first are addressed to the priority projects (a discussion about those kinds of projects follows) and to their quick implementation. The latter are complements to the first and address key TEN-T issues like elimination of bottlenecks. The greatest proportion of the TEN-T money (80-85%) is allocated to the Multi-annual projects and the rest goes to Annual Call projects. This leads to us to the assumption that the TEN-T Agency prefers supporting long-term projects. The evaluation and selection of submitted proposal is carried out by the DG TREN Commission and the TEN-T Agency. Independent external experts are also involved in this procedure, in order to ensure that only high-quality proposals that meet the criteria will finally be funded. There are two official documents that have been published by the Commission that include information related to the specific types of projects which are funded and in what amounts. Those documents are the TEN Guidelines and TEN Regulation. The criteria that need to be met are:

a. Relevance to the TEN-T priorities and policy objectives
b. Maturity
c. Impact, especially on the environment
d. Quality including completeness, clarity, soundness, and coherence

A list of recommended proposals is prepared and the successful applicants are called to begin the negotiations. If agreement is reached, then the funding support is given.91

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Appendix II- Literature Review of Papers relevant to the topic of economic evaluation of transportation systems

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A. Economic Development Effects Promoted by Transport Investment in General

Authors: Banister D. and Berechman J. (2000)
Title: Transport Investment and Economic Development
UCL Press, UK and USA

Summary:

Part I: Objectives and scope

Chapter 1 – Background and objectives

It is strongly believed that transport infrastructure investment is related with economic growth and this relationship has been widely used to justify the allocation of funds to the transport sector. Generally speaking, arguments for transport investments are the relief of congestion and the fundamental link with the growth of GDP. Also, it is supported that in combination with appropriate policies, urban and regional development can happen. Banister and Berechman are concerned with the relationship of transport infrastructure and economic development and question the effects of the first to the latter. They believe that in developing countries and cities, the relationship does exist and is quite clear, but in developed countries those links are unclear. Specifically for developed countries, they are arguing that additional transportation investment has little impact on the overall accessibility and has as a result the change of business patterns and mode trends and not economic growth. The key questions they set to answer are:

1. “Is the growth impact of any new transport link in developed countries likely to be significant?
2. Are transport costs a small part of total production and labor costs?
3. Are buoyant local economic conditions more important than transport infrastructure improvements in generating growth?
4. Are the unique characteristics of the area and the spatial extent over which the growth impacts are to be felt considered?
5. Can one generalize about the results from specific case studies?
6. What is the role of technological change in affecting the relationships between transport investment and economic growth?
7. How slow, long term and complex are the adjustment and readjustment processes within the regional economy following a transport investment?
8. Does a good transport infrastructure raise the image and perceptions of an area, thereby attracting additional private investments?
9. How can one assess the course of economic development in an area if the transport investment was not made?
10. What is the role of expectations, regarding the impacts of investment, in achieving growth?

Chapter 2 - Scope of analysis: Definitions, approach and methodological framework

First of all, there is a difference between the expressions of economic growth and economic development. The first applies to the case when studying the changes in the GDP, whereas the second when studying the effect on additional investment on the urban and regional levels. It is stated that the degree that a transport infrastructure improvement affects economic development dependents on the economic and geographical characteristics of the region where it is applied and also on the level and performance of the investment capital infrastructure. The methodological framework followed by Banister and Berechman is depicted in figure II-1.

![Diagram](image-url)

Figure II - 1: The basic causality paradigm of the relationships between transport infrastructure investment and economic development (source: Banister and Berechman (2000))
Part II: Contemporary issues

Chapter 3 - Transport infrastructure investments

The analytical issues discussed in this chapter are:

1. "Definition of transportation infrastructure types
2. Pricing and financing
3. Public and private sector – the role of each sector and their collaboration
4. Risk of selecting the wrong project to implement and uncertainty on the forecasts of demand and costs”

Chapter 4 - The evolving economy

In this chapter, an extended discussion is presented, from the point of view of economic evolution and travel demand.

1. "Changing work and leisure patterns
2. Economic and technological changes
3. Global cities and spatial change”

Chapter 5 - Social, spatial and environmental effects

This chapter discussed the following topics from the point of view of economic evolution and travel demand.

1. "Demographic changes
   a. Ageing and changing family structures (household size, increase of women in labor force etc)
   b. The motorization effect
2. Spatial and social equity effects
3. Environmental and sustainability effects
   The environmental cost of transport has been categorized into four groups:
   I: Pollutants (Carbon dioxide, nitrogen oxides, sulphur dioxide, carbon monoxide, benzene, lead, hydrocarbons and particulates)
   II: Resources (Oil, land take, ecology, ecosystems and accidents)
   III: Environment (Noise, vibration, community severance, visual impact and aesthetics, conservation and townscape)
   IV: Development (Regional development, local economic impacts, congestion, urban sprawl and construction effects)
4. Urban form and structure”
Part III: Methodology – analytical approaches and modeling

Chapter 6 – Modeling the growth effects of transport capital investments: a macro level analysis

This chapter tries to answer the following questions:

1. “Does the level of the infrastructure stock affect national or state economy growth?
2. If it does what is the marginal contribution from additional investment in public capital on factor productivity?”

Two types of models are developed; production function and cost function models. The main assumptions for the building of the models are that:

- “Infrastructure capital expansions helps in the increase of efficiency and profitability of businesses
- The increase of efficiency of businesses stimulates investment in private capital.”

Figure II - 2: The complementarity of approaches (source: Banister and Berechman (2000))
The problems faced with the use of the above models are many. First, they perform statistical analysis. Second, they assume that the level of capital stock is already efficient and that growth can occur only with additional investment. Third, they also assume that investment in stock leads to greater output and that is questionable. Specifically for production function models, they omit input prices and place restrictions. The conclusion is that while using such models, attention should be made for misspecifications that might occur.

Chapter 7 - Economic evaluation of transportation projects

Figure 11 - 3: The scheme of evaluating economic growth benefits from infrastructure investments by Banister and Berechman (source: Banister and Berechman(2000))
The most common approaches of evaluation are Net Present Value (NPV) and Internal Rate of Return (IRR). The benefit cost analysis is also widely used. A classification of available methods follows:

1. "Benefit cost comparisons
   a. Cost-effectiveness analysis (CEA)
   b. Benefit-cost ratios
   c. Benefit-cost analysis (BCA)
   d. Risk-benefit analysis
2. Multi-criteria analysis (MCA)
   This kind of analysis includes a series of methods that are designed for particular application
3. Impact statements (IS)
   a. Social impact statement
   b. Environmental impact statement
4. Others
   a. Total cost analysis
   b. Full costs and benefits analysis
   c. Project's life cycle analysis"
Summary:

Banister and Berechman believe that further investment in a well-connected transport infrastructure network of high quality, doesn’t result in economic growth on its own (see figure II-4). Moreover, they believe that positive economic externalities, investment factors and political factors have to co-exist in order for a transportation investment to result in economic growth.

