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Aims and Scope

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Correspondence: John Karkazis, Department of Shipping, Trade and Transport, University of the Aegean, Korais 2a str., 82100 Chios, Greece (e-mail: ikarkazis@aegean.gr)

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Contents

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HIGHWAY-BASED LOGISTICAL LINKS SPANNING TOKYO TO PIRAEUS VIA ISTANBUL: EURO-ASIAN DECENTRALIZED MODULAR SUPPLY CHAINS

Nikhilesh Dholakia, Mark M. Lennon, Syagnik Banerjee and Jerri Paquin
College of Business Administration
University of Rhode Island
Kingston, USA

Ahmet Süerdem
Istanbul Bilgi University
Istanbul, Turkey

Abtract. In the contemporary globalized economy, the nature of competition is shifting from mere direct rivalry amongst firms to more complex and systemic forms of supply chain-based rivalries. Contemporary competition is often amongst entire supply chains, interlaced with instances of cooperation

In this vein, the aim of this paper is to demonstrate that international supply chains of Asian firms have to evolve from a maritime, west-facing model to a more comprehensive model that incorporates multiple modes of transport and reaches deep into Asia. Galloping intra-Asia trade demands this, and the gradually evolving Asian Highway system presents some opportunities to Asian firms to establish flexible, customized, market-oriented supply/logistics chains that can reach deeper into many more Asian markets than is possible under current conditions. This paper analyzes the strengths and weaknesses of a future Asian-Highway to link the farthermost eastern and western ends of Asia – Tokyo and Istanbul – via a land-based artery that winds its way through all the major economic centers of emerging Asia.

More specifically this paper investigates the contributions of such a project to the peace and cooperation between Greece and Turkey. Turkey and Greece's cooperation with Japan around the AH-1 project may also benefit the EU to implement policies for a radical transformation of its economy and society towards the directions required by globalization and the new knowledge economy.

INTRODUCTION

In the contemporary globalized economy, the nature of competition is shifting from mere direct rivalry amongst firms to more complex and systemic forms of supply chain-based rivalries. Contemporary competition is often amongst entire supply chains, interlaced with instances of cooperation (Brandenburger, and Nalebuff 1996). As Kumar (2001, p. 58) points out:

Customer-facing firms at the retail level, whether large department stores, automobile dealerships, or fast-food franchises, are only the tip of the iceberg. Behind them exist entire networks of manufacturers and distributors, transportation and logistics firms, banks, insurance companies, brokers, warehouses and freight-forwarders, all directly or indirectly attempting to make sure the right goods and services are available at the right price, where and when the customers want them.

Starting with the Japanese export miracle of the last century, international supply chains of Asian firms have mostly been Pacific facing, with North America usually the main destination. This state of affairs is beginning to change, with rapid ratcheting up of intra-Asia trade. China and India's rapid growing export economies require more complex supply chain management systems connecting to multilateral destinations.

A number of political and economic developments have created the conditions for setting up Euro-Asian supply chains that rely on land-based transport using rail and road links. Consider the following:

- The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) launched the Asian Highway program, modeled roughly on the European highway system, in the early 1990s. These highways are supposed to be operational by 2010.
- At the Davos conference in January 2006, India proposed a free trade area that would encompass the ASEAN nations and six countries including Japan, China, India, Korea, Australia and New Zealand; paving the way for a common economic community in the eastern section of Asia.
- Asian Highway 1 will enable, via a ferry link between Japan and South Korea, road-based transport all the way from Tokyo to Istanbul, going through China, parts of the ASEAN region, India, Middle East, and some Caucasus countries (see Figure 1).

There is also growing desire to link the farther reaches of Asia to Europe via roads, reminiscent of the ancient Silk Road, and in a manner akin to the decades long TIR-reliant contemporary highway links between several nations of Central Asia (the former Soviet republics) and the Middle East on the one hand and EU on the other hand. TIR of course is the international system of “TIR carnet” documentation for customs-sealed road transport cargo that can cross multiple borders, developed by International Road Transport Union (IRU), the Geneva-based UN affiliated agency that promotes and facilitates road-based transport of goods and people. To demonstrate the possibility of such road links, the October 2005 IRU successfully sponsored a caravan of trucks that traveled from Beijing to Brussels. The caravan crossed from China to Kazakhstan, then through Russia and the Baltic States, entered Poland, then on to Berlin, and arrived at Brussels. The travel time was about two weeks, compared to the typical 6-7 weeks to send goods via ships from Chinese to European ports.

Within the frame of “UNECE-UNESCAP Euro-Asian Land Bridges component project”, UN emphasized the importance of developing Euro-Asian transport linkages in a meeting at Thessaloniki, in Greece. In this meeting, experts from different countries discussed the role of the Asian Highway and Trans-Asian Railway for developing intermodal interfaces as focus for development. Contributors to this meeting emphasized the necessity of analyzing economic benefits of intermodal interfaces, preparation of policy recommendations and enhancing awareness of the project for the concerned parties within the affected regions.

Under appropriately favorable conditions, Euro-Asian transport linkages could revolutionize supply chain logistics in Asia, supplementing today’s mostly maritime trade routes with various flexible routes. Euro-Asia routes for the future could be purely land-based or combine land-based options with other transport modes for versatile multimodal logistical chains.

In fact, there are several feasible alternative routes that may complement, supplement, and compete with each other: Possible land-based routes include ***Northern via Russia and Baltics; Middle via Kazakhstan, the Caspian region and Eastern Europe; and Southern via India, Iran, Turkey and Greece.*** Each of these routes has its own strengths and weaknesses. *Northern* route basically passes through the vast Russian landmass, making it too dependent merely on one country. Although management of a logistical chain system under the management of a single political power may seem to be an advantage in terms of efficiency, such a dependency carries the danger of being used as a political weapon. As may be witnessed from recent natural gas crises, it is not an uncommon practice for Russia to deploy its monopolistic position over energy sources and routes as a strategic dissuasion tool. Besides, the political relations between China and Russia are not always straightforward.

Middle route seems to be a better alternative since it connects China in a more straightforward way through Central Asian and Caucasian countries. The economies of these countries, however, usually depend on monoculture sectors such as natural resources, cotton, or animal husbandry. Their international trade turnover would not require an investment for such a grand, complex project when the economies of scale are considered. Therefore, these countries will have neither resources nor incentives for investing their parts in such mega-projects. Besides, these countries are always considered by Russia as its hinterland; thus making them vulnerable to political instabilities.

Southern route on the other hand, passes through the most dynamic parts of Asia such as ASEAN, India, and SAARC (South Asian Association for Regional Cooperation). These countries would happily invest their shares in an enhanced supply chain logistics, since their economies are oriented to the export of diverse products. Moreover, since such a chain envisions a decentralized and modular system, it would be easier to replace the missing link of the chain in case of a political or social disturbance. Alternative routes can easily replace disturbed modules. Besides, all these links; northern, middle and southern; do not exclude each other and might emerge at some point. This makes easier switching from one route to another in case of a disturbance. When we consider these advantages, a southern highway-based logistical link spanning Tokyo to Thessaloniki via Istanbul seems to be the best viable option in today's political and economic conditions.

Within this framework, the purpose of this paper is to examine the impact of decentralized Euro-Asian modular systems on supply chain logistics. Our illustrative focus is on Asian Highway 1, the only main arterial highway in the system that has Tokyo as a terminus, and that has the ambitious goal of linking several key economic centers of Asia.

Starting with a general introduction to the decentralized modular supply chain systems we examine Asian Highway system and its potential impacts on supply chain logistics. Further, we analyze the future of supply chain management under divergent scenarios to show the immense opportunities as well as the illimitable risks that various nations and corporations could face when using Asian Highway 1 as a major supply chain artery. We next turn to issues of managing logistics under such uncertainties, and on the more complex task of "managing the futures" – the very environmental conditions that spawn the opportunities and the threats. We draw implications for Turkey and Greece, and provide conclusions.

DECENTRALIZED MODULAR SUPPLY CHAIN LOGISTICS

Introduction of a series of new organization and production techniques in the late 1970's has commonly been called postfordism. Contrary to fordism which refers to a system of mass production and consumption, postfordism refers to flexible production, organization, consumption and finance systems (Jessop, 2002). As its predecessor, postfordism was brought to public attention by managerial technologies advanced in the automobile industry. Implementations of new flexible management systems by Japanese companies lead by Toyota Car Company have served as a prototype for emerging postfordism. Empowerment of workers during the production process (lean production), improvement of the quality of products and services through ongoing refinements in response to continuous feedback (TQM), customized production reckoning on constant consumer feedback instead of mass production, thus reducing the need for standing-by inventory (JIT) have lead to management systems that reduced costs while improving the quality of the end-product (Piore and Sabel, 1984).

Competitive advantages endorsed by these technologies have encouraged many other companies to follow the "Japanese management example" at the global level. Yet, large scale implementation of Japanese example extended to larger socio-sphere affecting how we live and what we consume, leading to what is referred to as postfordism. Postfordism reflects the declining importance of both scale and scope and is driven by the implementation of cost reducing information technologies in communications, logistics, and information (Reschenthaler and Thompson, 1996).

Just in time production plays an essential role in the emergence and maintenance of postfordist sociosphere. First emerged in Japan because of high land costs, JIT attempts to utilize storage and warehousing facilities optimally to achieve lean production by providing the right materials, in the right quantities and quality. Smaller but more frequent deliveries reduce the need for inventories, space requirements; smaller batch sizes facilitate to remedy defects more easily improving quality control and reducing waste (Cua, et al. 2001) and provide firms with a greater flexibility in changing product mixes according to feedback from consumer. Compared to just-in-case supply management which requires holding large inventories to back-up possible supply disruptions, the reliability of delivery, product quality and service, and communication and coordination with suppliers are substantial for sustaining JIT production environment (Karpak et al., 2001).

Although JIT works fairly well in terms of supplying techniques designed to deliver products faster and cheaper, it creates a supply chain that is extremely sensitive to risks. JIT logistics concept requires optimized, linear supply chains that operate in a fairly predictable environment. However in today's dynamic globalized business environment, demand is ultimately unpredictable requiring extremely agile and flexible strategies that will support dynamic, modular, adaptive operations. In "Adaptive Enterprise," Haeckel and Slywotsky (1999) propose a sense-and-respond (S&R) business model that would provide organizations with more anticipative, adaptive, and responsive strategies. S&R model considers unpredictability and change as a challenge for energy and growth rather than a problem to be solved.

In a concept document (2003), inspired by S&R and adaptive enterprise, US Department of Defense, Office of Force Transformation suggests some modifications to JIT. According to sense-and-respond logistics (S&RL) an effective supply chain is organized through modular units operating through interactive network structures rather than optimization of hierarchical linear chains. Networks self-synchronize through a common environment and a set of shared objectives supported by a sophisticated IT system enabling information flow, commitment tracking, and role reconfiguration. While JIT systems are sensitive to disruptions in the links of the chain, networks are strong enough to withstand node failures since they have the flexibility to switch easily from one node to another. S&RL networks distribute the risk by creating adaptive options and use transportation flexibility and robust IT to handle uncertainty.

Current efforts to modernize Supply Chain Management then focus on adaptive, flexible, modular, integrated systems rather than linear, bi-directional transportation infrastructures. Conventional logistic infrastructure systems organized according to JIC inventory systems relied on transporting inputs to the point of production and transporting the finished product to the destination of consumption. Rail and maritime routes were an effective and efficient way of transporting bulky items. On the other hand, in today's highly uncertain environment where demand is unpredictable and average life cycle for products is measured in terms of months, such an infrastructure do not have the capability to satisfy economies of scale. Logistically supporting localized production units which are more adaptive to real-time demand signals depends on adaptability and speed of response. This brings forth the importance of a transportation infrastructure relying on a network of *decentralized modular systems* which coordinate rail, maritime and highway systems through sophisticated IT replacing linear transportation infrastructure systems.

ASIAN HIGHWAY SYSTEM

In principle, the Asian Highway System presents immense opportunities to Asian and non-Asian multinational firms to develop rapid-response post-fordist supply chains. In a post-fordist environment, decentralized modular systems and tight coupling are employed to reduce warehousing and increase the integration between elements of the production and distribution systems in a complex network of relationships (see Table 1). Such a system is demand-driven. The post-fordist supply chain adapts to ongoing fluctuations at key demand and supply centers. The post-fordist transport function is tightly coupled to the production and the distribution to minimize transit and warehousing delays (Rodriguez 1999).

TABLE 1: Fordist and Post-Fordist Supply Chains

Supply Chain Characteristics	***Fordist Supply Chains***	***Post-Fordist Supply Chains***
Integration of production, distribution, and sales Activities	Discontinuous, very loosely coupled	Continuous, tightly coupled
Transportation delays	Long delays and long lead times	Short delays and lead times: aiming for decentralized modular supply chains
Stocks and inventories	Large, extensive demand-side warehousing	Small stocks, maintained at supply-side logistics centers
Demand expectations	Idealistic: stable and constant	Realistic: variable and flexible
Product form	Standardized, mass produced and marketed	Customized, often built-to-order
Sources of efficiency	Economies of scale in transport and Warehousing	Cost reduction via inventory and lead-time minimization

Source: Authors' research and conceptualization

When AH-1 is substantially operational, for example, it may be possible for a firm like Sony or Toshiba to establish an efficient, low-cost logistical hub in a location such as Vietnam to rapidly supply finished goods as well as parts and subassemblies via flexible road transport – allowing any size loads, from a single package all the way to a full container – to various locations in China, ASEAN, and India. Similarly, a logistical hub in Istanbul, Turkey can service all of Central Asia, Caucasus region, the Middle East, and southeastern EU, especially Greece where AH-1 can be connected to Europe and North and West Africa.

In essence, a post-fordist system requires fast and efficient transport of relatively non-bulky components sourced from different producing regions to be assembled according to the prevalent demand patterns in the consuming region. AH-1 offers multiple new possibilities for such post-fordist production, distribution, and demand management. To the extent AH-1 and other transnational Asian highways become operational and efficient, Asian and other companies would be able to operate distributed, flexible, and market-responsive supply chains and logistical hubs in ways that simply are not possible under a maritime transport regime (see Table 2).

FIGURE 1: The Asian Highway System, with AH-1 Emphasized

TABLE 2: Supply Chains With and Without Asian Highway System: Illustrative Case of a Japanese MNC Serving Global Markets

Supply Chain Characteristics	*Maritime-based Supply Chains*	*Multimodal Supply Chains: Maritime and Asian Highways (especially AH-1)*
Factory (assembly plant) locations	Yokohama (Japan), Guangzhou (China), Tennessee (USA)	Yokohama (Japan), Sinuiju (N. Korea), Guangzhou (China), Da Nang (Vietnam), Dhaka (Bangladesh), New Delhi (India), Teheran (Iran), Istanbul (Turkey), Thessaloniki (Greece)
Warehouse Locations	Yokohama, Hong Kong, Long Beach (USA)	Pireaus (Greece) Rotterdam (Netherlands) Lisbon (Portugal) Long Beach (USA)
Stocks and Inventories	Large	Minimal; Flexible JIT deliveries from nearest assembly plant
Main Global Markets	USA, Some EU, Eastern China	North America, Europe: EU and non-EU, Central Asia, Middle East, India and South Asia, China, Russia, ASEAN
Shipping Methods	Container Ships, then Road-based	Mostly Road-based, Container Ships for North America
Transportation Lead Times	2-6 weeks	1-7 days
Order Quantities	Usually Full Container Load (FCL)	Any quantity, even single items
Transporters	Major Global Shipping Lines	Major Global Shipping Lines; Plus Flexible Third-Party (3PL) and Fourth-Party (4PL) Logistical Service Providers

Source: Authors' research and conceptualization

The realization of the implied multimodal supply chain benefits, illustrated in Table 2, is contingent on how the geopolitical situations along the AH-1 route unfold in the coming years.