They suggest a twin approach to project appraisal and that is:

c. "Traditional cost benefit analysis
   i. User transport benefits
ii. Costs of investment
d. Complementary economic development analysis
   i. Network effects – accessibility analysis
   ii. Value added from project – changes in employment, factor productivity, environmental quality
   iii. Priority – spatial impacts in terms of location, social impact in terms of distribution"

Authors: Bruinsma F. and Rietveld P. (1993)
Title: Urban Agglomeration in European Infrastructure Networks
Urban Studies, Vol. 30, No. 6, pp. 919-934

Summary:

Bruinsma and Rietveld demonstrate the belief that transportation infrastructure constitutes an "economic determinant" of urban agglomeration. Thus, they study the positioning of 42 European cities according to the rail, air, and road networks that they have. The methodology used is the formulation of a simple gravity model, with travel time being the main parameter, which measures the accessibility of each. First, the model is applied to air traffic then to rail and then to road. According to the ranking of the cities, suggestions are made for the improvement of the existing networks. Specifically for the rail network, a discussion of the scenario of HSR in the European Union is presented. Moreover, they study the aspect of the national borders as barriers to the road network.

One of the main conclusions is that rail inaccessibility is the highest and road inaccessibility the lowest. Also, it is realized that the impacts of HSR will be greater regarding the issue of accessibility, in comparison to road and air improvements. Lastly, it is realized that the national borders will mostly serve as obstacles to agglomeration to smaller countries. Thus the European Commission should consider this when deciding the transportation policies of the Union.
Author: Cambridge Systematics Inc. and Reilly M. (2007)
Title: Economic Growth Effects Analysis for the Bay Area to Central Valley Program - Level Environmental Impact Statement Report and Tier 1 Environmental Impact Statement, final report
retrieved from

Summary:

The results of this report are developed with the use of a software program called Transportation Economic Development Impact System (TREDIS). This software enables the economic development impact evaluation and benefit-cost analysis for a transportation investment (applicable for all modes). It can also be used for examining different scenarios. The process considered the effects that change travel options, congestion and delay between existing conditions and future years would have in the State’s economic growth. They also modeled several dimensions of growth and spatial re-allocation that could occur with any of the system alternatives and considered many possible impacts of HSR on jobs, population and land development.

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Authors: Elhorst J.P. and Oosterhaven J. (2003)
Title: Effects of Transport Improvement on Commuting and Residential Choice
43rd European Congress of the Regional Science Association, August 27-30, Jyvaskyla, retrieved from

Summary:

Elhorst and Oostehaven are developing a commuter location model. Their model has been created to simulate residential location changes of commuters that are affected by transport improvements. Their results have an estimation error of 7%, justifying the accuracy of their model. Six high-speed rail connections between Amsterdam and Groningen were used to test the model. According to their literature review, there are three strands that deal with the issue of the reaction of households.

1. “Gravity and entropy models in which all individuals have a standard residential location
2. Urban economic models which assume that workers choose their residency according to the maximization of their utility by trading off commuting and housing costs
3. Models that elaborate on urban economic models”
While developing an assignment model, their objective is to predict at best accuracy for the actual spatial distribution of the working population.

**Data needed**

6. "Number of jobs per employment zone
7. Commuting times
8. Zoning pattern and variance in travel times
9. Number of modes
10. Residential attractiveness
11. Empty time classes: those occur when an employment zone is isolated from other zones"

**Assumptions made**

"All municipalities studied have the same commuting time distribution"

This model is suggested to be used for any transportation improvement both in the private and public sectors. It is not so data-intensive, thus can be used more easily than other models in which the database needed might not always be available.

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**Author:** Givoni M. (2006)

**Title:** Development and Impact of the Modern High-speed Train: A Review

*Transport Reviews*, Vol. 26, No. 5, 593–611, September

**Summary:**

Givoni is concerned with the different elements of High Speed Train operation, the impacts delivered from its design, and what it can deliver. In the beginning a review of the main high speed train technologies is presented (the Shinkansen, the TGV, the tilting HST and the Maglev HST). The following benefits are recognized for High Speed Trains as modes:

1. "Increase of capacity
2. Travel time reduction and increase of service that changes the mode shares and generates new demand. Diverted passengers are mostly coming from the air share and not from the car share.
3. Ability of achieving very high operating speeds (above 120km/h)
4. Dense and dominant cities are mostly attracted to HST"

Great emphasis is given to the fact that HST constitutes a great substitute to airplanes. This is because of the competitive travel times it offers due to the station placement in the city centers (ex. Paris-Lyon where there is no air connection). The previous assumption holds for specific distances (up to 1000km at maximum) and when there are direct connections. Moreover, there
are situations in which high-speed trains constitute complements to aircraft rather than substituting for them (ex. “London-Paris where 70% of the market is captured in HST but there are still about 60 flights a day that connect the two cities”). On the contrary, when HST is introduced by large airports, then they do substitute for air travel.

Other impacts are also possible to observe when HST are applied, and those are spatial and socio-economic impacts. The shorter travel times offered bring cities closer and also improve the level of their connectivity and can lead to economic growth. This is not a rule, because there are regions whose economic situation led to drainage of economic activities after HST were implemented. Furthermore, new stations are built and existing ones are expanded. There are cases in which the above alternations were positive to the development of the surrounding areas and others in which nothing different happened. In conclusion, although there is a strong determination that HST will have positive economic impacts, there is no evidence that this is definite.

As far as the environmental impact of HST is concerned, it is believed that it is the most environmental friendly mode and especially compared to airplanes. However, the operations related with HST have negative impacts on air pollution, climate change, noise, and land-take. Sulfur dioxide (SO2) and nitrogen dioxide (NOx) are considered to be the most harmful pollutants produced by HST.

The cost of infrastructure varies greatly depending on the country where it is constructed. The reason for variation is due to the different terrain along the route, which determines the number of bridges or viaducts and tunnels (works that increase the cost significantly) that are needed. In addition, the cost is affected by the general economic characteristics that determine the cost of land and labor.

The main conclusion is that HST can result in positive socio-economic benefits but not always.

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Title: Review of Methods for Estimating the Economic Impact of Transportation Investments


Summary:

There is a variety of ways, methods, models and tools to estimate the economic impact of transportation improvement. Thus, Iacono and Levinson present such methods with particular interest focused on those that use projects that add highway capacity in urban areas.
The issues that exist with the economic impact of transportation improvements are two. One is the issue of geographical scale studied, and the other is that there are many parameters to be assessed, like travel time reductions, more efficient supply chains and others. Project-level studies are mostly focused on price of land, whereas more aggregate methods are applied to property and product issues.