LOGISTICAL PLANNING UNDER DIVERGENT SCENARIOS

With the continuing build out of the assorted segments of AH-1, positive network externalities could be triggered. It is well known that in a telecommunications or Internet network, as the network expands with additional nodes, branches, and users; the entire value of the network increases – as a whole and to each user (Hellofs and Jacobson 1999, Katz and Shapiro 1985, Katz and Shapiro 1986). Similarly, as more areas become reachable by road-transport options provided via the Asian Highway system, the network externality effects would kick in, and the entire AH-rail-port logistical network would become increasingly more valuable. Ongoing construction efforts to connect all regions along AH-1 route would serve to boost trade, travel, and business growth along the route and amongst the various countries that AH-1 crosses.

A major necessary condition for these positive externalities to occur, however, is the issue of compatibility. Similar to the structuring of airlines, efficiencies are only achieved when one carrier can offload to another with a minimum of effort (Brueckner and Spiller1991). Along AH-1, the ability to ply trucks across multiple borders, with minimum transshipment, would help to boost the externality of the highway.

To expedite the creation of a homogeneous transport system along AH-1, free and equal negotiations involving all AH-1 nations may not necessarily be the most efficient method (Perrot 1993). Larger economies (e.g., Japan, China, and India) should agree on mutually compatible standards – not just for construction aspects but also for “soft” areas such as border-crossing protocols and GPS/sat-nav tracking methods. These larger economic powers could then use diplomatic means and economic incentives to persuade smaller countries – such as Bangladesh, Myanmar, and Turkmenistan – to accept such standards. While perhaps taking longer to implement, all affected countries along the highway, should conduct a dialogue to determine the most effective transport standards for all stakeholders (Farrell and Saloner 1988).

Having said this, however, not all standards should necessarily be dictated by governmental directives. Rather, country level cooperation should also permeate into private enterprise, with extensive inputs being sought from the firms that would conduct the actual traffic and trading. Once again, with its huge base of MNCs, Japan should involve its private corporate sector intimately in developing the standards and operating procedures for AH-1. It would make sense, for example, for Toyota to provide inputs so that its various assembly plants in diverse countries along AH-1 can link up easily via rationalized logistics/supply chains. Through “co-opetition” between companies, many operating aspects of AH-1 could be more readily implemented as de facto standards, such as which language(s) to conduct business in (Brandenburger and Nalebuff 1996). Companies that wish to take advantage of the new logistics and supply chain options emerging from the supplementary road-based transport mode possibilities of the Asian Highway system would have to be prepared with flexible and contingent ways of supply chain development and management (Kumar 2001).

MANAGING THE FUTURES: MACRO AND MICRO ASPECTS

For the operationalization of new road-based infrastructures, such as that promised by AH-1, and the creation of innovative post-fordist supply chains and logistical systems that take advantage of the AH-1 route spanning the entire Asian continent from Tokyo to Istanbul, we need a framework that develops and integrates macro and micro level policies in a stepwise fashion. The IREDOP framework, outlined in Table 3, lays out stages – requiring public policies and private strategies evolving in tandem – to convert the implied supply chain benefits of AH-1 into reality.

LIMITATIONS OF AH-1

There are, however, specific sources of risk associated with the Asian Highway system, and especially AH-1. Some major sources of risk are:

- Vast disparities in income levels and economic growth rates along the AH-1 route, making it difficult to achieve anything resembling uniform standards of road maintenance, service levels, and security/safety of transport.
- Pockets of stark underdevelopment along AH-1, creating uncertain and dangerous conditions for traffic traversing through these pockets.
- To the extent AH-1 becomes a major engine of economic change, radical transformations from agrarian (or even hunting-gathering) economies manufacturing/services economy could occur vary rapidly, causing massive social and political upheavals.
- Fundamental differences in culture, language, religion, and food could engender different political and economic goals – and spawn conflicts.

TABLE 3: Stages in Developing New Supply Chains Utilizing AH-1

Stage	What needs to be done	Entities involved in order of priority
I Identification	Manufacturing and trading companies seeking to utilize AH-1 have to identify products – raw materials, semi-finished goods, and finished products – that would be moving across land borders. Major sources (origins), destinations, and possible transshipment junctions should be mapped out.	Manufacturing firms, Trading firms, Transportation companies, Governments
R **Resolution**	For cross-border links to be operational, all potential conflicting political, economic, and legal implications of mass volume cross-border trade must be resolved. Since this is a time consuming process relying on diplomacy and intergovernmental negotiations, it should start in parallel with the "identification" stage.	Governments
E **Estimation**	Several estimations must be made prior to the commencement of cross-border road-based trade: ▪ Quantity and mix of goods that would be transported per period (say every month) ▪ Traffic flow rate and peak and off-peak times ▪ Average vehicle speeds across borders, including time spent at border crossings ▪ Potential night halt locations ▪ Potential locations of customs-bonded warehouses and transshipment points ▪ Special needs such as for refrigerated "cold logistics links" ▪ Taking all these into account, estimating the return on investment (ROI) for fleet operators and cross-border transporting firms	Manufacturing firms, Trading firms, Transportation companies, Governments
D **Development**	Development of the hard infrastructure – highways, border posts, rest areas, fueling stations, etc. Also, development of soft infrastructure such as GPS/sat-nav tracking and mobile communication networks.	Governments, telecom and IT companies, Energy companies, Hotel industry
O **Operationalization**	Commencement of road-based cross-border operations by traders and companies setting up post-fordist supply and logistics chains.	Manufacturing firms, Trading firms, Transportation companies, Governments
P **Participation**	Generating local participation and encouraging contributions of villages, cities, and businesses along AH-1 for the ongoing support, security, and viability of these supply chains.	Small Businesses, Regional Trade Associations, Local and National Police Forces

Source: Authors' research

While the economic benefits to major corporations from the post-fordist integration and flexibility afforded by AH-1 are obvious, the overall social impact and economic welfare implications are less clear-cut. Those with critical views of post-fordist production and distribution systems argue that – in these new style production systems – there is a shift in power from workers to large multinational corporations, which often results in declining wages and welfare standards (Rahman 2003). It is also likely that the ultimate gainers would be consumers in advanced nations, enjoying benefits of low prices; and giant retail enterprises with global supply chains (such as Wal-Mart); rather than newly emergent Asian multinationals or Asian small and midsize firms.

IMPLICATIONS FOR TURKEY AND GREECE

The creation of distributed supply chain networks along the length of AH-1 have the potential for boosting cross-border trade, reducing income disparities across the regions along the AH-1 route, and triggering off a Keynesian multiplier effect – leading to improvements in consumption, employment, productive skills, and other socioeconomic factors. To the extent the conditions for "peace and cooperation" can be maintained, AH-1 and its connections to the E-routes can become the foundation of a new wave of economic miracles.

Therefore, creating viable major land-rail-sea transport corridors between Asia and Europe as alternative options to traditional sea routes for multimodal operations will basically boost the economies involved. Although, at a first glance Greece seems to be a loser in this project since it has a dominant position within traditional sea routes, AH-1 may have great potential for boosting its position as a maritime hub connecting Asia to Europe, and North and West Africa.

Another important implication of AH-1 for Turkey and Greece would be to find alternative opportunities for financing the development of new industries and transportation systems. We have mentioned in the previous lines that industrial production systems are witnessing some major transformations requiring a network organization of supply chain logistics. As the nation with the longest experience and deepest knowledge of postfordist production systems, Japan is in a strong position to become a disseminator of such knowledge to involved enterprises and populations. Also, as World's preeminent nation in terms of surplus available capital, Japan can contribute substantially to the huge expense of developing the hard and the soft infrastructure for the construction and operation of supply chain networks. Involvement of Japan to this project means more finance opportunities at competitive interest rates and will provide Turkey and Greece with more negotiation power towards other sources. Evidence of such a role by Japan is already evident in India, where Japan is providing massive assistance to upgrade India's highly inadequate internal highway and port infrastructure.

Turkey and Greece's cooperation with Japan around the AH-1 project may also benefit the EU to implement policies for a radical transformation of its economy and society towards the directions required by globalization and the new knowledge economy. The Lisbon Agenda (2000) sets fundamental objectives for the future of EU as pursuing economic reforms to prepare for the knowledge economy and strengthening the European social model by investing in people. Japan's know-how in combining knowledge economy with network types of organization may serve EU to reach the first one of these objectives. Furthermore, the private sector may benefit from the alternative finance opportunities provided by Japan, facilitating EU and individual governments to concentrate more on social policies. Multiplier effect contributed by the AH-1 project may relieve the "enlargement fatigue" of the EU and may facilitate the integration of new members.

SUMMARY AND CONCLUSIONS

International supply chains of Asian firms have to evolve from a maritime, Pacific-facing model to a more comprehensive model that incorporates multiple modes of transport and reaches deep into Asia. Galloping intra-Asia trade demands this, and the gradually evolving Asian Highway system presents some opportunities to Asian and European firms to establish flexible, customized, market-oriented supply/logistics chains that can reach deeper into many more Asian markets than is possible under current conditions. Such supply chains can also provide fast and alternate road-based Euro-Asian links, in some cases saving up to 70% of the time spent by goods on ships.

In particular, AH-1 presents a unique opportunity to link the farthermost eastern and western ends of Asia – Tokyo and Istanbul– via a land-based artery that winds its way through all the major economic centers of emerging Asia. Greece appears as a major hub for bridging AH-1 to Europe through maritime routes. When AH-1 is substantially operational, Japanese and other Asian firms would be able to craft out efficient logistical hubs at various strategic locations along AH-1, and serve much of Asia and

Europe in flexible, low-cost ways. Pireaus port may serve as a gateway to Europe, North and West Africa, and further to North America within this system.

As the Asian Highway system takes shape, besides the need for continuous and intense government-level and corporate-level efforts, academic research enterprise would also need to reorient to study the new patterns of competition and supply chain logistics enabled by such land-based transport infrastructure. We hope this paper contributes by motivating further academic research and policy oriented thinking focusing on new patterns of Euro-Asian supply chain logistics.

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THE GREEK OIL TANKER FLEET IN THE MIDDLE EAST

George Economakis
University of the Aegean
Chios, Greece

Maria Markaki
National Technical University
Athens, Greece

Panayotis Michaelides
National Technical University
Athens, Greece

Abstract. The purpose of the present paper is to examine the role of Greek controlled oil tanker fleet in the building of Middle East oil sea transportation network. Meanwhile, we examine the factors that affect, both, the magnitude and the modernisation of Greek controlled oil tanker fleet that operates in the area. In this context, the paper investigates the factors that presumably influence the magnitude and the average age that, practically, expresses the rate of upgrading and modernising the Greek controlled oil tanker fleet. The paper uses regression models which test for the significance of these factors. The empirical results show that crucial factors which influence the magnitude and the average age of the Greek controlled oil tanker fleet that is active in the Middle East are the macroeconomic environment of the country, and the EU framework as well as the volume of seaborne trade of crude oil in the area.

Keywords: Greece, Middle East, sea transportation, oil tanker fleet, modernisation.

1. INTRODUCTION

Crude oil constitutes an important energy resource to the international economic system, and at the same time it functions as raw material and intermediate good for the chemical and plastic industries. The strategic importance of oil depends, primarily, on two factors: the quantity of crude oil reserves and the availability of these reserves. Since oil transportation, globally, is dominated by seaborne trade, the strategic importance of oil accentuates, in turn, the strategic importance of oil tanker fleet. As we know, the great majority of oil reserves are to be found in the Persian Gulf. However, their accessibility is very limited and it is made possible only through hazardous routes. Japan and Europe are the most susceptible geopolitical areas in the supply of crude oil. Given that the main volume of crude oil reserves is to be found in the Middle East, its oil transportation by sea routes is of great importance for the integration of the international network transportation system, especially that of Middle East - Europe - Japan (Ioakeimoglou and Milios 1991).

The purpose of the present paper is to examine the role of Greek controlled oil tanker fleet in the building of Middle East oil network sea transportation, while attempting to examine the factors that affect the magnitude and the modernisation of Greek controlled oil tanker fleet operating in the area. In other words, the present paper empirically tests for the factors that presumably influence the magnitude and the age of the Greek controlled oil tanker fleet with the aid of the relevant econometric techniques.

The paper is structured as follows: in section 2 we present some stylized facts about the Greek fleet; in section 3 we examine the factors that presumably influence the magnitude of the Greek owned oil tanker fleet in the Middle East; in section 4 we examine the factors that presumably influence the modernisation of the Greek owned oil tanker fleet in the area; finally, section 5 concludes the paper.

2. STYLIZED FACTS ABOUT THE GREEK FLEET

According to Shipping Statistics and Market Review (1997-2006), in 2005 Greece controlled nearly 18% of the world's fleet and, in particular, 19% of the world tanker’s fleet by tonnage. The country specializes in oil tankers and carriers that transport bulk commodities. Also, in 2005 the fleet controlled by the Greek tanker owners had increased by 40% since 1997, while over the same period the total world tanker fleet had increased by only 21.7% (Shipping Statistics and Market Review, 1997-2006).

With the exception of cargo and passenger ships, increases were noted in all categories, while the largest increases are, among other categories, in oil tankers. However, the Greek fleet has embarked on a renewal program with a significant number of new-building orders and purchases of more modern vessels.[1] More specifically, according to the Shipping Statistics and Market Review (2002-2006) the average age of the Greek controlled fleet continued to decrease during the past years (from 19.6 in 2002 to 17.7 ages in 2005) as was the case with the Greek controlled tanker fleet (18.4 in 2002 to 14.4 ages in 2005) and thus came closer to the average age of the world fleet, i.e. 17.4 and 15.3 in 2005 respectively. On the other hand, the average age of the existing Greek flagged fleet (from 18 in 2002 to 14.2 in 2005) and Greek flagged tanker fleet (from 16.7 in 2002 to 11.1 in 2005) has slightly decreased (Shipping Statistics and Market Review, 2002-2006).

Finally, the Greek oil tanker fleet has increased significantly as percentage of the world's oil tanker fleet since 1997 (from 16.6% in 2002, to 19.9% in 2005) a fact that underlines the crucial strategic role of Greek oil tanker fleet in the international oil network sea transportation[2] (Shipping Statistics and Market Review, 1997-2006).

TABLE 1: World and Greek Owned Fleet, World and Greek Owned Oil Tanker Fleet (selected years)

Year	World fleet (dwt)	Greek owned fleet (dwt)	Greek owned fleet share (%)*	World's oil tanker fleet (dwt)	Greek owned oil tanker fleet (dwt)	Greek owned oil tanker fleet's share (%)*
1997	713,303	114,951	16.12%	300,132	49,949	16.64%
2000	753,226	131,722	17.49%	318,415	57,720	18.13%
2002	791,345	148,856	18.81%	327,548	65,030	19.85%
2005	879,922	160,560	18.25%	365,316	70,101	19.19%

Source: Shipping Statistics and Market Review, various volumes 1997-2006

Notes: * Authors' elaboration

Inasmuch as the main volume of crude oil reserves is to be found in the Middle East, the role of Greek

[1] However, the continual change in regulations has created a strict environment for vessels and shipping companies since they have to comply with higher quality and specification standards and more rigorous inspections. In this context, there is tendency towards fewer and larger tanker companies which are in a position to invest in younger vessels and new-buildings (C.E.C. 2001).