- **Software tools for impact analysis**
  - "MicroBENCOST is a sketch planning tool that estimates basic benefits and costs for highway improvement projects and capacity additions.
  - Sketch Planning Analysis Spreadsheet Model (SPASM) is a benefit-cost model designed for "screening level" analysis. The outputs are project costs, cost-effectiveness, benefits and energy and air quality impacts. It also allows the comparison of multiple modes and non-modal alternatives.
  - The Surface Transportation Efficiency Analysis Model (STEAM) is a planning-level extension of the SPASM software, which helps to design a fuller evaluation of cross-modal and demand management policies.
  - The Spreadsheet Model for Induced Travel Estimation (SMITE) is a sketch planning application which works with STEAM in order to account the effects of induced travel in traffic forecasting.
  - SCReening for ITS (SCRITS) is a sketch planning tool used for rough estimates of ITS benefits.
  - Highway Economic Requirements System for states (HERS-ST) is a model for economic impact evaluation of highway improvements.
  - Those software tools are unable to capture the full range of impacts of new highway capacity projects in particular. As far as benefit-cost analysis is concerned, it is necessary to make simplifying assumptions in order to apply them. This simplification involves uncertainty and risk. Thus, [the] UK and many other European countries have changed into using multi-criteria approaches where economic development is one of the result components. Other serious issues are also captured such as environmental, equity and safety.

- **Aggregate economic and econometric methods** are exploring economic impacts at a larger scale.

- **Regional economic models** are used to measure the effects at a regional level. Those apply macroeconomic simulation modeling methods to measure cost savings and productivity enhancement. Such regional input-output models are IMPLAN, RIMS II and REMI (Regional Economic Model, Inc.).

- **Aggregate production functions**

- **Clio metric methods** (after the Clio muse from the Greek mythology)
• Disaggregate economic and econometric methods
  o Disaggregate economic models that relate levels of highway capital spending to economic parameters like employment and income.
  o Hedonic models for property valuation which capture the property value associated with infrastructure accessibility”

The main conclusion is that, although there is a variety of methods and models to be used, none of them should be used by itself, since all of them lack the ability to model all the effects of upgraded facilities. Thus, the solution is to choose, compare, and combine one or more of the above methods according to the nature of the project that is desired to be evaluated.

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Title Analyzing the Economic Impact of Transportation Projects using RIMS II, IMPLAN and REMI
Prepared for Office of Research and Special Programs U. S. Department of Transportation, Washington D. C

Summary:

It is of great importance to perform the economic analysis of the impacts of transportation projects in order to decide on their implementation. For that purpose, the most used software use the input-output models. These are models that can capture the “direct, secondary indirect and induced effects”. “They account for inter-industry relationships within regions, since they produce input-output (I-O) multipliers”. In this paper three such models are presented.

4. Regional Input-Output Modeling System (RIMS II)

This model was developed by the U.S. Department of Commerce and is the cheapest. It is used both for public and private sector projects and at all levels of analysis (national, state and local). For each industry, “an I-O table shows the industrial distribution of inputs purchased and outputs sold”. The advantages of this model are that multipliers can be estimated for any region and that their cost is relatively low. As far as its accuracy is concerned, it has been proved that the results produced do not have great differences in magnitude from the results of expensive surveys. Moreover, the model helps to avoid “aggregate errors” and also has the ability of comparing results across areas. Lastly, multipliers are consistently updated in order to reflect the most recent local-area wage and salary and personal income data. The data input are industry category, year of
expenditure, location, and the output given are earnings, output (change in the dollar value of production), and jobs.

5. IMPLAN

This model was developed by the Minnesota IMPLAN Group, Inc. IMPLAN is not expensive and is more complex than RIMS II. The data in this model are “built from top to bottom”. “National data serve as control totals to state data”, which serve county data. The resources of employment and earnings data are County Business Patterns data and U.S. Bureau of Economic Analysis (BEA).

6. Regional Economic Modeling, Inc (REMI)

REMI is the most sophisticated and expensive model of the three. It is an integrated output-econometric model developed by Regional Economic Modeling, Inc. One can say that this model is more than an econometric model. It is a tool that combines an input-output model with an econometric model, and whenever the second is suppressed then REMI downgrades to an I-O model. The description of the model is highly complex. One needs to know that it consists of five basic blocks:

- “Output
- Labor and capital demands
- Population and labor supply
- Wages, prices and profits
- Market shares”

As far as input data is concerned, employment, income and output data is of greater importance. The sources that this model uses are BEA ES-2 and County Business Patterns data published by the Bureau of the Census.

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Author: Oster C., Rabin B. and Strong S. (1997)

Summary:

Oster et al. are concerned with the estimation of the economic benefits of an air cargo hub facility on the local economy. They are using and comparing methods of estimation; one is a static input-output model (RIMS II) and the other is an econometric technique. They are doing so, because the first cannot capture the effects that arise from business location decision, whereas
the second can. In their study, the application is being used for four local Midwestern economies (Indianapolis, Cincinnati, Louisville and Memphis).

RIMS II is widely used for the estimation of economic impacts of transportation investments. It is a model that can measure the effect of a change in a regional economy. It has the ability of recognizing that the outputs of an industry might be the inputs of another and also that the wages of employers are spent on goods that are produced from a variety of industries. All input-output models are developing multipliers, a convenient way of capturing secondary effects throughout the economy. Data can be collected on the national and regional level in order to input in the model. Moreover, the analysis can be performed on all levels of country, state, county and region, since all kinds of multipliers can be produced by the model. Also, a variety of multipliers can be developed for all industries individually or in an aggregated manner.

The advantages of multipliers development are as follows:

- "Available nation-wide so can be used for comparison of different regional economies
- They are available at a low cost"

Disadvantages of RIMS II model:

- "No estimation of the duration of the effects
- The aggregation of industries limits precision
- There are dimensions of the economy that cannot be examined
- Incapable of capturing effects of substantive changes that result in structural shifts of the regional economy"

The econometric model was used in order to “capture the effect of employment changes in the air industry of the regional economy to the total employment of the region”. Economic development impacts from transportation infrastructure investments are highly complex, and the development of a model that captures the interaction is not easy. The data needed need to come from reliable sources. For the purpose of this study, data were taken from the Bureau of the Census County Business Patterns data series for all the metropolitan areas for the period 1977-1990. In the equations tested, the dependent variable was the change in total regional employment. All variables, both dependent and independent, were estimated as changes occurred in the prior year. The reason for estimating changes was because the change of transportation employment was of main interest and also to overcome technical econometric problem related to the use of time series data. The factors captured in the model were the following:

1. "Change of employment in the transportation sector
2. Change of employment in manufacturing
3. Change in Gross National Product
4. Change in personal income in the region
5. Change in National Unemployment Rate"

** **

Title: Statewide Economic Benefits of Transportation Investment

Summary:

Colorado Department of Transportation (CDOT) did research on exploring the economic benefits of transportation investments and formed the Economic Benefits Research Scoping Study. After that, CDOT asked from BBC Research and Consulting (BBC – an economics research firm) and Felsburg Holt & Ullevig (FHU – a transportation engineering firm) to estimate the economic benefits of different transportation investment scenarios in order to understand the link between transportation investment and economic growth. The objectives of the study were to estimate the statewide economic benefits and also to identify the data needed for studies to be performed in the future. The steps followed were the following:

1. “Set baseline and alternative investment scenarios
   Two levels of investment were identified. One consistent with current revenue forecasts (“Forecast revenue”) and one higher level of investment that would maintain current system performance (“Sustain current performance”).
2. Evaluate benefits
3. Incorporate a vision for the future”

The benefits were divided into those which can be quantified and those that cannot be quantified.

➢ "Quantifiable benefits
   o Travel time savings
   o Reduced vehicle operating costs
   o Reduced congestion
   o Better pavement quality
   o Safety condition improvements
   o General system improvements
   o Shorter travel times
   o Reduced vehicle operating costs
   o Fewer accidents and injuries
   o Business expansion and attraction
   o Air quality changes
Non-quantifiable benefits
  o Economic competitiveness
    ▪ Increased access to labor and other inputs
    ▪ Expanded market reach
    ▪ Depends on level of investments in other states
  o Benefits to tourism (finding from the I-70 Programmatic Environmental Impact Statement)
    ▪ Increased visitor days
    ▪ Increased out-of-state visitor spending
  o Quality of life
    ▪ Local air quality improvements
    ▪ Access to jobs and services
    ▪ Improved public transportation in metropolitan areas
    ▪ Increased leisure time
  o Short-term construction benefits
  o Efficient transportation investment

Benefits of the 2030 vision
  o Improved safety
  o Economic development
  o Public transport demand increase resulting from improved transit system
  o Access to recreation destinations”

The figures that follow depict the methodology that was followed for the estimation of benefits on each category.
Figure II - 5: Methodology for estimating travel time savings (source: Pickton et al 2007)

Figure II - 6: Methodology for estimating reduced vehicle operating costs (source: Pickton et al 2007)
Figure II - 7: Methodology for estimating safety effects (source: Pickton et al 2007)

Figure II - 8: Methodology for estimating the macroeconomic benefits (source: Pickton et al 2007)
In the conclusion, it is emphasized that several data limitations constrained the study. It is suggested that a more in-depth analysis requires local data, enhanced traffic, economic modeling capabilities and additional specific information on the local level, original-destination patterns of trucks and commercial vehicles, changes in vehicle miles traveled, more detailed economic data of regions and timing costs and benefits.

B. Studies of Economic Development Effects of HSR on Urban and Regional Levels

Author: Atkins Company (2004)
Title: High Speed Line Study – Final Report
Department of Environment, Transport and the Regions, London
Retrieved from

Summary:

The Atkins Company, which was commissioned by the Strategic Rail Authority (SRA), carried out the feasibility study for the High Speed Line in the UK. This line was planned to traverse the country from the north to the south and would be dedicated to passengers only. The objectives of this study were to determine whether it would be realistic and defensible to construct HSL in the UK, who were going to be the potential stakeholders, how would those support this idea, and, finally, to design a forward plan. Many different aspects were investigated in order for the final suggestion to be fully supported. The following activities were carried out:

- “Option development and costing
- Demand modeling, forecasting and passenger surveys
- Economic analysis with the method of cost-benefit analysis and consideration of wider economic impacts
- Environmental assessment
- Financial modeling and project structuring advice
- Risk management
- Stakeholder consultation”

After reviewing the transportation statistics of the country, by performing a background study of the mode shares and the trends of the passengers travelling from north to south and vice versa, the base case scenario was studied. In this scenario, no upgrade in the existing rail line is
included, only some other modernization construction. The forecasted demand of rail, highway, and air suggests that rail has to be expanded. Next, a review of the existing high speed rail line in Europe was performed and then the rationale behind the idea of HSL for UK was analyzed. The following criteria are taken into consideration for the formation of the HSL alternative:

9. "Environmental constraints and habitation
10. Synergy with land use and transport policy
11. Technical constraints and affordability
12. Stakeholder concerns
13. Different High Speed Line routes
14. Station access
15. Costs including construction, land acquisition, rolling stock purchase etc
16. Investigation of HSL capabilities from the time savings point of view"

Four other alternatives are also formed in order to be compared with the HSL option and those are:

1. "A new conventional rail line
2. Classic rail upgrades
3. Roads upgrade
4. Airport upgrade"

The transport case is then presented, where the impact on the different modes of the HSL is studied. The conclusion of the performed analysis is that HSL will attract passengers and also form diverted passengers, leading to the alleviation of the congestion problem on the roads of the major cities of the country. Moreover, it is believed that the number of diverted passengers will not affect the air market of the UK.

In addition, the appraisal of HSL under the schemes of the environment (landscape, heritage, biodiversity, water, noise and air quality), safety (forecast of accident reduction), economy, accessibility (service frequency, crowding effects, speed, and interchange) and integration with potential regional and national policies are held in order to fulfill the Government’s key criteria of consideration for a transport mode. The conclusions of the above appraisal are:

1. “Safety on the transport network has the potential to be improved by HSL
2. There is an economic case for HSL with a cost-benefit ratio of at least 1.4 and the PPP scheme is required for delivering the system
3. Accessibility to the public transport network could be substantially widened by HSL
4. HSL has a reasonable level of integration with land use and transport policy
5. In environmental terms, it is difficult to construct a new railway without significant adverse impacts upon the natural and built environment"
The conclusion of the whole study is that the forecasted demand of north-south travel movements shows that the rail network needs to be expanded in order to serve the passengers and the socioeconomic studies performed support the idea of the HSL implementation.

Title: The Regional and Urban Effects of High-Speed Trains
The Annals of Regional Science, 31, pp. 1-20

Summary:

Blum et al. believe that high-speed trains can solve two problems of accessibility; either constitutes a good substitute to air travel or triggers the creation of a new economic corridor with high interregional accessibility. The main hypothesis is that cities that are connected with modes such as HSR are transformed into an extended functional region. They are mostly concerned with the economic integration in the corridor formulated by High Speed Rail in the short, medium, and long term. In the short-term analysis, they are studying the integrations of goods, service markets, labor markets, markets for shopping, private services and leisure activities. In the medium-term analysis, they lay emphasis on the household and firm relocation along the formulated corridor.

With the application of high-speed trains, they believe that the travel intensity will increase significantly and that economic growth will occur with the stimulation of the region and the extension of the markets. Before the presentation of their model, an analysis is carried out regarding the impact of high-speed trains to the following areas:

1. "Economic integration
   a. In general
   b. From the relocation perspective
   c. From the regional adjustment perspective
2. Trade in services and knowledge exchange
3. Time gains for business travelers
4. Productivity differences and commuting cost
5. Shopping, service and leisure time"

They use an equation in order to measure the employment in sector j in region I depending on travel time and travel cost of commuters. While studying when equilibrium applies and the net benefit of commuting, they find that the former equation is non-linear in some cases.

The conclusion of their analysis is that there exists a combination of travel time and cost that under certain mode availability will lead to new location patterns, but non-linear reaction might occur after the line has opened up.
Chapter 2: Urban dynamics and transport infrastructure – towards greater synergy (Hugo Priemus)

Priemus is concerned with the “synergy between urban development and the development of transportation networks in Europe” and what is the role of various policies in this. The hypothesis is that this relationship has weakened since cars and airplanes have been widely preferred. Typical examples of good synergy are monocentric cities like London and Paris, where the metro system is extensively developed and ease the access to downtown. This relationship can be reinforced in European cities with the development of the HSR network. First, the areas where the stations are and are going to be built will cope with an increased flow of passengers, thus increasing the purchasing power of the area.