[2] And in the international network sea transportation in general as well, since already at the beginning of 1960s the volume of seaborne oil has overcome the total amount of any other load (Thanopoulou 1994: 46).

oil tanker fleet is strategically crucial in the building of Middle East, and thus international, oil network sea transportation: the magnitude of Greek controlled oil tanker fleet indicates the importance of Greek controlled shipping in the building of Middle East and international oil network sea transportation.[3] But at the same time, the Middle East oil production (the load of oil that is being transported by sea routes in the area) exerts impact on Greek controlled oil tanker fleet, on the magnitude of Greek owned oil tanker fleet that operates in the area and on the modernisation of Greek controlled oil tanker fleet in general and in particular of that part of it operating in the Middle East (decrease of middle age: the age of fleet constitutes a very important characteristic of the fleet's performance). It is a matter of negative relation to the role that Greek controlled oil tanker fleet plays in the building of Middle East oil network sea transportation.

However, except for the linkage between Greek controlled oil tanker fleet and Middle East oil production, our findings underline the significance that the Greek social formation holds in the advancement of Greek controlled shipping and especially in the fleet's modernisation. This means that the Greek controlled oil tanker fleet (and therefore that part of it operating in the Middle East) is affected by the economic dynamic of Greek social formation (as this is roughly expressed through Greek G.D.P.). Our findings also show the impact of the E.U. environment (expressed through E.U. real interest rate) in the growth of Greek controlled oil tanker fleet that operates in the Middle East.[4]

In our investigation we use hypothesis testing with linear regressions which is appropriate for the purposes of the present analysis.[5] Also, it should be noted that the time series analysis was subject to data availability.

[3] The "cross-trading" character of Greek navigation (see Thanopoulou 1998), underlines its strategically crucial role in the building of the Middle East and international oil network sea transportation.

[4] For a microeconomic approach to world shipping, and in particular tanker fleets, based on the theoretical notion of equilibrium between supply and demand see Beenstock & Vergottis (1993, ch. 5).

[5] In our analysis we make the assumption that the independent variables we use do not depend on any other variables. Such an investigation (of the dependence of the – independent – variables we use on any other variables) would be extraneous to the theoretical or empirical scope of this paper. Thus, we do not use a system-of-equations approach for the empirical estimation of the model.

3. THE MAGNITUDE OF GREEK OWNED OIL TANKER FLEET

3.1. The hypotheses

In order to investigate the factors that presumably influence the magnitude of the Greek owned tanker fleet which is involved in the Middle East crude oil trade we use hypothesis testing:

The first hypothesis is that the Middle East oil production (the load of oil that is being transported by sea routes in the area) exerts a positive impact on the magnitude of Greek controlled oil tanker fleet that operates in the area. This hypothesis could be viewed as the result of a broader assumption, namely that, in the long run, the world production (and demand) determines *ceteris paribus* the volume of the transportation services (that is the volume of the carriers that intermediate between production and consumption), and especially the volume of the merchant fleet, inasmuch as it determines the amount of freights, that is the revenue of ship-owners (see Thanopoulou 1994: 152-153). More precisely, the magnitude of the world oil trade (the seaborne trade of crude oil and oil products) determines the relevant (and corresponding to it) magnitude of the sea transportation, i.e. fleets of oil tankers, both at a national and international level (see Economakis et al 2003).

The second hypothesis is that the (average) E.U. real interest rate (as expression of the cost of capital in the E.U. macroeconomic environment) has a negative impact on the growth of Greek controlled shipping that operates in the Middle East.[6] This assumption is based on the traditional Keynesian framework (see e.g. Milios et al 2000: 415), according to which the interest rate, as a measure of the cost of capital, should affect decisions to invest. The direction of this impact is well documented to be negative (see e.g. Dornbusch and Fischer 1990: ch. 9; Milios et al 2000: ch. 9) in the sense that, the lower the interest rate is, the higher the present value of the cash flows is. At the same time, interest rate, as part of the cost of capital, aggravates the profits of firms and therefore, given the fact that firms

[6] Instead of the (average) E.U. real interest rate which is the typical expression of the cost of capital in the E.U. macroeconomic environment, the Eurolibor could have been alternatively used. It expresses the global interest reference rate (benchmark) used throughout the capital and derivatives markets. However, its use is limited as a macroeconomic variable, since investment expectations and decisions are not based on it, and especially in the shipping sector. This is due to the fact that Euro libor rate is fixed once a day by a small group of large banks and fluctuates throughout the day. Actually, at this interest rate banks borrow funds from other banks in the London interbank market. Euro LIBOR exists mainly for continuity purposes in swaps dating back to pre-euro times and is not commonly used (Investopedia, 2007).

borrow to (partly) finance their investments, we may affirm the thesis that the lower the interest rate, the more favourable these acts of investment are.

However, empirical studies have shown that although the effect that the interest rate has on investment is statistically significant, the investment is inelastic with respect to interest rate (e.g. Petraki-Kotti 1996; Michaelides et al 2005). However, this second hypothesis is based on the fact that “maritime capitals circulate in the first place from European credit and banking institutions” (Kachris : internet). That is the reason why we use average E.U. real interest rate as a measure of the cost of capital that affects maritime investment decisions of Greek capitalists.

Finally, there are two key assumptions related to our investigation. First, we assume that the Greek ship-owners lease their ships with no specific preference for sea routes[7] and, second, we assume that there is no differentiation in the order of magnitude (tonnage) of the oil tankers that operate in the various sea routes. Given these assumptions we will test the hypothesis that the Greek oil tankers which are involved in the Middle East oil trade follow (or are determined by) the proportion of the crude oil seaborne trade of this area to the world’s crude oil seaborne trade.

3.2. The data and the variables

The data is on annual basis and covers the period 1997-2006. The data time series for the magnitude of Greek owned oil tanker fleet and seaborne crude oil trade from the Middle East comes from various volumes of the annual edition “Shipping Statistics and Market Review” published by I.S.L. (Institute of Shipping Economics and Logistics). The macroeconomic data about the average E.U. interest rate comes from the “Statistical Annex of European Economy” published by the European Commission.

[7] Or, in other words, “the Greek navigation takes traditionally action in the sector of TRAMP navigation” (Thanopoulou 1994: 67, see also 29).

TABLE 2: Crude Oil Seaborne Trade and Greek Owned Oil Tanker Fleet Involved in the Middle East (selected years)

Year	World's crude oil seaborne trade (million tons)	Crude oil seaborne trade from Middle East (million tons)	Middle East's crude oil seaborne trade share (%)	Greek owned oil tanker fleet involved in Middle East (dwt)*
1997	1534,4	782,7	51.01%	25,479
2000	1607,5	789,5	49.11%	28,348
2002	1588,2	721,1	45.40%	29,526
2005	1795,2	885,2	49.31%	34,567

Source: Shipping Statistics and Market Review, various volumes 1997-2006

Notes: * Authors' elaboration

TABLE 3: EU real interest rate (selected years)

Year	(%)
1997	6,1
2000	5,4
2002	4,9
2005	3,4

Source: Statistical Annex of European Economy, 2006

Dependent variable:

- The dependent variable, magnitude of the Greek owned oil tanker fleet in year *t*, is measured in deadweight ton (dwt).

Independent variables:

- The independent variable, Seaborne Crude Oil Trade from Middle East in year *t,* is measured in million tons.
- The independent variable, EU average real interest rate in year *t*, is given as a percentage (%).

3.3. Empirical Results

As we have already said, our analysis tests for the significance of the factors, which presumably influence the magnitude of the Greek owned tanker fleet which is involved in the Middle East crude oil trade. The relationship is assumed to be linear, and we use a time-series data set for the time period 1997-2006. The results of the regression analysis demonstrated no evidence of serious multicollinearity among the independent variables, so in the basic specification we use all of them simultaneously. Also, the DW-statistic does not provide evidence of autocorrelation of the residuals.

Specifically, the basic model for estimating the Greek owned oil tanker fleets' magnitude is:

$TF_t = f\,(OIL_t, i_t)$

where:

TF_t = Magnitude of the Greek owned tanker fleet involved in Middle East in year *t*

OIL_t = Seaborne Crude Oil Trade from Middle East in year *t*

i_t = Average EU Real Interest Rate in year *t*

f : Linear Function

Table 4 presents the regression results.

The estimated coefficients are statistically significant and the regression explains 0.894 of the variability of the Greek tanker fleet involved in Middle East. Also a constant term is included because omission of this term might bias the results substantially. The signs of the estimated coefficients are consistent with the theoretical framework presented above, since the increases in the seaborne crude oil trade from Middle East lead to increases in the magnitude of the Greek owned oil tanker fleet that operates in the area. Meanwhile, the decreases in E.U. real interest rate favour the maritime market, that is, in what we investigate here, investments aiming at the increase in the magnitude of the Greek owned oil tanker fleet that operates in the Middle East.

TABLE 4: Regression Results on the Determinants of the Magnitude of Greek Oil Tanker Fleet Operating in Middle East, 1997-2006

	TF
Constant	19857.029 (2.610)*
OIL	19.279 (2.293)*
i	-1979.065 (-4.400)*
R^2	0.894
Std. Error of the Estimate	1166
F-ratio	29.4
Durbin-Watson	1.804

Notes: * Significance at the 1% level or higher

An interesting observation is that the interest rate affects the magnitude of the fleet but not its modernisation (see also below). This is a logical outcome of the fact that the growth of the fleet does not imply in any case the purchase of new vessels. On the contrary, the purchases of second-hand vessels “were the spinal column and the vaulting horse”, particularly, for (the competitiveness of) Greek ship owning (Thanopoulou 1994: 143, 152-155).

We must point out that the age as a “structural fleet characteristic” seems “to have a potential two-edge impact on shipping competitiveness” (Thanopoulou 1998: 364). On the one hand, for a given constant cost and given the payments and the “naval profession” of the crew (see Thanopoulou 1994: 144-145) an aging fleet implies decreases in quality and competitiveness along with increases in the ship’s variable operation/transportation costs (Economakis et al 2003). According to Thanopoulou (1998: 363, 366) an older fleet would involve higher “variable costs”, that is “higher voyage and operating costs”: “higher fuel consumption” or “higher consumption/manning scales of older vessels”. Moreover, older fleets are “more labour intensive”. On the other hand, “in a paradoxical way”, although “detrimental” for the competitiveness of the fleet, in the case of Greek fleet “the old age…contributed largely to the increased cash-flow resilience and availability of reserves of Greek shipping as its old vessels bought second-hand and to a large extent paid-up had less or even nil financial obligations to lending organizations" (Thanopoulou 1998: 364). In this way the Greek shipping confronts the oil crisis of the decade of 1980 (see below).

A matter of great interest is the extent of change in the magnitude of Greek owned oil tanker fleet that operates in the Middle East as a result of a change in the seaborne crude oil trade from Middle East, and in E.U. real interest rate. In other words, we are interested in the elasticity of the magnitude of the Greek owned oil tanker fleet that operates in the Middle East. Table 5 presents the average elasticity of the Greek owned oil tanker fleet that operates in the Middle East, with respect to the independent variables.

TABLE 5: Elasticities of Magnitude of Greek Oil Tanker Fleet Operating in the Middle East, 1997-2006

Elasticities	*Formula*	*Estimate*
$\varepsilon_{TF,OIL}$	$\frac{\partial TF}{\partial OIL}\frac{OIL}{TF}$	0.52
$\varepsilon_{TF,i}$	$\frac{\partial TF}{\partial i}\frac{i}{TF}$	-0.186

The average elasticity of the magnitude of the Greek owned oil tanker fleet that operates in Middle East with respect to the seaborne crude oil trade from the Middle East is 0.52, which means that for an anticipated 1% increase in seaborne crude oil trade from Middle East, the magnitude of the Greek owned oil tanker fleet that operates in Middle East will increase on average by 0.52%. It is obvious that the magnitude of fleet is non-elastic with respect to seaborne crude oil trade from the Middle East. The inelastic behaviour of the magnitude of the Greek owned oil tanker fleet means that the magnitude presents a smaller percentage change for a given percentage change in the seaborne crude oil trade from Middle East. Therefore, although the effect which the seaborne crude oil trade from Middle East has on the magnitude of the Greek owned oil tanker fleet that operates in the area is statistically significant, a significant increase of seaborne crude oil trade from Middle East is required for a significant growth of the magnitude of the Greek owned oil tanker fleet that operates in Middle East (and vice-versa).

A possible explanation for this inelastic behaviour can be formed by building on the analysis of Milios and Ioakeimoglou (1991-b). Investigating the impact of the oil crises of the 1980s and the consequent reduction of the world oil trade in the tonnage of the world and Greek owned oil tankers fleet, they suggest that the fact that the tonnage of world oil tankers had decreased while the tonnage of Greek owned oil tankers had increased is due to the processes of concentration of the world oil tanker tonnage in the hands of the big maritime companies, among which belong the Greek shipowners (as one might expect: "Increased acquisitions of second-hand tonnage were on the basis of this increase" – Thanopoulou 1998: 364.) The trend towards concentration of maritime capital as long as it was activated by the reduction of world oil trade, during the 1980s, in a way, interrupts (or counteracts to) the positive relation between the magnitude of the Greek owned oil tanker and the seaborne crude oil trade during the investigated period, inasmuch they have led to an oversupply of Greek owned oil tanker fleet's tonnage. This oversupply during the crisis period is expressed through this inelastic behaviour of the magnitude of the Greek owned oil tanker fleet of the examined period with respect to the seaborne crude oil trade.

The elasticity of the magnitude of the Greek owned oil tanker fleet that operates in the Middle East with respect to the real E.U. interest rate is -0.186, which means that for an anticipated 1% decrease in real E.U. interest rate, the magnitude of the Greek owned oil tanker fleet that operates in Middle East will increase on average by 0.186%. It is then also obvious that the magnitude of the fleet is non-elastic with respect to real E.U. interest rate, as expected. The inelastic behaviour of the magnitude of the Greek owned oil tanker fleet means that the magnitude of the fleet presents a smaller percentage change for a given percentage change in the real E.U. interest rate. Therefore, although the effect which the real E.U. interest rate has on the magnitude of the Greek owned oil tanker fleet that operates in Middle East is statistically significant, a change in real E.U. interest rate will, practically, have a very limited effect on shipping investments, since these investment are non-elastic with respect to interest rate.

4. THE MODERNISATION OF GREEK OWNED OIL TANKER FLEET

4.1. The hypotheses

We turn now to the investigation of the factors that presumably influence the modernisation (i.e. decrease in the average age) of the Greek owned oil tanker fleet. We also make two hypotheses:

The first one is that the Middle East oil production (the load of oil that is being transported by sea routes in the area) not only exerts a positive impact on the magnitude of Greek controlled oil tanker fleet that operates in the area but also exerts a positive impact on the modernisation (and thus in the competitiveness – see above) of Greek controlled oil tanker fleet (decrease of middle age as the load of oil that is being transported by sea routes in the area augments).