Chapter 3: Station areas as nodes and places in urban networks – an analytical tool and alternative development strategies (Luca Bertolini)

Transport innovation triggers new development in the station area. Station areas constitute both ‘nodes’ and ‘places’ in both transport and non-transport networks. They constitute a “dense and diverse conglomeration of uses” and the dynamic that is developed is really important. The increase of accessibility creates favorable conditions for further development. The strategy formed for the paths and station locations is critical to development.

Chapter 4: HSR stations and urban dynamics – experiences from four European cities (Peter Pol)

This paper discusses about “two type of cities; Cities in Transition (CiTs) and International Service Cities (ISCs)”. The former are old cities that need to “diversify” their economy in order to “attract new businesses”. The latter are cities like London and Paris that are really competitive and already attractive with high levels of accessibility. HSR can contribute in the expansion of relevant regions of cities because distances are “shortened” by faster transport. This advantage attracts firms and residents to the proximity of the stations, thus increasing the status of the location. HSR “can affect the regional economy in two ways”; either by constituting “the catalyst or by having a facilitating role”. The first occurs when “new activities” are attracted, whereas the second occurs in already developed areas that need more investment to “accommodate their growth”.

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Chapter 8: Ex ante evaluation of railway station development projects – issues still to be solved (Piet Rietveld)

The most widely used method for ex-ante evaluation of railway system investments has been the Cost-Benefit Analysis (CBA) and “to a lesser extent” the Multi-Criteria Analysis (MCA). The CBA evaluates benefits on travel-time savings, induced demand and environmental impacts. The impact of the railway stations as nodes (the value of the position of the station to the network), and places (link between the station and the surrounding area) is also very important and analysis has been done on this topic by Bertolini and Spit.

Generally speaking, CBA is a method that illustrates the positive and negative impacts of a project. These impacts are quantified in monetary values whenever possible. Because costs and benefits occur in a different time from when CBA is carried out, the values are presented in Net Present Values. The main results that are used for judging the value of a project are the difference between cost and benefits, the return on investment and the benefit-cost ratio. It is a popular method for several reasons.

“Investment, maintenance and operations costs” can be easily found from data on analysis of previous similar projects. For “travel time savings”, it is not difficult to compare the times with and without the implication of the transport investment. Models are used to forecast demand of passengers and volumes of freight. Also, the Value Of Time for expressing “the value of shorter travel times” into monetary values is very useful. “VOT differs according to modes, “income classes and other characteristics of travel and travelers”. Last, one can say that it is more ‘neutral’ compared to its main competitor MCA.

Travel-time savings are not fully expressed in GDP in CBA, and that because there are situations that do not affect the GDP like when a commuter leaves from home to work later than usual since travel times have been reduced. CBA approaches welfare in such a way that all benefits for consumers are included. Also, it calculates the induced demand benefits that also affect the consumer surplus. Benefits that refer to the company operating service, the environment and safety are also estimated with CBA.

The spatial and temporal boundaries are of great importance for CBA. Spatial boundaries should not be that tight, since impacts might occur outside the area of study. To continue, the opening year is very important, because after that benefits will occur and also the time horizon should be long (20-30 years), because there are some long-term benefits that need time to be realized. Another advantage of CBA is that it can take into consideration long-run adjustments of employment in terms of work and residential location and of services.

The Dutch transport advisory Council for Transport and Public Works has categorized the several benefits of public transport into the following:

1. “Spatial and economic development
2. Possibilities to participate in activities
3. Livability in central urban areas
4. Safety
5. Stimulation of innovation of market places’’

Unfortunately some of the above benefits are not fully or covered by CBA at all. This paper discusses the abilities of CBA for evaluating the “surplus equivalence issue”, the relationship between “transport cost” changes and “land prices”, the experiential benefits of the project, and the result is that CBA cannot capture them. It seems that CBA performs well when used for policy decisions. The final suggestion is to use CBA with MCA in order to include as many benefits as possible in the ex-ante evaluation.

Chapter 9: Multicriteria analysis of a high speed railway station area development project
(Ron Vreeker)

“Multicriteria decision analysis is a family of methods” that includes more than 100 ways of evaluating projects. They are mostly used for deciding from a variety of alternatives. Their categorization can be carried out according to the type of alternatives they address, their data capabilities or the decision problem they are addressing. In general, they use a set of criteria with a set of weights in order to reflect the preferences of the decision-maker. There are three types of aggregation procedures: iterative, complete, and partial agglomeration. The iterative procedure has the advantage of choosing the most efficient from an infinite set of alternatives. When speaking about HSR, the number of alternatives is discrete and restricted, so the use of iterative methods is not appropriate.

In this kind of analysis (MCDA), it is assumed that the decision-maker structures his/her preferences between indifferent and preferential relationships, which are transitive. One of the theories based on this assumption is the Multiple Attribute Utility Theory (MAUT), which has been “used widely for economic and financial problems”. MAUT is based on the assumption of utility maximization and applications have shown that the results produced are “well-defined” and easily explained.

Criticism of MAUT has led to the development of the “Multiple Criteria Decision Aid”, which focuses on learning about the problem and produces an acceptable solution. The models derived from this school are structured by means of “preference, indifference, weak preference, and incomparability relationships”, which are possibly intransitive. Other methods use pairwise comparisons on each criterion in order to study which alternative is the most suitable.

To conclude, MCDA methods are used in order to include multiple views of the problem and evaluate the influence of multiple criteria. A long list of criteria and indicators can be formed so that the decision maker can choose which are relevant and to what extent (decide the weights on each indicator).
Summary:

Investments on transportation result in reduction of travel time and cost, improved accessibility, and reduced accidents and air pollution. These improvements result in economic growth, since money is saved and can be used for other purposes, such as attracting businesses. In this study an analysis of the potential growth-induced effects and related indirect impacts of alternative for the Bay area to Central Valley is presented. The goal of the analysis is to understand the growth effects in the local, regional, and statewide levels, from the point of view of population and employment change and land consumption.

First, an overview of the current economic condition of California is offered. Second, California’s counties are grouped into seven geographic regions and alternative scenarios are built. The scenarios include the No Project/No Action alternative (situation as it is on the day of the study) and two HST alternatives. The economic growth impact was measured with the use of the TREDIS macroeconomic simulation model. This software estimates the economic impact of transportation investments on business output, business attraction, employment, and population. As far as demand and travel time and costs are concerned, those were forecasted by the California Statewide High-Speed Rail Travel Demand Model. The possible impacts considered for the alternatives are the following:

1. "Increased employment
2. Reallocation of employment
3. Population growth
4. Residential allocation
5. Employment and population reallocation to newly developed areas"

The methodology followed was the following:

- "Definition of transportation investments
- Estimation of transportation benefits with the use of the Travel Demand Model
- Estimation of direct economic impacts
  - Business cost savings
  - Business attraction effects
  - Amenity changes
- Forecasting of land consumption
• Assessment of potential secondary impacts”

The study continues with the investigation of the HSR impacts on traffic conditions for highways, roadways, passenger transportation services (bus, air, rail, and intermodal), goods movement, parking, and transit facilities. It also describes the potential impact of induced growth on air quality, noise and vibration, energy, electromagnetic frequency, and electromagnetic interference, land use, communities, property and environmental justice. Moreover, the following issues are further discussed:

• “Farmland and agriculture
• Aesthetics and visual resources
• Utilities and public services
• Hazardous materials and wastes
• Cultural and paleontological resources
• Geology and soils
• Hydrology and water resources
• Biological resources
• Wetlands”

For the last three categories, the urbanization forecasts resulted in conceptual urbanization footprints that were combined with GIS-based maps in order to estimate the changes.