This hypothesis is also a result of a broader assumption, namely that the world production (and demand) determines *ceteris paribus* the modernisation of the transportation services, and especially the modernisation of the merchant fleet. More precisely, the magnitude of the world oil trade (the seaborne trade of crude oil and oil products) determines the modernisation of the sea transportation, i.e. fleets of oil tankers, both at a national and international level, inasmuch as it ensures or not (as a market of freights) the realization of the value invested in new vessels. This realization of value invested in new vessels becomes particularly crucial for oil tanker fleets since, according to MARPOL and OPA's 90 regulations, the new building oil tankers must dispose after 1996 (MARPOL) or 1994 (OPA 90) double hulls, while all non-double hulls oil tankers must be taken off at the latest until 2015 (see also American Bureau Of Shipping, internet site; Ferrel internet site; Gibson 1997; Unites States Coast Guard, internet site; Thanopoulou 1998: 367). However, this does not mean that before the terminal dates the second-hand oil tanker vessels will be out of demand. Besides, this is why, as we have noted above, interest rate does not affect the modernisation of oil tankers fleet.

The second assumption is that the Greek controlled oil tanker fleet (and therefore that part of it operating in the Middle East) not only affects the Greek social formation,[8] but it is also affected by the conditions of reproduction of the Greek social formation, as they are roughly expressed through Greek G.D.P. This assumption is based on the theoretical argument (see Milios and Ioakeimoglou 1991a; Milios and Ioakeimoglou 1991b) that the Greek society produces and reproduces in expanded scale, and in the frame of the overall historic social reproduction of Greek social formation, the social relations and the social carriers of Greek navigation, producing-reproducing thus the corresponding productive forces (the modernisation- competitiveness of oil tankers fleet in our case); this is done either directly (the case of Greek flag fleet) or indirectly (the case of Greek owned fleet under flag of convenience). These relations and carriers do not simply express the "pure" capital dominance, but a capital dominance which embodies the historicity of "naval profession", as a historical element of (the capitalist reproduction of)

[8] "Shipping influences the economy… both Greek shipowners and seamen remit, in the form of foreign exchange inflow, funds into the economy for various reasons. […] Thus, shipping was and still is a sector that has helped the Greek Balance of Payment to balance" (Goulielmos 1997: 247-248).

Greek social formation: the skills of seafarers;[9] the “business acumen” of Greek ship-owners, as the historical product of capitalist dynamic which led to neo-Greek state through the dissolution of Asian relations of production (see Milios 2000); the articulation of sailoring as a factor of class emergence and complexness within the productive and class structure of Greek social formation, which is capitalistically reproduced, producing and reproducing its structural class and historical elements.[10] So, insofar as the expanded reproduction of the Greek capitalism (as it is historically formed) is linked with the expanded reproduction of Greek navigation, the latter’s reproduction is based on (and it is affected by) the overall conditions of national capitalist development, inasmuch as the former prompt the socioeconomic environment towards the reproduction of its vital elements.

In our analysis we assumed, implicitly, that there is no differentiation in the average age of the Greek owned oil tankers that operate in the various sea routes. Thus, our conclusions have simultaneously a general and a specific dimension (factors that affect the modernisation of Greek owned oil tankers and therefore that part of it operating in the Middle East).

4.2. The data and the variables

The data is on annual basis and covers the period 1997-2006. The time series for the age come from various volumes of the annual edition “Shipping Statistics and Market Review” published by the Institute of Shipping Economics and Logistics (ISL). The macroeconomic data on Greek G.D.P. comes from the “Statistical Annex of European Economy” published by the European Commission.

[9] If one aspect of the seafarer’s skill is historically spontaneous (pertaining to the historic past) the other is rather a conscious consequence of this Greek naval historicity: “Greek shipowners since 1973 accepted to help the Greek state to run nautical schools…through the so-called Marines Education Fund” (Goulielmos 1997: 249). Thus, in spite of the “reduction in nationality requirements for Greek flag vessels […] the importance of Greek seafarers for sustaining a pool of maritime knowledge cannot be underestimated” (Thanopoulou 1998: 371-372).

[10] According to Union of Greek Ship-owners “Shipping can enable one to raise a small capital very fast through one’s wages and it can enable one to sign off and start a new job or business of his own on shore at a very early age” (cited in Goulielmos 1997: 250). But, this is a case of emergence of simple commodity production and of traditional petite-bourgeoisie under capital dominance, and of articulation of a non-capitalist form of production within the capitalist system of production (see Economakis 2000).

TABLE 6: Average Age of the Greek Owned Oil tanker fleet (selected years)

Year	Age
1997	18.1
2000	18.9
2002	18.4
2005	14.4

Source: Shipping Statistics and Market Review, various volumes 1997-2006

TABLE 7 Greek GDP at constant 2000 prices (selected years)

Year	Billions of Euros
1997	112,69
2000	125,9
2002	138,28
2005	157,49

Source: Statistical Annex of European Economy 2006

Dependent variable:

- The dependent variable, average age of the Greek owned oil tanker fleet in year *t*, is measured in years.

Independent variables:

- The independent variable, Seaborne Crude Oil Trade from the Middle East in year *t*, is measured in million tons.
- The independent variable, Gross Domestic Product (G.D.P.) of Greece in year *t*, is measured in billions of Euros.

4.3. Empirical Results

The analysis tests for the significance of the factors, which presumably influence the age of the Greek owned tanker fleet that is involved in the Middle East crude oil trade. The relationship is assumed to be linear, and we use a time-series data set for the time period 1997-2006. The results of the regression analysis demonstrated no evidence of serious multicollinearity among the independent variables, so in the basic specification we use all of them simultaneously. Also, the DW statistic does not provide evidence of autocorrelation of the residuals.

Specifically, the basic model for estimating the Greek owned oil tanker fleets' magnitude is:

$AGE_t = f(OIL_t, Y_t)$

where:

AGE_t : Average age of the Greek owned oil tanker fleet involved in the Middle East in year *t*

OIL_t : Seaborne Crude Oil Trade from Middle East in year *t*

Y_t : Gross Domestic Product of Greece in year *t*

f : Linear Function

Table 8 presents the regression results.

The estimated coefficients are statistically significant and the regression explains a very high 0.928 of the variability of the average age of the Greek oil tanker fleet (and therefore that part of it operating in the Middle East). The signs of the estimated coefficients are consistent with expectations, since the increase of the seaborne crude oil trade from Middle East decreases the age of the Greek owned oil tanker fleet and the increase in Greek G.D.P. favours the modernisation of the Greek owned oil tanker fleet (while, as we have noted, the interest rate does not affect oil tankers fleet's modernisation).

TABLE 8: Regression Results on the Determinants of the Average Age of the Greek Oil Tanker Fleet, 1997-2006

	AGE
Constant	39,26 (13,669)*
OIL	-0,019 (-3,489)*
Y	-0,050 (-2,769)*
R^2	0,928
Std. Error of the Estimate	0,58895
F-ratio	22,054
Durbin-Watson	1,805

Notes: * Significance at the 1% level or higher

A matter of great interest is the change in the age of the Greek owned oil tanker fleet as a result of a change in the seaborne crude oil trade from Middle East, and in Greek G.D.P. In other words, we are interested in the elasticity of the age of the Greek owned oil tanker fleet. Table 9 presents the average elasticity of the age of the Greek owned oil tanker fleet (and therefore that part of it that operates in the Middle East), with respect to the independent variables.

TABLE 9: Elasticities of the Average Age of the Greek Oil Tanker Fleet, 1997-2006

Elasticities	*Formula*	*Estimate*
$\varepsilon_{AGE,OIL}$	$\dfrac{\partial AGE}{\partial OIL}\dfrac{OIL}{AGE}$	-0.883
$\varepsilon_{AGE,Y}$	$\dfrac{\partial AGE}{\partial Y}\dfrac{Y}{AGE}$	-0.393

The elasticity of the age of the Greek owned oil tanker with respect to the seaborne crude oil trade from Middle East is -0.883, which means that for an anticipated 1% increase in seaborne crude oil trade from Middle East, the average age of the Greek owned oil tanker fleet that operates in Middle East will decrease on average by 0.883%. It is obvious that the age of fleet is non-elastic with respect to seaborne crude oil trade from Middle East. The inelastic behaviour of the age of the Greek owned oil tanker fleet means that the age presents a smaller percentage change for a given percentage change in the seaborne crude oil trade from Middle East. Therefore, although the effect which the seaborne crude oil trade from

Middle East has on the age of the Greek owned oil tanker fleet is statistically significant, a significant increase of seaborne crude oil trade from Middle East is required for a significant reduction of the age (modernisation) of the Greek owned oil tanker fleet.

The elasticity of the age of the Greek owned oil tanker fleet that operates in the Middle East with respect to Greek G.D.P. is -0.393, which means that for an anticipated 1% decrease in Greek G.D.P., the age of the Greek owned oil tanker fleet that operates in the Middle East will decrease, on average, by 0.393%. It is obvious that the age of the fleet is also non-elastic with respect to Greek G.D.P. The inelastic behaviour of the age of the Greek owned oil tanker fleet means that the age of the fleet presents a smaller percentage change for a given percentage change in the Greek G.D.P. Therefore, although the effect which the Greek GDP has on the age of the Greek owned oil tanker fleet is statistically significant, a significant increase of Greek G.D.P. is required for a significant reduction of the age (modernisation) of the Greek owned oil tanker fleet.

Both these inelastic behaviours of the age of the Greek owned oil tanker fleet (and of its part operating in the Middle East) with respect to the seaborne crude oil trade from Middle East and to Greek G.D.P. pertains to the “paradoxical” significance (which we have tried to mark out in the previous analysis) that secondhand vessels have to the competitiveness of Greek shipping (secondhand vessels as “the spinal column and the vaulting horse” of the competitiveness of Greek ship-owning). More precisely, insofar as the second-hand vessels – as an investment choice of Greek maritime capital – secures the dominant world position of Greek ship-owning (increased cash-flow resilience, or even nil financial obligations to lending organizations in a process of concentration of maritime capital), the dynamism of the factors (independent variables) that could affect the modernisation of the oil tanker fleet (seaborne crude oil trade from Middle East and Greek G.D.P) run down, so that a significant increase of them is required for a significant reduction of average age (modernisation) of the Greek owned oil tanker fleet.

4. CONCLUSION

The purpose of the present paper was to examine the role of Greek controlled oil tanker fleet in the building of Middle East and thus international oil network sea transportation by attempting to examine the factors that affect the magnitude of Greek owned oil tanker fleet that operates in the area and the modernisation of the Greek controlled oil tanker fleet (in general and in particular of that part of it that operates in the Middle East).

In this framework, we empirically tested for the factors that presumably influence the magnitude and the age of Greek controlled oil tanker fleet. More precisely, the paper used regression models which tested for the significance of these factors. The empirical results indicated that crucial factors which influence the magnitude and the average age of the Greek controlled oil tanker fleet are the macroeconomic environment of the country, and the E.U. macroeconomic operational framework (expressed through Greek G.D.P. and EU real interest rate, respectively) as well as the volume of seaborne trade of crude oil in the area.

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FORECASTING WORLD FLEET: ISSUES FOR GREEK AND TURKISH FLEET

Oral Erdogan[11]
Department of Business Administration
Istanbul Bilgi University
Istanbul, Turkey

Mehmet Hakan Sengoz[12]
Faculty of Social and Administrative Sciences
Istanbul Bilgi University
Istanbul, Turkey

Abstract. This study focuses on forecasting world seaborne fleet and briefly assesses positions of Greek and Turkish merchant fleet. It employs an Auto Regressive Moving Average (ARMA) process as an econometric modeling. Furthermore, the model includes interest rates, global trade indicators, inflation rates, stock markets indices, and foreign currency parities as the explanatory variables. Consequently, it is obvious that shipyards and fleet integration between Turkey and Greece will influence for good, especially regarding the cost of shipping and shipbuilding, as a product of Turkey and Greece cooperation.

Keywords: Greek, Turkish, cooperation, Merchant fleet, forecasting

[11] Corresponding Author; Professor of Finance at Istanbul Bilgi University, and an advisor to the Undersecretary of Maritime Affairs, Turkish Prime Ministry; and to the Chairman of the Chamber of Shipping. Author is grateful to the participants of the Chios Workshop titled "Cooperation, Security, Communication and Scientific Dissemination in Eastern Mediterranean" April 14, 2007. E-mail: orale@bilgi.edu.tr

[12] Research Specialist in Capital Markets Certificate Program, Faculty of Economics and Administrative Sciences, Istanbul Bilgi University.

1. INTRODUCTION

The cost of transportation is value for the economy. According to Adam Smith; final prices of goods include transportation costs, hence transportation itself represents a division to the aggregate economy. Freight rates, within the components of economy, are determined in conjunction with the demand and supply in the world transportation markets. Greater need for transportation brings about changes in freight rates. In addition, variations in supply or demand of shipping market may influence the direction of freight rates, which are one of the leading indicators of growth in industrial production and/or economic growth. In fact, freight may be classified as a cost for shippers, sales for carriers, expenditures for consumers, primary indicator for academicians, and a financial tool to speculate or arbitrage or hedge for finance.

From the perspective of maritime transport and international trade, Bendall and Stent (2003) argue that shipping is a service sector with its demand related to changes in global trade situations and volumes. Furthermore, Goulielmos & Psifia (2006) explain that the shipping industry with its 30000 world-wide companies is one of the three most capital-intensive industries in the world, requiring 80 billion dollars per annum for financing new buildings alone.

Historically, on international trade and economy subject, Price (1989) shows that trade growth, from 1660-1790, is dependent on development of a broad variety of credit operations, supported primarily by big wholesalers and export merchants. Sicotte (1999) stresses that the shipping Act of 1916 created a government-owned shipping company within the US. He presents that in 1914, the US merchant fleet hardly carried 10% of its ocean-borne trade. By 1918 that share had risen to more than 40%. Fagerholt (2004) explains the reasons for the growth that international trade has experienced a continuous increase in standard of living. He also suggests that shipping should be the most-used transportation mode for international trade and modest improvements in routing and in scheduling may result in large savings. On the other hand, Juda (1981) raises a question regarding the economics of shipping. He questions that the developing states are somewhat doubtful about the claims by the shipping lines of developed countries that shipping is a low-profit, low return business. If that is so, they wonder, why do the shipping lines stay in business?

Related to the literature on shipping markets, some researchers have also focused on the volatility of the market. Harley (1988) explains that throughout the nineteenth century freight rates dramatically declined because of the new industrial technology. Specifically, Tvedt (2003) claims that “adding time to-build” will most likely create even larger cycles of freight rate. It is obvious that the freight rate volatility is strongly correlated with the delays in the building time. Fusillo (2004) discusses that liner shipping capacity is indeed fixed in the short term, which will lead to higher levels of volatility of freight rates and, thus increasing the cost of international trade. On the other side, Matthews (2003) emphasizes that a rise in ocean-shipping rates increase prices of commodities for consumers in the US.

Davies (1983) argues that in the cost structure of scheduled liner services high proportion of costs are fixed and do not vary with changes in output and the persistent and valuable role of the liner conference system in the servicing of world trade is likely to endure for many years.

Regarding the economic aspects of trade growth, Benham (2004) suggests that it is the issue of sustainability of the oceans translated into how the future will evolve based on our actions or inactions in the past and in the present. Such an action is investigated by Pires, et al (2005). They stress the establishment of new shipyards, the modernization of existing ones and the recovery of the merchant fleet (in Brazil) have been the subject of a severe national controversy. Goss (1965) discusses *three assertions as to whether* nations with shortages of foreign currencies sometimes consider investment in merchant shipping as a way of improving matters. However, Krugman (1995) shows that the most apparent and also most controversial subject is the growth of low-wage manufactured exports. This growth almost certainly has had some role in the growth both of unemployment in Europe and of; wage inequality in the US. Finally, Kumar (2006) argues that China's continuing economic growth and her increasing trade surplus are the most important drivers of another solid year of shipping market performance.

On forecasting shipping market, Stopford (1997) states that at their best; shipping market models are educational in the sense that they help decision-makers to understand what could happen in simple graphical ways, but when it comes to predicting what will really happen, they could be insignificant.

Following this section, the second chapter gives the explanation of the model. After introducing the data and methodology in section three, we give the main finding in section four. Finally, section five concludes.

2. MODEL

Regarding with many related studies, we accept that changes in the world seaborne fleet gross tonnage are correlated with changes in volume of world trade.

$$\Delta fleet \Leftrightarrow \Delta trade$$

In a simple model; in two consecutive time periods, if the change in the volume of trade between two countries (A and B), freight rates and other operational costs are constant, capacity of ships will stay constant. On contrary, if there is an increase in the volume of traded goods (assuming all other costs are constant), with a constant freight rate, supply of ships are expected to increase eventually. Hence, volume of world trade will change depending on the production levels and world merchant fleet tonnage. Of course, the monetary value relationship between those two countries (payer of the freight and receiver of the freight payment) should be considered carefully.

Furthermore, according to the rational expectations in financial markets, investors can anticipate future outcomes of the economy. Thus, fleet tonnage vis-à-vis stock markets returns should be correlated.

According to the Dow's theory, stock market returns are leading factors to forecast economic growth. So, in case that there is a relationship between fleet tonnage and world trade, a model of fleet tonnage as a function of stock markets is also defended.

$$\Delta Fleet_t \Leftrightarrow \Delta Trade_t$$

$$\Delta Trade_t \Leftrightarrow \Delta Stockmarket_{t-k}$$

Thus;

$$\Delta Fleet_t \Leftrightarrow \Delta Stockmarke\ t_{t-k}$$

Change in fleet gross tonnage is the consequence of numerous factors. These factors are as follows; economic growth, change in industrial production levels, change in bunker rates, preceding changes in freight, "mobile average" of freight changes, "benchmark stock market" return, other factors. Besides, world seaborne fleet, which has grown dramatically in recent years, three main concepts aroused. First of all, economic growth indexed to US and EU has been partially replaced with that of Asia. Second, transportation of inputs to Asia from other World, and of outputs to Europe and America from Asia, has fuelled the shipping demand. And for the last but not least, seaborne trade has increased both in terms of tonnage and distance (tone-miles).

3. DATA AND METHODOLOGY

Models we used in the study emphasizes the importance of development of world foreign trade volume, world GDP (real 2000), world merchant fleet (in grt), bulk trade volume and Baltic Freight Index (BFI) returns. Correlation tables of parameters are also given to evaluate the relationship between these factors. FIGURE 1 presents the annual development of main variables from 1985 to 2006. Upwards trends in world GDP and world trade, relatively conservative increasing trend in world fleet and volatile behaviour of freight rate index are the main observation that comes out in the first place.

In addition to FIGURE 1, a correlation matrix table for possible explanatory variables of world seaborne fleet is constructed. It is developed via main indicators for changes in world trade volume, U.S. interest rate, S&P 500 returns, exchange rates (US/YEN, US/FRN), commodity (steel and oil) prices, GDP (world, EU, US and Japan) and fleet data (gross tonnage and number of vessels).

As an econometric model, two ARMA models are employed while the first model explains the annual change in world seaborne fleet gross tonnage level according to the annual changes in world total foreign trade, stock market (S&P 500) returns and commodity (steel and oil) prices. However, the second model, definitely a “user manual” one, estimates annual change in the world seaborne fleet gross tonnage level with respect to less explanatory variables, only annual change in world trade.

4. EMPIRICAL RESULTS

World trade growth is a determinant of fleet gross tonnage level, and an autoregressive process. Notwithstanding; there is a strong evidence that the trade (demand side of the shipping market) is significantly explained by the current and preceding economic growth. The changes in steel and oil prices are also significantly correlated with the changes in fleet tonnage. In addition, stock market return is another significant variable for the fleet tonnage change.

As it is previously mentioned, the first model (Model 1) defines annual change in world fleet tonnage by change in the volume of world trade with a lag of 2 years, change in S&P500 returns with a lag of 3 years and change in oil prices of previous year, all significant at 1% significance level. Unlikely, change in steel prices with a lag of 2 years is significant at 10% significance level. In addition, mean-reversion after nine years is observed which may yield possible nine years long cycles in the world merchant fleet.

User Manual Model (Model 2) again explains annual change in world fleet tonnage with respect to the change in the volume of world trade with a lag of 2 years and mean-reversion of possible nine years long cycle holds.

5. CONCLUSION

Current studies on the relationship between the shipping markets and the world economy and/or trade are neither the first nor the last. This study attempted to demonstrate the significance of the analyses of the relationship between world merchant fleet and world trade growth.

To put it plainly; world trade growth is a determinant of fleet gross tonnage level, and an autoregressive process. Notwithstanding; there is a strong evidence that the trade (demand side of the shipping market) is significantly explained by the current and preceding economic growth. The changes in steel and oil prices are also significantly correlated with the changes in fleet tonnage. In addition, stock market return is another significant variable for the fleet tonnage change. For a step further, our study will need to cover the effect of costs of shipbuilding, delivery deadline, and related factors. As confirming Stopford, we will feel satisfied in our efforts if this submission contributes to the decision making process of those in position to do so.

When the global economy and trade expand, it is obvious that the seaborne fleet will definitely keep growing. According to the model implications, it is also certain that the maritime sector participants should also be prepared for the potential adverse movements. From this point of view, on the one hand Greece as one of the biggest ship operators in the world, and Turkey as one of the emerging shipbuilding country in Europe can combine their market powers to create a synergy. If we believe that the world fleet expands, we also infer that the shipbuilding demand will increase. The Turkish shipyards can produce their modern ships to the Greek operators, while the latter can find lower cost tailor made new building ships.

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FIGURES AND TABLES

FIGURE 1: Sustainable World Growth Supports Trade (and Shipping)

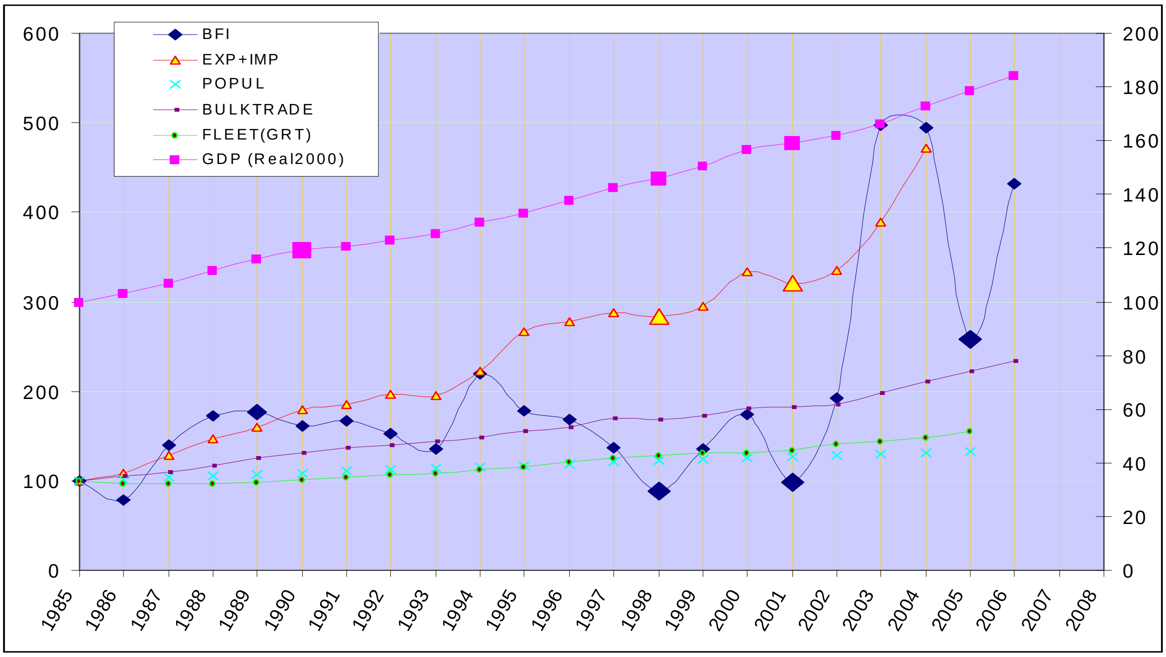


TABLE 1: World Seaborne Fleet (Correlation Matrix)

	imp	ex	trbal	trtot	uson	us30	sp500	usyen	usfrn	cpi	steelp	oilp	fleetn	fleetgr	gdpus	gdpjap	gdpw	gdpeu
imp	1,000																	
	.																	
ex	0,991	1,000																
	0,000	.																
trbal	0,112	0,041	1,000															
	0,468	0,791	.															
trtot	0,997	0,996	0,077	1,000														
	0,000	0,000	0,621	.														
uson	0,602	0,595	0,215	0,597	1,000													
	0,000	0,000	0,161	0,000	.													
us30	0,302	0,298	0,050	0,303	0,427	1,000												
	0,046	0,049	0,745	0,046	0,004	.												
sp500	-0,225	-0,237	0,098	-0,226	-0,254	-0,285	1,000											
	0,142	0,122	0,527	0,140	0,096	0,061	.											
usyen	0,115	0,123	0,119	0,117	0,154	0,079	-0,011	1,000										
	0,458	0,428	0,440	0,449	0,320	0,610	0,945	.										
usfrn	0,457	0,489	-0,198	0,472	0,194	0,014	-0,261	0,527	1,000									
	0,002	0,001	0,199	0,001	0,207	0,930	0,087	0,000	.									
cpi	0,447	0,424	0,041	0,446	0,241	0,362	-0,237	-0,057	0,099	1,000								
	0,002	0,004	0,794	0,002	0,115	0,016	0,122	0,713	0,521	.								
steelp	0,306	0,348	-0,157	0,326	0,364	0,337	-0,019	0,359	0,175	-0,020	1,000							
	0,043	0,021	0,310	0,031	0,015	0,025	0,902	0,017	0,257	0,898	.							
oilp	0,563	0,570	0,140	0,564	0,410	0,419	-0,177	-0,082	0,198	0,449	0,217	1,000						
	0,000	0,000	0,365	0,000	0,006	0,005	0,251	0,596	0,197	0,002	0,157	.						
fleetn	0,208	0,202	-0,182	0,210	0,106	0,208	0,045	-0,076	-0,005	0,252	0,096	0,181	1,000					
	0,176	0,189	0,238	0,172	0,494	0,176	0,771	0,623	0,972	0,098	0,535	0,238	.					
fleetgr	0,256	0,264	-0,150	0,262	0,088	0,174	-0,129	-0,027	0,212	0,097	0,058	0,280	0,815	1,000				
	0,093	0,083	0,331	0,086	0,571	0,260	0,403	0,862	0,168	0,532	0,711	0,066	0,000	.				
gdpus	0,132	0,107	0,248	0,115	0,437	0,045	-0,085	0,101	0,038	-0,121	0,056	-0,152	-0,048	0,054	1,000			
	0,395	0,491	0,104	0,458	0,003	0,769	0,583	0,514	0,804	0,433	0,716	0,325	0,758	0,727	.			
gdpjap	0,281	0,293	-0,146	0,291	0,301	0,206	-0,040	-0,046	-0,011	0,222	0,082	0,006	0,581	0,346	0,266	1,000		
	0,065	0,053	0,344	0,056	0,047	0,179	0,794	0,766	0,944	0,147	0,598	0,970	0,000	0,021	0,081	.		
gdpw	0,378	0,391	0,013	0,380	0,519	0,106	-0,126	-0,060	0,082	-0,118	0,225	0,010	0,270	0,297	0,698	0,635	1,000	
	0,011	0,009	0,931	0,011	0,000	0,492	0,414	0,701	0,597	0,444	0,142	0,949	0,076	0,050	0,000	0,000	.	
gdpeu	0,338	0,356	-0,248	0,340	0,380	0,071	-0,134	-0,044	0,152	-0,040	0,118	0,017	0,399	0,387	0,477	0,716	0,775	1,000
	0,025	0,018	0,104	0,024	0,011	0,649	0,387	0,775	0,323	0,794	0,445	0,915	0,007	0,009	0,001	0,000	0,000	.

World Seaborne Fleet Model 1:

Dependent Variable: Annual Change in the Gross tonnage Level

Variable	Coefficient	St.Error	t-statistic	P-value
C	0.013329	0.005927	2.248943	0.0313
TRAD(-2)	0.068753	0.017348	3.963225	0.0004
SP500(-3)	-0.030239	0.007487	-4.038882	0.0003
OILP(-1)	-0.011667	0.003185	-3.663153	0.0009
STEELP(-2)	0.006864	0.003551	1.932621	0.0619
AR(1)	0.806404	0.078949	10.21423	0.0000
MA(9)	-0.909219	0.027247	-33.36898	0.0000

R square	0.943875	Mean of Dep.Var.	0.035867
Adjusted R-square	0.933670	St.Dev of Dependent Var.	0.032560
Regression S. Error	0.008386	Akaike Criteria	-6.566970
Sum of error squares	0.002321	Schwarz Criteria	-6.271416
Log likelihood	138.3394	F-statistics	92.49530
Durbin-Watson	1.998530	Prob(F-statistics	0.000000

World Seaborne Fleet Model 2: A "User Manual" Model

Dependent Variable: Annual Change in the Gross tonnage Level

Variable	Coefficient	St.Error	t-statistics	Prob.
TRAD(-2)	0.063652	0.019730	3.226127	0.0025
FLEETGRAR1	0.697503	0.075480	9.240947	0.0000
MA(9)	-0.888363	0.025209	-35.23941	0.0000

R-square	0.874993	Mean of Dep.Var.	0.036325
Adjusted R-square	0.868583	St.Dev of Dep.Var.	0.031832
Regression S. Error	0.011540	Akaike Criteria	-6.017300
Sum of Errors Squares	0.005193	Schwarz Criteria	-5.893181
Log likelihood	129.3633	F-statistics	136.4915
Durbin-Watson	2.121068	Prob (F-statictics)	0.000000