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Author: de Rus G. (2008)
Title: The Economic Effects of High Speed Rail Investment

Summary:

De Rus faces the investment of High Speed Rail as one more transportation investment whose economic benefits have to be studied before choosing to apply it. A cost-benefit analysis can help in the judgment of whether public funds should be allocated to this specific work.

High speed trains, which, according to European standards, are running at a speed of 300-350 km/hr are a very effective solution for reducing congestion, accidents, and environmental externalities. As far as the cost of its infrastructure maintenance is concerned, it can be compared to conventional rail; the problem lies with building costs, acquisition, operation, and maintenance of specific rolling stock which are very expensive. In addition, the question is whether there are social benefits that can support this new transport mode. Some of the several benefits that are produced by HSR are:
a. "Passenger time savings  
b. Increase of comfort  
c. Generation of new trips  
d. Congestion and delay reduction in roads and airports  
e. Accident reduction  
f. Environmental externalities reduction  
g. Release of needed capacity in conventional rail lines and airports  
h. Development in less developed regions (wider economic impact)"

In economics, what matters is the net benefit of the construction. In order to achieve that, different scenarios (including air and road improvements) have to be built and compared to the HSR scenario, in terms of their net balance. The reason behind this is that modal split achieves equilibrium when users have compared the generalized costs of different modes available and have chosen according to those and their willingness to pay. Also, the scenario of ‘do nothing’ has to be included, where no projects are programmed for the future, and the networks stay the same as on the day of study, but with the projected demand according to current growth. This scenario is analyzed in order to investigate whether there is any case for making an investment.

The total social costs for building and operating a HSR line can be divided in the following categories:

1) **User costs**
   a) Total time costs  
      i) Access time  
      ii) Egress time  
      iii) Waiting time  
      iv) Travel time  
   b) Reliability  
   c) Probability of accident  
   d) Level of comfort

2) **Producer costs**
   a) Infrastructure cost  
      i) Planning and land (land expropriations are quite costly)  
      ii) Infrastructure building (ex. Terrain preparation and platform building)  
      iii) Superstructure (this is the cost for the rail specific elements such as tracks and signaling system)  
   b) Operating costs  
      i) Infrastructure maintenance (ex. Cost of labor and energy consumed)  
      ii) Operating costs (ex. Train operations, sales and administration)

3) **External costs**
   a) Construction costs (ex. Barrier effect and visual intrusion)  
   b) Environmental costs (ex. Noise and air pollution, global warming effects)
It is worth noting that the average calculated ratio is not homogeneous along the network, and this has to be considered and not disregarded. The HSR benefits mostly come from the reduction of total travel time, the higher comfort and reliability that HSR offers, the reduction of the probability of accident, and the reduction of congestion that alleviates the congestion faced by other modes. Although the environmental impact of HSR is less than the other modes, it is not such an important element to consider. As far as regional impacts and inequalities are concerned, the impact of HSR cannot be captured with the analysis of cost-benefit. That does not mean that those effects are not important. On the contrary, they should also be analyzed and considered in the process of deciding whether to invest on HSR or not.

The equation that the cost-benefit analysis suggests to be fulfilled in order for the HSR investment to be socially profitable is the following (see figure II-5):

\[
\int_0^T B(H)e^{-(r-g)t}dt > I + \int_0^T C_f e^{-rt}dt + \int_0^T C_q(Q)e^{-(r-g)Q}dt .
\]

where:

- \( B(H) \): annual social benefits of the project.
- \( C_f \): annual fixed maintenance and operating cost.
- \( C_q(Q) \): annual maintenance and operating cost depending on \( Q \).
- \( Q \): passenger-trips.
- \( I \): investment costs.
- \( T \): project life.
- \( r \): social discount rate.
- \( g \): annual growth of benefits and costs which depends on the level of real wages and \( Q \).

Figure II - 9: Equation that has to be fulfilled in order for HSR to be socially profitable (de Rus Gines (2008))

The net present value of the benefits included in the above equation can be expressed as:
\int_0^T B(H)e^{-(r-g)t}dt = \int_0^T \left[ v(r^o - r^i)Q_0 + C_c \right](1 + \alpha)e^{-(r-g)t}dt + \sum_{i=1}^N \int_0^T \delta_i (q^i_1 - q^i_0)e^{-(r-g)t}dt

where:

\(v\): average value of time (including differences in service quality).

\(r^o\): average user time per trip \textit{without} the project.

\(r^i\): average user time per trip \textit{with} the project.

\(Q_0\): first year diverted demand to HSR.

\(C_c\): annual variable cost of the conventional mode.

\(\alpha\): proportion of generated passengers \textit{with} the project with respect to \(Q_0\).

\(\delta_i\): distortion in market \(i\).

\(q^i_0\): equilibrium demand in market \(i\) \textit{without} the project.

\(q^i_1\): equilibrium demand in market \(i\) \textit{with} the project.

Figure II - 10: Net Present Value of Benefits included in equation of figure II-9 (source: de Rus Gines (2008))

The literature review suggests that the rationale behind the investment of public funds to HSR depends on its ability to alleviate the congestion problem of road and air traffic, since it increases the capacity of the rail network. The direct benefits of time savings and the net willingness to pay seem to be of no such importance. Thus, it is critical to investigate the airport capacity, rail and road network situation, and existing volumes of demand, in addition to performing the cost benefit analysis.

**HSR and air transport**

As travel distance increases, the market share of HSR decreases. HSR constitutes a great alternative when the travel distance is about 500-600km, because it competes with the access, egress and waiting time of aircrafts. Moreover, the comfort served in a train is of higher level than in an airplane. HSR is also punctual and reliable, whereas airport delays occur at a more frequent rate. To conclude, the generalized cost of air transport is penalized with the cost of security control and the need for passengers to arrive at the airport earlier because of security checks, an attribute that reinforces the attractiveness of HSR.
Summary:

Knox is concerned with the question of whether high speed rail will help in the economic development of the UK. He assumes that “there is some sort of case for HSR in terms of cost-benefit analysis”. So, he is mostly interested in the wider economic effects that are not captured in the standard procedures and specifically in the potentiality for HSR to “contribute to closing the productivity gap between London and the South East and the three Northern Regions”.