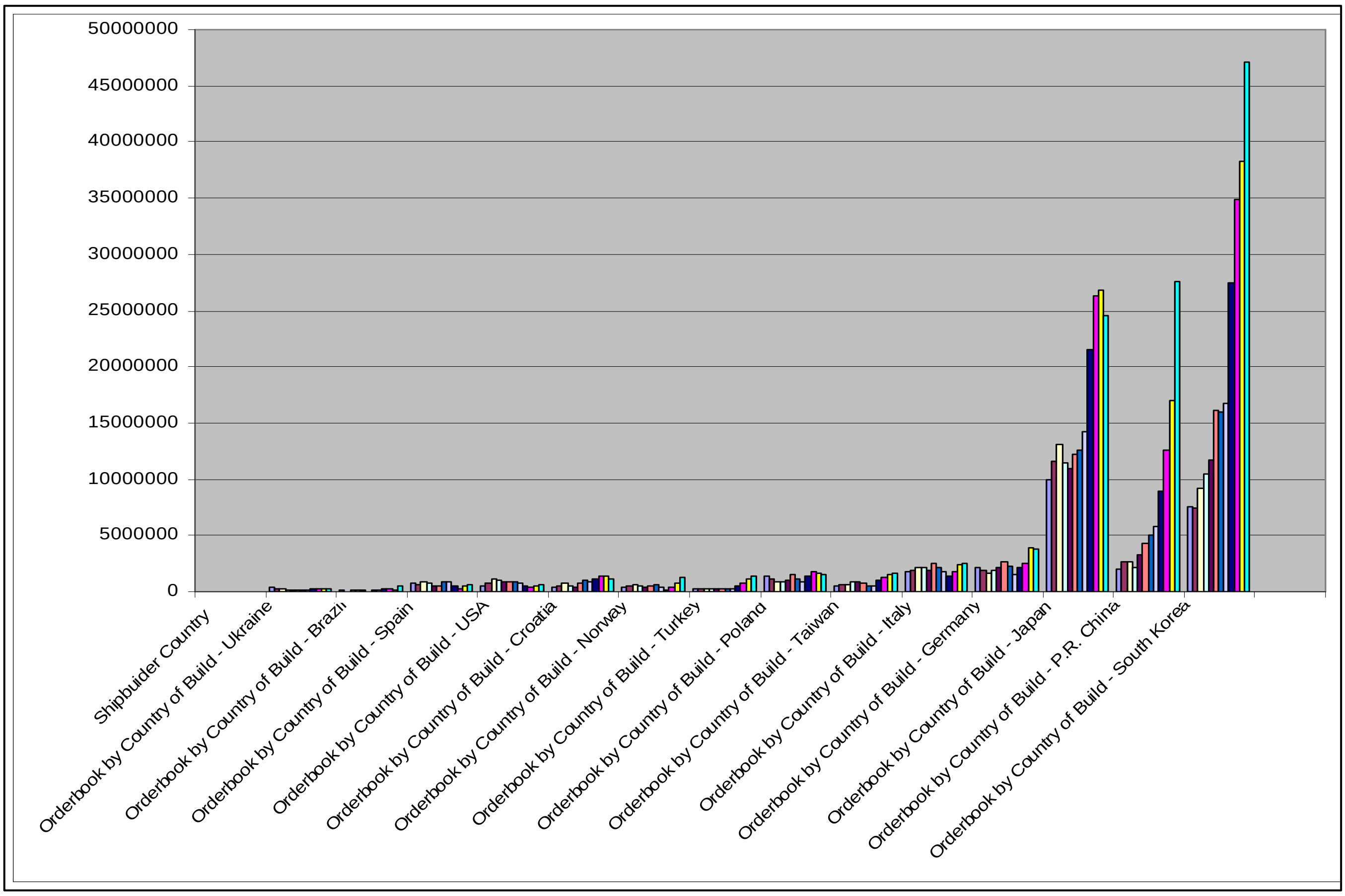
TABLE 2: World Fleet

	Tankers*		Combined Carriers		Bulk & Ore** Carriers		Total Fleet		% Total
	No.	*Dwt*	*No.*	*Dwt*	*No.*	*Dwt*	*No.*	*Dwt*	
Panama	974	60,752,414	13	1,767,355	1,786	117,825,167	2,773	180,344,936	24.5%
Liberia	600	50,877,503	18	1,473,416	326	19,671,051	944	72,021,970	9.8%
Greece	278	31,717,546	1	54,500	265	19,415,985	544	51,188,031	7.0%
Hong Kong	115	11,767,317	3	228,846	495	32,118,348	613	44,114,511	6.0%
Marshall Is.	366	32,134,465	11	913,518	168	9,752,170	545	42,800,153	5.8%
Bahamas	245	25,041,691	17	1,301,110	311	15,931,528	573	42,274,329	5.7%
Singapore	417	27,336,938	7	1,110,961	176	11,516,933	600	39,964,832	5.4%
Malta	258	13,725,913	2	174,149	442	20,769,202	702	34,669,264	4.7%
Cyprus	111	6,475,830	-	-	371	19,484,551	482	25,960,381	3.5%
China P.R.	220	7,470,397	2	86,928	368	14,564,781	590	22,122,106	3.0%
Norwegian Int'l	203	9,132,865	17	1,752,121	86	5,406,053	306	16,291,039	2.2%
Isle of Man	128	9,205,094	-	-	42	3,483,120	170	12,688,214	1.7%
India	109	8,702,736	2	258,619	77	3,532,678	188	12,494,033	1.7%
South Korea	148	1,466,125	-	-	125	8,564,495	273	10,030,620	1.4%
Italy	186	5,514,910	1	54,500	43	3,248,058	230	8,817,468	1.2%
Iran	35	6,163,094	-	-	40	1,789,317	75	7,952,411	1.1%
Japan	194	3,624,589	-	-	48	3,919,701	242	7,544,290	1.0%
United States	91	5,171,189	-	-	14	644,822	105	5,816,011	0.8%
Belgium	13	3,472,583	-	-	17	2,339,503	30	5,812,086	0.8%
Turkey	95	1,523,202	2	153,139	111	4,071,079	208	5,747,420	0.8%
St. Vincent & G.	42	713,966	-	-	116	4,916,872	158	5,630,838	0.8%
Bermuda	15	1,688,669	-	-	26	3,626,865	41	5,315,534	0.7%
Philippines	25	462,765	-	-	85	4,552,353	110	5,015,118	0.7%
Malaysia	83	3,759,918	-	-	25	875,820	108	4,635,738	0.6%
France	46	3,776,883	-	-	4	410,805	50	4,187,688	0.6%
Taiwan	14	1,410,461	-	-	34	2,621,827	48	4,032,288	0.5%
Cayman Islands	56	2,070,703	-	-	32	1,624,979	88	3,695,682	0.5%
United Kingdom	93	1,899,084	-	-	21	1,594,295	114	3,493,379	0.5%
Kuwait	19	3,357,145	-	-	2	93,189	21	3,450,334	0.5%
Danish Int'l	56	2,726,946	-	-	4	321,829	60	3,048,775	0.4%
Norway	25	2,544,938	-	-	3	137,991	28	2,682,929	0.4%
Brazil	49	1,536,032	-	-	24	1,122,749	73	2,658,781	0.4%
Thailand	36	286,448	-	-	79	2,231,377	115	2,517,825	0.3%
Russia	97	1,078,015	-	-	47	980,299	144	2,058,314	0.3%
Indonesia	81	1,231,943	-	-	21	662,144	102	1,894,087	0.3%
Vanuatu	2	203,454	-	-	33	1,571,198	35	1,774,652	0.2%
Croatia	7	569,628	-	-	20	972,980	27	1,542,608	0.2%
Germany	23	836,348	-	-	5	502,546	28	1,338,894	0.2%
Antigua & B.	10	34,416	-	-	28	1,124,750	38	1,159,166	0.2%
Spain	31	1,104,569	-	-	1	26,972	32	1,131,541	0.2%
Egypt	6	308,199	-	-	16	794,703	22	1,102,902	0.1%
Australia	7	319,849	-	-	15	736,365	22	1,056,214	0.1%
Venezuela	15	807,676	-	-	4	208,723	19	1,016,399	0.1%
Bulgaria	6	24,615	-	-	39	973,938	45	998,553	0.1%
Mexico	30	955,690	-	-	3	40,689	33	996,379	0.1%
Portugal	15	890,146	-	-	2	71,201	17	961,347	0.1%
Canada	21	763,452	1	26,440	5	156,627	27	946,519	0.1%
Vietnam	15	469,721	-	-	24	475,906	39	945,627	0.1%
Qatar	10	901,082	-	-	-	-	10	901,082	0.1%
Sweden	58	847,635	-	-	3	43,318	61	890,953	0.1%
Cambodia	18	122,983	-	-	31	698,048	49	821,031	0.1%
Georgia	5	49,259	-	-	25	714,735	30	763,994	0.1%
Dominica	7	402,498	-	-	4	360,215	11	762,713	0.1%
Netherlands	49	583,168	-	-	5	95,600	54	678,768	0.1%
Saudi Arabia	23	629,272	-	-	-	-	23	629,272	0.1%
Others	366	7,319,296	1	13,360	174	5,382,757	541	12,715,413	1.7%
Total	**6,247**	**367,963,273**	**98**	**9,368,962**	**6,271**	**358,773,207**	**12,616**	**736,105,442**	**100%**

** All tankers above 1,000 dwt. ** Excludes Great Lakes only vessels*

Source: SRO-Autumn 2006, Clarksons.net

FIGURE 2: Orderbook (CGT)



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THE IMPACT OF TRANSPORT COST ON THE EUROPEAN GEO-ECONOMIC DYNAMICS

John Karkazis
Department of Shipping, Trade and Transport
University of the Aegean
Chios, Greece

Abstract. The E.U. enlargement process (mainly upon its eastern neighbors and in particular upon Turkey), which is expected to last for many years, offers significant opportunities mainly in the economic sphere for all participants. The maximization of the positive impact of these opportunities on all partners requires the introduction of appropriate policies, incentives and infrastructure investments.

In this context, the analysis of the impact of economic growth type scenaria on the spatial dimension of the general and local geo-economic profiles and trends of Europe could offer valuable insight into the mechanism controlling their regional socio-economic attractiveness (regional efficiency). Consequently, such an analysis could greatly assist the exploration of the spatial dimension of emerging opportunities and it could also enhance negotiating partners ability to intervene in making these trends more cooperative.

In this paper the notion of the "Geo-Economic Gravity System" will be employed as a conceptual tool in the analysis of the key issue of "regional efficiency" and as a modeling tool in the effort to tackle the above problems. Note that the term "Geo-Economic Gravity System" refers to a system of area-type supply poles (spatial conglomerations of supply units covering an administrative area) which satisfy the demand of a system of demand poles with the minimum transport cost.

Keywords: Regional Efficiency, Geo-Economic Dynamics, Transport Cost

1. INTRODUCTION

The E.U. enlargement process towards its eastern European neighbors, which is expected to last for many years, offers significant socio-economic opportunities for all parties involved in this process. The maximization of the positive impact of these opportunities requires the introduction of appropriate policies, incentives and infrastructure investments. In this context, the combined analysis of regional geo-economic trends of Europe could offer valuable insight into the mechanism controlling the regional socio-economic attractiveness (regional efficiency). More specifically, this paper focuses on the location of areas, at a pan-European level, that can competently serve as global or regional “supply centers”, and on the subsequent polarization process introduced by the supply centers gravitational forces. Consequently, such an analysis can greatly assist the exploration of the spatial dimension of emerging opportunities and it can also enhance negotiating partners ability to intervene in making these trends (external and internal) more cooperative.

In this paper the notion of the “Geo-Economic Gravity System” will be introduced as a conceptual tool in the analysis of the key issue of “regional efficiency” and as a modeling tool in the effort to tackle the above problems. Subsequent analysis is divided into the following 4 sections. In section 2, selected regional efficiency models are presented and discussed. In section 3, the notion of the “Economic Gravity System” is introduced and analyzed. In section 4, numerical results regarding the application of the general geo-economic model at a pan-European level, are presented and discussed. Finally, section 5 gives the concluding remarks of the preceding analysis.

2. REGIONAL EFFICIENCY MODELS

The introduction of policies enhancing the ability of administrative units (provinces, regions or states) to better exploit the capabilities of their infrastructure as well as of their human and natural resources so as to attain sustainable growth both in the social and the economic sphere is of paramount importance in regional planning.

In this context, the location of administrative units or areas possessing (hidden or partially exploited) comparative geo-economic advantages and the development of new or the expansion of existing infrastructure which could unleash the growth generation power of them, is critical. Such regions will be thereon called “efficient regions”. Modeling the above problem is a very difficult process and relevant attempts were not always fully convincing.

There are two basic approaches in the literature as far as modeling of regional efficiency is concerned:

(a) The systemic approach and

(b) The cost approach

2.1 The systemic approach

The systemic approach encompasses models that can be further distinguished into two categories:

(a1) Frontier analysis models and

(a2) Regional image attractiveness models

Frontier analysis models

Frontier analysis models express regional efficiency through an input-output systemic structure (figure 2.1).

Figure 2.1   Frontier analysis models

In general, a region is considered efficient if it can best exploit existing inputs (resources, investments and infrastructure) so as to produce high levels of socio-economic growth.

Karkazis and Thanassoulis (1998) applied this approach to assess the effectiveness of regional development policies in Northern Greece using Data Envelopment Analysis (DEA), a specialized linear programming based method. They employed the following systemic structure (figure 2.2):

Figure 2.2 Karkazis and Thanassoulis approach

The interested reader can find suitable introductions to DEA in Dyson et al (1990) and Charnes et al (1994).

In the above context, Athanassopoulos and Karkazis (1997) introduced the concept of "Systemic Duality" as a modeling tool to analyze regional growth sustainability and they applied it to assess the effectiveness of the prefectures of Greece to perform the following dual transformation process:

(a) to transform improvements in five key indices of their regional social image (education, health care, culture, telecommunications and transportation) into GDP growth and

(b) to transform GDP growth into further improvements of the above social image indices.

Regional image attractiveness models

Regional image attractiveness models focus on the structure of the socio-economic profile of an area and in particular on its capability to attract capital and labor. According to this approach the socio-economic image (profile) of an area is expressed through a set of social, environmental and economic elements (indices) capable of being easily and commonly identified both by employees and investors candidate to move in this area. Then an “area attractiveness” function, employing relevant indices as independent variables, is developed. This function employees catastrophe theory concepts to express the relative attractiveness of an area as perceived by employees and investors candidate to move in it.

Stellakou and Karkazis (1992) applied this approach to evaluate the effects of infrastructure on the long-term viability of investments in the North Aegean Region whereas Angelis and Dimaki (1998) examined the trends of selected areas’ images and applied a survival analysis approach to study their variations.

The interested reader can find suitable introductions to this subject in Hunter and Reid (1968), Isnard and Zeeman (1976) and Townroe (1979).

2.2 The cost approach

In the cost approach the key concept of regional efficiency is expressed as the geo-economic ability of an area to act as a distribution (supply) center under cost criteria. The notion of the “supply center” is expressed by a system of facilities, with the necessary infrastructure, supplying surrounding areas with services or products at low cost. The notion of cost covers both the cost of establishing and operating the facilities as well as the associated transport cost. Note at this point that, when the cost of establishing and operating the facilities does not exhibit significant spatial variations then relevant models employ only the transport cost. This is the case of the Weber model that will be presented in the following chapter. The demand of the surrounding areas on services or products, in general, is usually expressed by regional summary measures such as population, GDP, Manufacturing Value Added (MVA), imports etc.

The geo-economic ability of an area to act as a distribution center lies mainly on two factors:

(a) on its spatial position on transport networks connecting wider geographical areas (position centrality) and

(b) on its infrastructure and on its human and exploitable natural resources that offer economies-of-scale (profile attractiveness)

It is interesting to note at this point that, although certain areas possess a favorable spatial position on transport networks they lack the appropriate profile attractiveness (as an example absence of relevant infrastructure) necessary to exploit the former advantage. It lies in the ability of regional planners and above all in the intuition of decision makers to unearth these hidden geo-economic advantages and thus allow relevant areas to develop rapidly. Such areas, capable of attracting supply center facilities, will be thereon termed “Geo-Economic Gravity Areas” and the supply centers attracted by them “Geo-Economic Gravity Centers”. Geo-Economic Gravity Centers will be characterized as Social, Economic, Industrial and Trade if demand summary measure is the population, the GDP, the MVA and the imports respectively.

Karkazis (1999a) introduced the simple Geo-Economic Gravity Model and applied it to E.U. regions. According to his findings, the Social Gravity Center of E.U. during the period 1985-1994 was located in northeastern France moving at a rather low for the size of E.U. velocity of 5 km per annum towards Belgium. In 1985 it was located 100 km east of Paris whereas in 1994 it was located near the borders of France with Belgium. During the above period, the Economic Gravity Center of E.U. exhibited a significant relocation moving at a velocity of 20 km per annum from the northwestern part to the southeastern part of Belgium. In 1985 it was located between the city of Brussels and the city of Lille in France whereas in 1994 it was located near the city of Namur in Belgium.

Karkazis (1999b) applied the simple Geo-Economic Gravity Model to the Balkan countries. The author noted that, in 1993 the population of Turkey was approximately 90% of the total population of the rest of the Balkan countries whereas the Manufacturing Value Added (MVA) of Turkey was approximately equal to the total MVA of the rest of the Balkan countries. On the other hand, in 1993 the GDP of Turkey was significantly higher than the total GDP of the rest of the Balkan countries. The above, favourable for Turkey, distribution of the socio-economic indices under consideration forced all three Geo-Economic Gravity Centers (Social, Economic and Industrial) to be located inside Turkey.

3. THE GENERAL GEO-ECONOMIC GRAVITY MODEL

The n-Facilities Location Problem regards the location of n non-competing supply facilities in a geographical area which will fully cover the demand for services (public sector or social type facilities) or commodities (private sector or economic type facilities) of a system of demand poles at a minimum, fixed and transport, cost. The term “fixed cost” refers to the facility establishment and operations cost. The notion of the “demand pole” plays a crucial role in the modeling process varying widely as its spatial size is concerned. It can represent a small size “point-type demand pole” which may coincide, for example, with an industrial plant or warehouse or a market complex (mall or supermarket) or even with an industrial zone demanding raw materials, intermediate products or services for its activities. On the other hand, it can represent an “area-type demand pole”, which is a larger spatial conglomeration of demand points such as an urban area or even an administrative unit (province, region or a state). The notion of the “supply facilities”, which is mainly determined by the characteristics of the relevant demand poles, can vary widely from “point-type supply facilities” coinciding with industrial plants, warehouses, industrial zones etc (which act this time as supply sources for a system of demand poles) to “area-type supply facilities” which represent a system of social or/and economic activities covering an urban area or even an administrative unit. For example, a point-type supply facility may represent a plant or warehouse that a firm plans to establish in an area so as to cover the demand of a system of demand poles in it at a minimum, fixed and transport, cost (the case of private sector supply centers) or it may represent a public facility, health or athletic center or school, that a local authority plans to establish in an administrative area that will cover the associated demand of it with the minimum social cost (the case of a public sector supply facility). Note that, in the context of the modeling process, area-type demand poles are spatially represented by a “central” point inside them, usually the location of the corresponding administrative center (as an example the capital of the province, region or state, figure 3.1). Note also that, in the context of regional development approaches, the demand of large geographical areas (cities or administrative units) can be represented by summary measures such as their population, their GDP, their MVA or their imports.

The mathematical formulation of the above problem is given below:

THE N-FACILITIES LOCATION MODEL

$\mathrm{Min}_{P1,P2,..,Pn \in \boldsymbol{P}} \quad C(P_1, P_2,.. ,P_n) = F(P_1, P_2,.. ,P_n) + T(P_1, P_2,.. ,P_n)$

where $F(P_1, P_2,.. ,P_n) = \sum^{n}_{i=1} f(P_i)$, $T(P_1, P_2,.. ,P_n) = \sum^{m}_{j=1} t(b_j, d(A_j, \boldsymbol{P}))$

and $d(A_j, \boldsymbol{P}) = \mathrm{Min}_i\, d(A_j, P_i)$

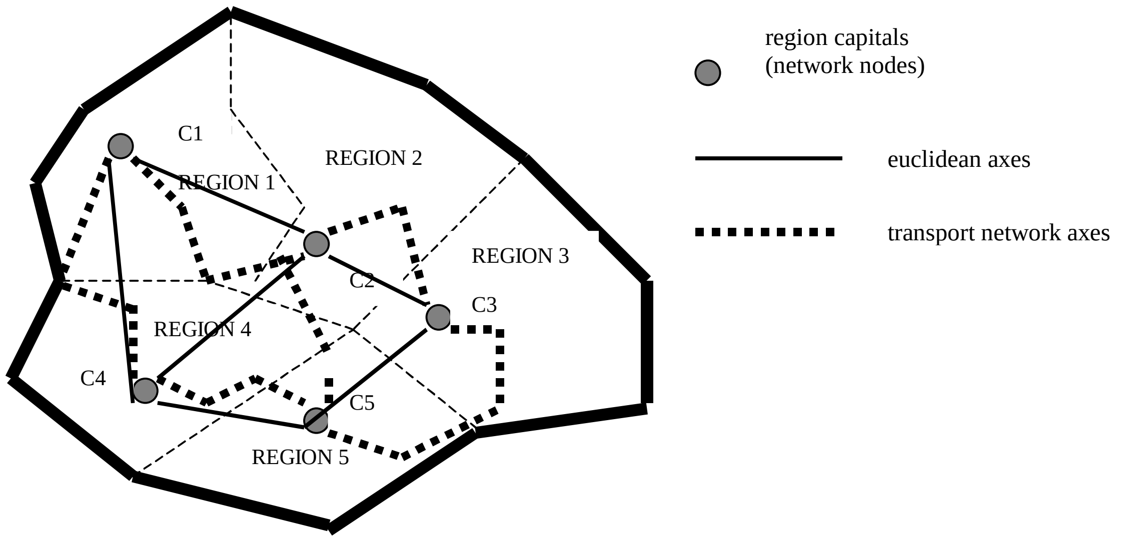

Figure 3.1 The n-Facilities Location Problem

The above formulation regards the selection of n points from the set ***P*** (the set of permissible positions for establishing the facilities) that will minimize cost function C which is the sum of the fixed cost F and the transport cost T. f(Pi) represents the cost for establishing and operating a facility at point P_i. The sum $\sum^{m}_{j=1}$ t(b_j, d(A_j,***P***)) represents the total transport cost for supplying the m demand points A_j j=1,2,…,m. In this context b_j represents the demand of A_j and d(A_j,***P***) the distance (either on the network or on the plane) between point A_j and the closest to it point (facility) of the set ***P***.

The n-Facilities Location Model has two methodological versions:

(a) The n-Facilities Location Model on a transport network (the network case)

(b) The n-Facilities Location Model on the plane (the planar case)

In the network case, ***P*** represents the nodes (demand poles) of the transport network (urban centers or administrative unit capitals) and the distance between two demand poles represents the length of the shortest path on the network connecting these demand poles. In the planar case, ***P*** represents an area in which supply facilities can be established (the area enclosed by the bold line in figure 3.1). In this case f(Pi) is considered as independent of the position Pi (it is everywhere the same) and hence cost function reduces to its transport part only. Also in this case the distance between two points, A_j and P_i, is taken to be their “euclidean distance” given by the following formula:

$d(A_j, P_i) = \sqrt{(x_j-x_i)^2 + (y_j-y_i)^2}$

where (x_i, y_i) and (x_j, y_j) are the planar coordinates of the points Pi and Aj respectively. Consequently, euclidean distances are employed as approximations of the real ones (the shortest path lengths on networks). The accuracy of this approximation varies with the morphology of the ground and the quality and density of the transport system. In the case in which the analysis is focusing on the location of whole areas (instead of specific points inside them) to establish a center then numerical experience has shown that the solution of a planar model employing euclidean distances represents an acceptable approximation of the solution of the corresponding network model even in cases of mountainous ground morphology (Karkazis (2006)).

Karkazis and Boffey (1981) and Boffey and Karkazis (1984) introduced efficient optimal algorithms for the n-Facilities Location Problem on a transport network. It is interesting to note that, Weber (1909) introduced the 1-Facility Location Problem on the plane with a linear cost function whereas Weiszfeld (1936) introduced a rapidly converging algorithm for its solution.

In the case of area-type demand poles coinciding with administrative units (provinces, regions, states etc.) corresponding n-Facilities Location Model will be called thereon "General Geo-Economic Gravity Model" since the role of the network nodes attracting supply facilities is played by administrative units which exercise geo-economic type gravitating forces on their environment. The solution of this model, that is the system of the n supply center locations minimizing corresponding cost function C, will be called thereon "General Geo-Economic Gravity System".

If the demand summary measure is *regional population* then the corresponding Geo-Economic Gravity System will be called *Social Gravity System.* This system of supply centers is associated with public sector facilities offering social services. On the other hand, if the demand summary measure is *regional GDP*, *regional MVA* or *regional imports* then the corresponding Geo-Economic Gravity System will be called *Economic, Industrial or Trade Gravity System* respectively. The last three systems are associated with private sector facilities.
In order to distinguish between the various values n is taking in the applications performed in this paper, the Geo-Economic Gravity Systems corresponding to the values n=1, 2 and 3 will be thereon called simple, dual and triple Geo-Economic Gravity Systems respectively.

4. THE GEO-ECONOMIC GRAVITY SYSTEMS OF EUROPE

In this section, numerical results produced by the application of the General Geo-economic model on Europe, are presented and discussed

4.1 The Social Gravity Systems of Europe

In 2004, the simple Social Gravity Center of Europe was situated in Wroclaw, Poland near the borders with Czechia. (Appendix A, point C in map A1)

In 2004, the dual Social Gravity System of Europe consisted of a center in northeastern France near Reims (Appendix A, point C1 in map A1) and of a second center in Ukraine near Kiev (Appendix A, point C2 in map A1).

In the same year the triple Social Gravity System of Europe consisted of a center in northern France near the borders with Belgium (Appendix A, point C1 in map A2), of a second center in the Germany-Poland-Czechia borders (Appendix A, point C2 in map A2) and of a third one in central Ukraine (Appendix A, point C3 in map A2). The eastern center was the largest one accounting for 50% of system's total transport cost.

The allocation of European demand poles to the gravity centers of the triple Social Gravity System is as follows:

(a) Switzerland, Spain, Portugal, Belgium, the Netherlands, U.K. and Ireland are assigned to the center in France which accounts for 20% of system's total transport cost

(b) Russia, Belarus and the eastern Balkan countries (Turkey, Greece, Bulgaria,Romania and FYROM) are assigned to the Ukraine center which is the largest among the three accounting for 50% of system's total transport cost and

(c) the rest countries (central Europe, Nordic and Baltic as well as western Balkan countries) are assigned to the German-Poland-Czechia center.

4.2 The Economic Gravity Systems of Europe

In 2004, the simple Economic Gravity Center of Europe was situated in Thuringen, Germany (Appendix A, point C in map A3).

In 2004, the dual Economic Gravity System of Europe consisted of a center in Paris, France (Appendix A, point C1 in map A3) and of a second center in Poznan, Poland (Appendix A, point C2 in map A3).

In the same year the triple Economic Gravity System consisted of a center in Calais, France (Appendix A, point C1 in map A4), of a second center north of Rome, Italy (Appendix A, point C2 in map A4) and of a third one in Wroclaw, Poland (Appendix A, point C3 in map A4). The center in Poland was the largest one accounting for 51% of system’s total transport cost.

The allocation of European demand poles to the gravity centers of the triple Economic Gravity System is as follows:

(a) Switzerland, Spain, Portugal, Belgium, the Netherlands, U.K. and Ireland are assigned to the center in France which accounts for 29% of system’s total transport.

all Balkan countries except Romania are assigned to the center in Italy and

(c) Nordic and all central and eastern European countries are assigned to the center in Poland which is the largest among the three accounting for 51% of system’s total transport cost.

4.3 The Trade Gravity Systems of Europe

In 2003, the simple Trade Gravity Center of Europe was located in Frankfurt, Germany (Appendix A, point C in map A5).

In 2003, the dual Trade Gravity System of Europe consisted of a center in Paris, France (Appendix A, point C1 in map A5) and of a second center in Berlin, Germany (Appendix A, point C2 in map A5).
In the same year, the triple Trade Gravity System consisted of a center in Calais, France (Appendix A, point C1 in map A6), of a second center north of Rome, Italy (Appendix A, point C2 in map A6) and of a third one in Dresden, Germany (Appendix A, point C3 in map A6).

The allocation of European demand poles to the gravity centers of the triple Trade Gravity System is as follows:

(a) Switzerland, Spain, Portugal, Belgium, the Netherlands, U.K. and Ireland are assigned to the center in France,

(b) All Balkan countries are assigned to the center in Italy and

(c) Nordic and all central and eastern European countries are assigned to the center in Germany which is the largest among the three ones.

5. CONCLUSIONS

The rapid geographical expansion of the E.U. towards the East, in combination with its principal dogma of economic convergence on the one hand and the rapid growth of the Russian economy on the other hand, seem to drastically alter the current geo-economic equilibrium defined here as the spatial distribution of the Geo-Economic Gravity Centers of Europe.

During the first half of the 20th century Germany possessed significant geo-economic advantages in the context of Europe. These geo-economic advantages were due to a synergy of three main factors:

(a) its dominating socio-economic power,

(b) its central position in Europe both geographically and economically and

(c) the under-developed economies of the eastern Europe and the Balkan countries.

The notion of "economic centrality", which is a key characteristic of a gravity center, refers to a favorable for an area distribution of economic power around it, in the sense that the economic power of the area appropriately combined with the external economic powers towards any direction can out-weight the external economic powers towards the opposite direction. In the case of Germany, its socio-economic centrality is examined along the two principal, for Europe, directions: East-West and North-South.

During the second half of the 20th century the geo-economic power balance along the East-West direction exhibits signs of weakening stability. As an example, in 1980 the combined GDP of Germany (East and West) and of all countries lying east of it only marginally out-weighted the combined GDP of all countries lying in the opposite (west) direction. The prospect of a sustained growth for Russian and Turkish economies in combination with the economic convergence policies of E.U. that will benefit most its eastern members, are expected to strengthen again the geo-economic position of Germany by making the power balance along the East-West axis more stable.

On the other hand, the heavy territorial losses of Germany during WW I and WW II, weakened the geographical and economic centrality of this country. These lost territories are characterized by a significant geo-economic value which is now emerging to the benefit of Poland. Indeed, in 2004, the simple Social Gravity Center of Europe was located in Wroclaw, the eastern center of the dual Economic Gravity System was located in Poznan and in 2003 the eastern center of the triple Trade Gravity System was located again in Wroclaw.