He recalls research carried out by the European Spatial Perspective Observation Network (ESPON), which has estimated that regions experiencing increase of accessibility from the application of the European TEN-T, might increase their GDP by 4%. This percentage is not enough to alleviate the existing productivity gap of Northern Way. It is certain that large cities will be benefited, but will smaller ones be benefited as well or not? So, he tries to find out whether relocation of businesses will occur by investigating which of those are more attracted to time saving that HSR offers. He also analyzes the belief that time on HSR is really productive, since there is the possibility of video conference and mobile broadband internet. The influence of HSR on London and its huge agglomeration economies is also discussed.

It seems that HSR will help in the expansion of labor market and also in the linking of the economies. Moreover, economic benefits will arise from the increase of the capacity of the total network, since local and commuter rail services will be strengthened, and freight services will increase. Finally, it is believed that substantial agglomeration benefits will occur.

The conclusion of this analysis is the realization of the difficulty of quantifying the benefits of HSR, since there are many and both positive and negative. Furthermore, there are effects that have to be found a way to quantify since they aren’t captured in the standard ways of appraisal but are really important, like the clustering of “knowledge industries” that exist in the UK. To answer the question set in the beginning the solution seems to be “the linkage of regional cities together without connecting them to London”.
Title: Florida High Speed Ground Transportation Economic Benefit and Cost Impact restudy
retrieved from http://www.cefa.fsu.edu/docs/maglev.pdf

Summary:

Lynch is restudying the Florida high speed rail proposal. He focuses on four separate high speed rail studies already completed and calculates the costs and benefits into 2002 dollar values. The evaluation of the following parameters is being carried out:

1. "Economic benefits
   a. HSR project life benefits in dollars
   b. Net Present Value benefits
   c. Average NPV of economic benefits created per linear mile

2. Economic costs
   a. Net Present Value of construction costs

3. Operating costs to operate revenues

4. Job creation in absolute number

5. Benefit/cost ratio"

The economic impacts were estimated with the use of the RIMS II and REMI econometric input-output models.

The benefits of transportation are divided into "travel time savings, operating cost savings, accident costs avoided, and induced trips". The economic impacts of generated activities are divided into "sales among Florida firms, earnings by Florida workers, direct economic impact, and permanent jobs for Florida residents". Indirect benefits are categorized into "average household income and aggregate property value increase". Users' benefits included "consumer surplus, system revenues, and resource savings". Community benefits were measured by the estimation of potential increase in "employment, household income, and property values". Moreover, a sensitivity analysis was performed for the examination of impacts of changes in the corridor such as route alignment and socioeconomic outlook. Energy and air quality impacts were also studied.

The result of the researchers was that HSR will benefit the state of Florida by boosting the economy. A great number of jobs will be created, and salaries will increase.
Summary:

Pol (2003) supports the idea that urban actors are the ones that determine the level of impact of new transport infrastructure. Everything is dependent on their reaction and on the strategies they develop. The question is whether there are certain preconditions to be fulfilled in order to help the improvement of external accessibility and whether threats are also generated.

Urban actors are all the inhabitants, companies and governmental actors. Spatial behavior is different for each of these, and it is believed to be driven by the maximization of their welfare. In order to maximize welfare, people either change their transportation behavior or their location behavior. Moreover, spatial behavior is connected with the “maximum acceptable transportation distance” (MATD) of the individual and in order to predict whether HST will cause changes either in urban actors’ transportation behavior or location behavior, it is necessary to explore the way they value transport costs. The MATD of each individual is closely related with his/her income, mobility, and purpose of travel. Moreover, it is explained that infrastructure investment does not occur simultaneously in all regions, thus leading to the increase of prosperity of those who are benefited by the application of new technologies.

There is a theoretical distinction that can be made between two different types of urban systems and those are the central-places model and the network model. The first model is dominated by one single central city, the positioning of which is determined by the diversity of services that it offers. The second model mainly consists of decentralized cities, and each city is positioned depending on the relation of its services with the other ones. HST will affect the development of cities, reinforcing the existing hierarchical position of cities, perhaps improving it, but also worsening it. The growth-pole effect might occur, where economic growth does not occur in a balanced way across the region. Also, the spread effect might be illustrated, as a result of the growth-pole effect, where economic activities are not center-located but are spread in the periphery. Backwash-effects are also possible to be noted in some regions due to the decreased accessibility that they will have after HSR is introduced and some areas will be benefited versus others. Last, it is believed that new horizontal urban networks will be formed with HST, and the interaction among such cities will be enlivened.

As far as the net impact of HST in the urban region is concerned, it can be depicted in figure II-11.
Depending on:

- Connection to the HST-network
- Lower generalised transport costs (GTC)
- Longer maximum communication distance
- Economic potential of an urban region

Influence on the urban economy:
- Catalysing role
- Facilitating role

Figure II - 11: Influence of the HST on urban areas (source: van den Berg and Pol, 1998)

The “catalyzing effect” occurs when HST attracts new activities, the economy grows, and the facilitating effects when the city is already prosperous and is greatly benefited with the introduction of HST. This effect cannot be measured, since there are many other variables that influence economic growth.

The table that follows shows the categories that were developed by Schütz, who described three development areas that might be formed with the implementation of HST. According to the distance of the area and the HST station, he states the potentials of the location, the building density, and the dynamism of the development that might occur.
<table>
<thead>
<tr>
<th>Accessibility to and from the HST-station</th>
<th>OG1: Primary development zone</th>
<th>OG2: Secondary development zone</th>
<th>OG3: Tertiary development zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>direct</td>
<td>indirect</td>
<td>indirect</td>
<td></td>
</tr>
<tr>
<td>5-10 minutes</td>
<td>&gt;15 minutes, via</td>
<td>&gt;15 minutes, via</td>
<td></td>
</tr>
<tr>
<td>on foot or by a transport</td>
<td>complementary transport modes (incl. travel and change time)</td>
<td>complementary transport modes (incl. travel and change time)</td>
<td></td>
</tr>
<tr>
<td>mode such as a people mover</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location potential</th>
<th>OG1: Primary development zone</th>
<th>OG2: Secondary development zone</th>
<th>OG3: Tertiary development zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>location for high-grade (international functions)</td>
<td>secondary location for high-grade functions. Specialised functions related to specific location (cluster)</td>
<td>variety of functions depending on specific location factors</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building density</th>
<th>OG1: Primary development zone</th>
<th>OG2: Secondary development zone</th>
<th>OG3: Tertiary development zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>very high</td>
<td>high</td>
<td>high</td>
<td>depending on specific situation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development dynamism</th>
<th>OG1: Primary development zone</th>
<th>OG2: Secondary development zone</th>
<th>OG3: Tertiary development zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>very high</td>
<td>high</td>
<td>high</td>
<td>modest</td>
</tr>
</tbody>
</table>

Table II - 1: Development zones related to the accessibility of an HST-stopping place (source: Schütz, 1998)

All the issues discussed are performed in the city of Lille, France.

* * * * *

Authors: Sasaki K., Ohashi T. and Ando A. (1997)

Title: High-speed rail transit impact on regional systems: does the Shinkansen contribute to dispersion?

*The Annals of Regional Science, 31, pp. 77-98*

Summary:

Sasaki et al. are interested in evaluating the impact of high speed rail transit on spatial dispersion of economic activities and population. They formulate a supply-oriented regional econometric model and simulate five alternative hypothetical scenarios on the Shinkansen network in Japan. Their conclusion is that, if the Japanese network becomes denser, it is not sure that it will contribute to regional dispersion.

Their goal is to prove that HSR will contribute positively to the efficiency and attraction of the regions and will result in the allocation of private investment and population. The main idea of
their model is that the regional investment function is based in a two-stage process as proposed by Crow (1979), in which national investment is initially determined and then is distributed among regions according to their relative efficiency and requirement for investment. The outline of their model is depicted in figure II-2.

First, accessibility of each region is calculated according to the length of the line in each region, then the distance between the centroids of the region and the rail line, and, last, the number of passengers using the line. Then several formulas are tested based on the data collected. The data referring to the period 1975-1986 are:

d. "Prefectural incomes

e. Private investments

f. Private capital stocks

g. GDP"
The final suggestions for future research say that tourism attraction should also be studied. Also, factors such as wage differences and housing market that affect regional dispersion or concentration of population should also be included in order for the model to be more realistic.

* * * *

Authors: Schneekloth N. and Broecker J. (2003)

Title: Regional Impacts and Peripherality Issues

5th seminar of the IMPRINT-EUROPE Thematic Network “Charges for heavy goods vehicles”

retrieved from


Summary:

Schneekloth and Broecker are working in the IASON project which deals with the economic impacts of the TEN European transport investments and policies. The regional impacts of the infrastructure and the pricing policies are evaluated with the use of the following models:

3. SASI model: a quasi production function model (developed in the SASI project for the 4th framework program of the European Union)

4. CGEurope model: a spatial computable general equilibrium model (developed by Prof. Johanned Broecker)

CGEurope is a comparative static non-monetary spatial computable equilibrium model in which the world is subdivided into 1373 regions. Static means that the comparison is performed with respect to the transport cost only, while keeping everything else constant. Each region is allocated with a number of households that try to maximize their utility and firms that produce and trade goods and are maximizing their profit. The data needed are GDP, population, area characteristics, and trade flows in nominal values in Euros, which have been collected for the sake of this study from reliable European resources. Transport costs include specific characteristics of speed limit and likelihood of congestion and are composed of costs related to geographic distance (functions related to time and distance) and costs for overcoming impediments to international trade. The transfer costs of goods include both costs of freight and of personal contact for exchanging business information. The way users choose mode is calculated with a logit choice model. The scenarios were developed by the Institute of Spatial Planning of the University of Dortmund and were implemented with the use of GIS-based database available from the same Institute. Those assume a “with-world” version, in which the applied infrastructure or policy is applied and a “without-world” version.
Summary:

- "User benefits (for business and non-business travelers)
  - Travel time savings in dollars – estimated from door-to-door travel assuming average access and egress time for all modes and average in-terminal and waiting time for air, bus and high speed rail. The value of time of business travelers is greater than the non-business travelers.
  - Travel cost savings in dollars

- Economic development
  - Short to medium term changes by measuring the employment expansion in number of jobs and the employment expansion income in dollars.
    - External attraction – business growth and attraction of businesses
    - Intra-provincial –specific location business growth and attraction along the HSR corridor
  Those changes were modeled with the use of a business attraction model that captures the effects of changes in travel time and costs and has the ability to assess the corresponding impacts on business attraction. The disadvantage of this model is that it does not capture long-term and secondary effects.

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![Diagram](image)

Figure II - 13: HSR business attraction model (source: Calgary - Edmonton High Speed Rail pre-feasibility study)

- Long term effects
  - Calgary-Edmonton complementarity
- Competitive image – HSR will act as a catalyst to economic growth. It will give the potential to the corridor to be perceived as a single economic unit. Moreover, it creates the opportunity for the creation of greater economic cooperation and development between communities of the corridor.

- Property values – increase and especially near suburban stations
- Transportation network optimization
  - Road congestion and highway infrastructure – congestion problem might be alleviated
  - Average annual growth of daily vehicle volumes
  - Inter-modal connectivity and competition
    - Effect on inter-city bus transportation – might reduce its service quality
    - Effect on air transportation – add a mode choice for travelers
  - Rail freight operations and shipper benefits – contribute in the reduction of delays and improvement of speeds. Also, shipping cost shaving might decrease and create potential for existing and/or new businesses.
- Social benefits
  - Accident reduction in dollars
  - Re-shaping of growth and development – it will result in the shifting of development along the corridor and relief the pressure on land and prices in Calgary and Edmonton. The critical point here is that planning is needed in order for uncontrolled urban sprawl to be avoided.
- Environmental benefits
  - Air emissions – reduction of GHG in million metric tones
  - Noise – highway noise might be reduced, but there is the possibility of increased noise along the corridor
- Financial benefits both to residents and businesses
  - Construction employment
  - Construction employment income in dollars
  - Operations employment in number of jobs
  - Operations employment income in dollars”
C. Study of Forecasting Passenger Demand

Authors: Profillidis V.A. and Bontzoris G.N. (2005)

Title: Econometric Models for the Forecast of Passenger Demand in Greece

Summary:

Profillidis and Bontzoris have developed three econometric models for forecasting passenger demand in Greece. One is for estimating the total demand, the second for rail, and the third for private car demand. Before developing the models, analysis of the market share of each transport mode was carried out. The parameters that were found to be crucial were the car ownership and cost of fuel for the market share of private cars and the car ownership, GDP, rail fares, fares of competitive modes and travel time for the market share of railways and buses. The dependent variable was decided to be the number of passenger-kilometers. The independent variables for each model were the following:

Model 1 (total demand): GDP and cost of fuel (C\textsubscript{fuel})

Model 2 (demand for private cars): Private car ownership index (I\textsubscript{co}) and cost of fuel

Model 3 (demand for rail): Cost of fuel, private car ownership index, rail use cost per pass.-km (C\textsubscript{r}), competition expressed as the cost of using bus instead of rail (C\textsubscript{b,r}) and a time lag dependent variable that represents habitual inertia and constrains on supply (D\textsubscript{rail}(-1))

The final models were tested with eleven statistical and diagnostic tests and were finalized with the study of elasticities of independent variables. The final models are:

4. \( \ln D_{tot} = 1.667 \times \ln GDP - 0.877 \times \ln C_{fuel} + 0.991 \)

5. \( \ln D_{car} = 0.691 \times \ln I_{co} - 0.066 \times \ln C_{fuel} + 1.723 \)

6. \( \ln D_{rail} = -0.192 \times \ln C_{r} - 0.078 \times \ln I_{co} + 0.111 \times \ln C_{b,r} + 0.109 \times \ln GDP + 0.766 \times \ln D_{rail}(-1) + 1.273 \)
Appendix III – Rail map of Portugal

Source: Comboios de Portugal website
http://cp.pt/StaticFiles/Imagens/PDF/Passageiros/mapas/mapa_servicos.pdf