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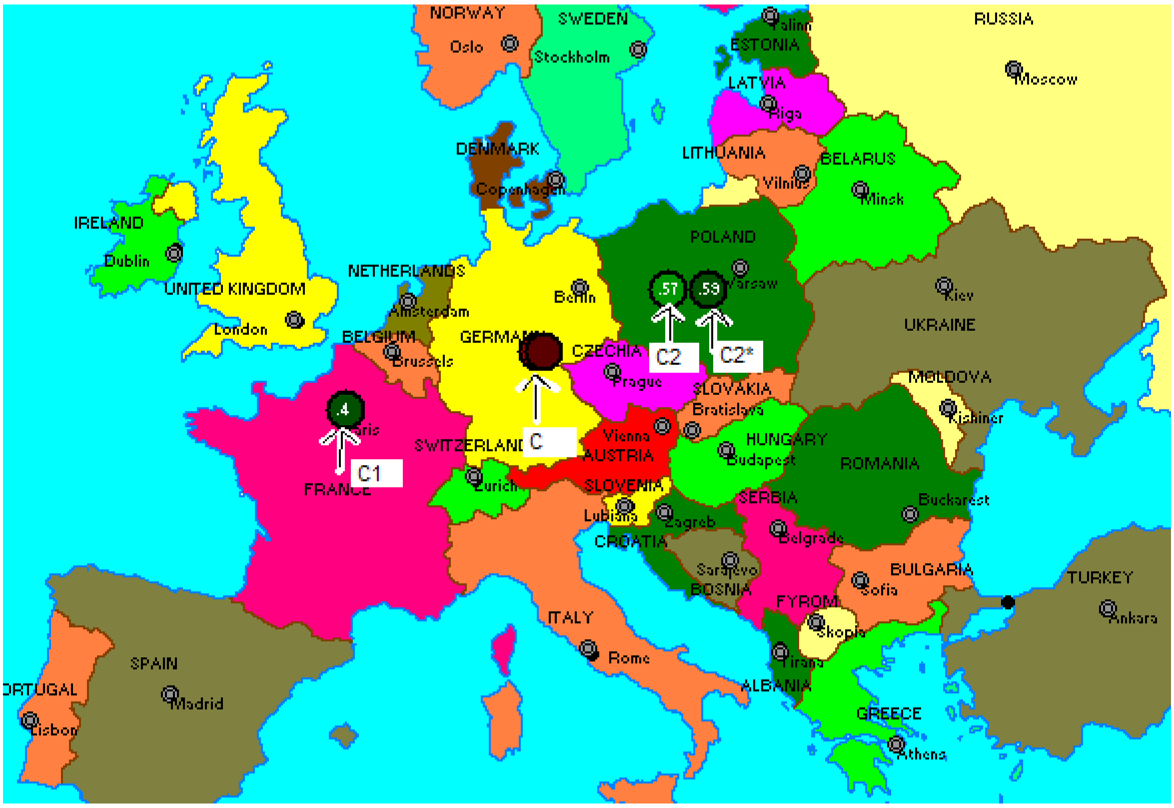
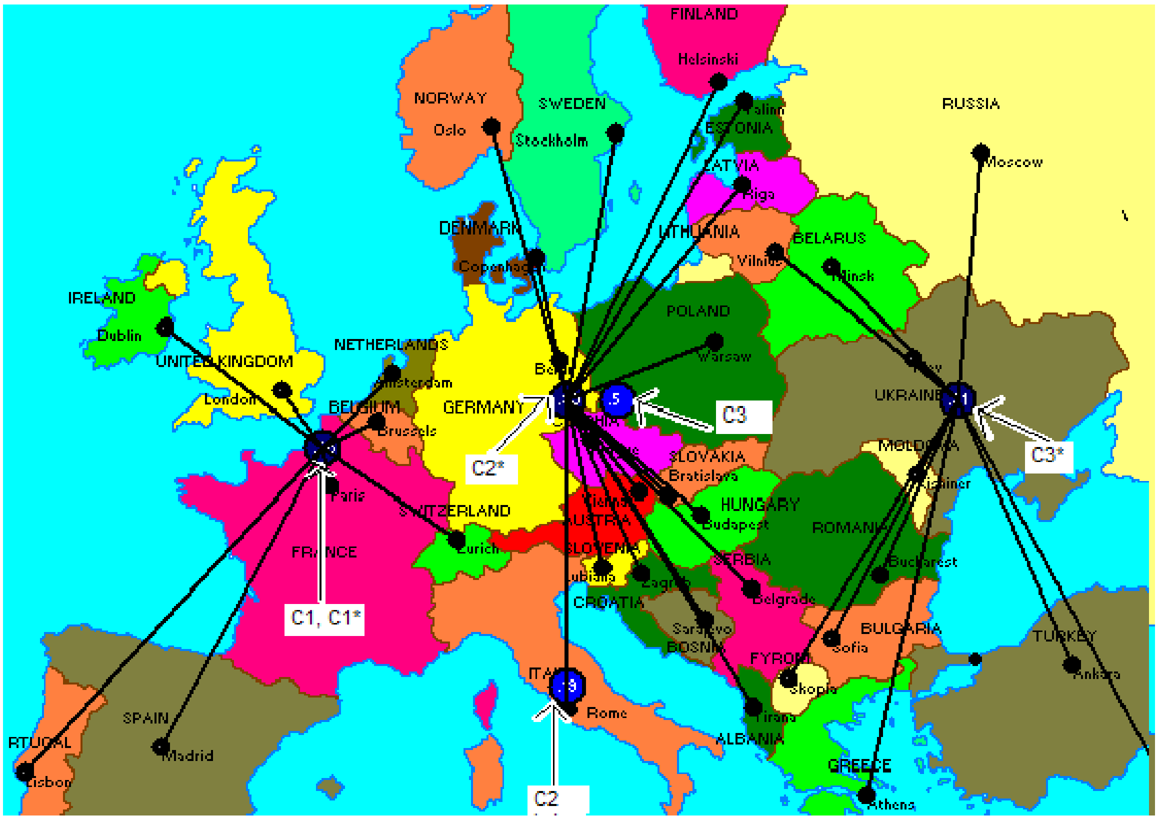
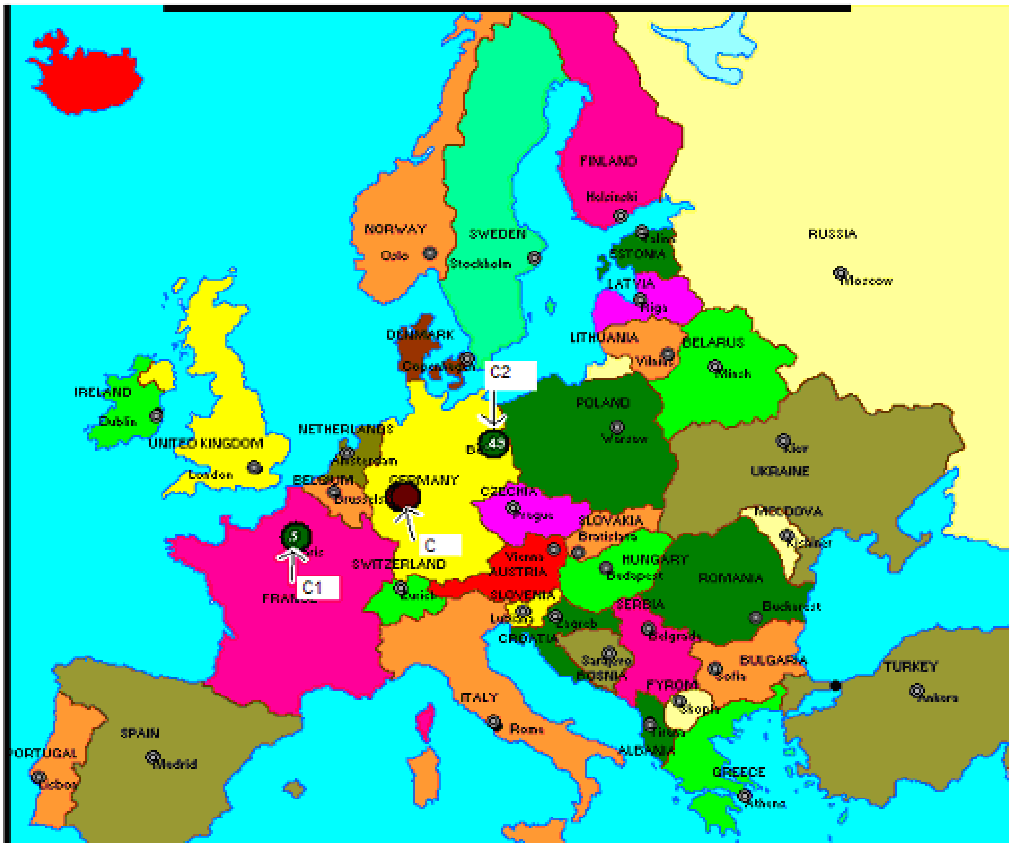
APPENDIX A



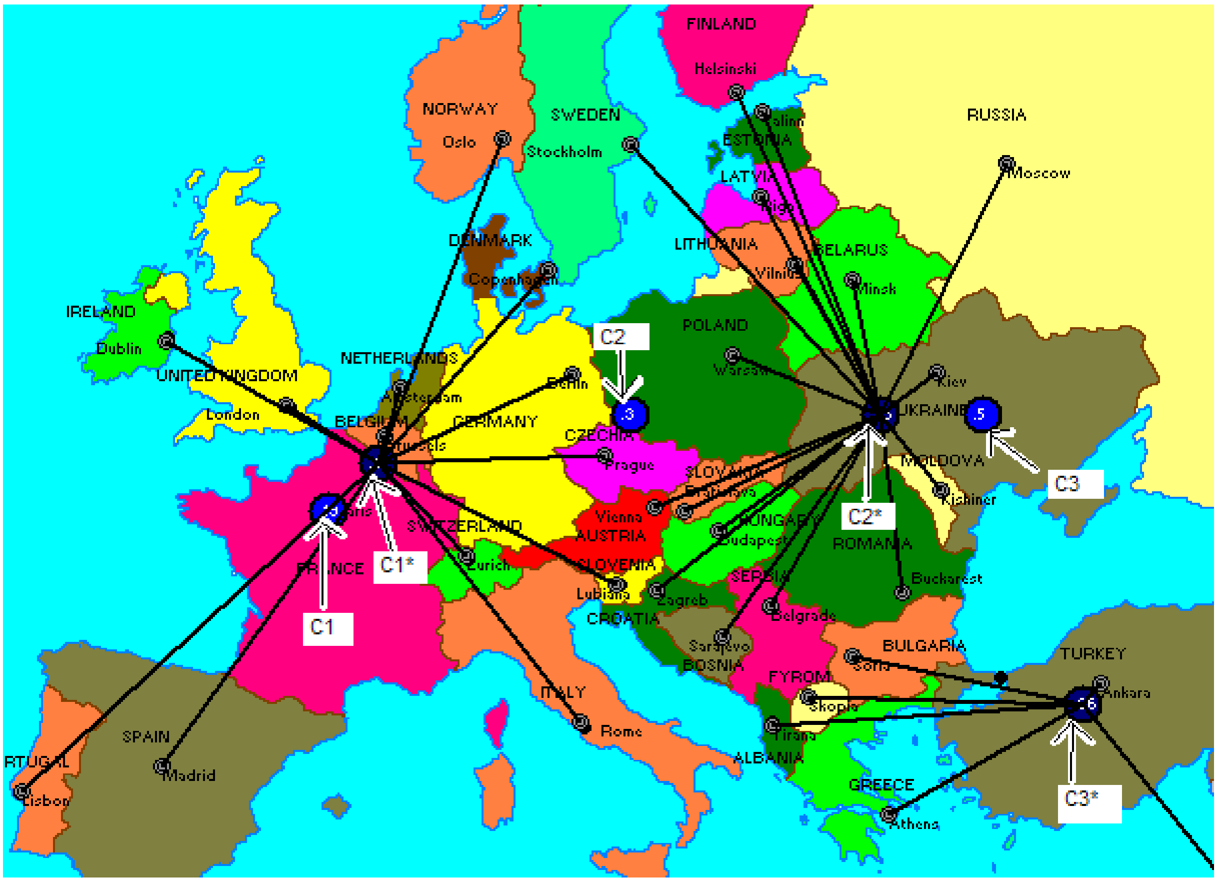
Map A1. The simple and dual Social Gravity Systems of Europe



Map A2. The triple Social Gravity System of Europe

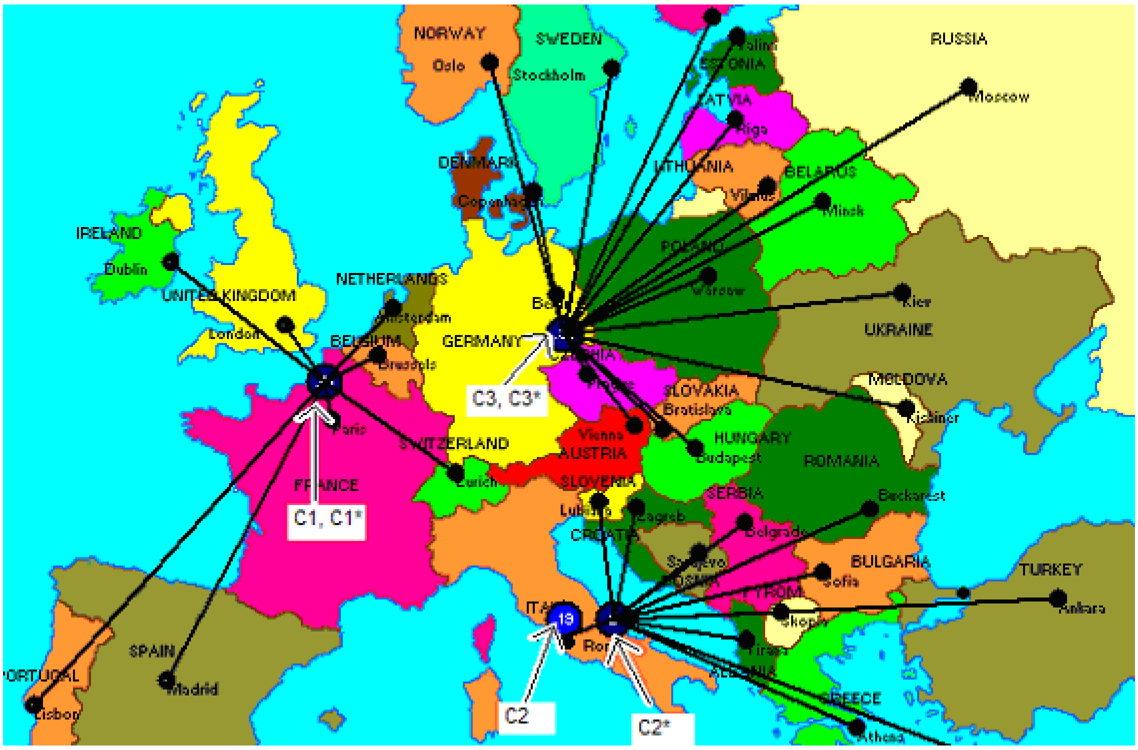


Map A3. Europe's simple and dual Economic Gravity Systems



Map A4. Europe's triple Economic Gravity System

Map A5. Europe's simple and dual Trade Gravity Systems



Map A6. Europe's triple Trade Gravity System

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CONNECTIVITY AND STABILITY OF THE AIR NETWORK IN THE SOUTHEASTERN EUROPE: A SMALL WORLD APPROACH.

Fabio Lamanna and Giovanni Longo
Department of Civil and Environmental Engineering.
University of Trieste
Trieste, Italy.

Abstract. In this study a new *small world* approach to air network stability will be presented, derived from the social analysis and applied for one of the first time on a transportation case.
The Southeastern Europe air network has been modelled and analysed by means of complex network theories, which help to defined the global behaviour of a network, in term of stability and efficiency.
Results show that, on the test case, it is not so easy to improve the efficiency of the system due to its particular topological properties. In spite of this fact, it has been possible defining its behaviour under missing connections and failures. The analysis show how a damaged connection between two nodes with higher number of flights than the others, is not always the most critical one in case of faliure, under the global network behaviour point of view.

1. INTRODUCTION

Air networks become one of the busiest transportation systems in the world, because of their crucial role and importance to the development of a country; they are one of the most significant signature of its economical growth and social progress. Air transportation networks are responsible of the mobility of millions of passengers every day, connecting their social and economical interests. For these reasons the study of the stability and of the connectivity of such networks has been always taking into fine account. Therefore, to provide a powerful study of an air network in all of its parts, is impossible not taking into account the behaviour of the structure in its totality, and the role that even a little single node or connection of a network could give in the global economy of the system.

The above considerations naturally fit with the special issue of the "Journal of Transport and Shipping", concerning the integration of transport network systems of the southeastern Europe. The new proposed approach will give a fundamental role at the air transportation mode in the global aspect of the network and it would be able to give answers to economic, social and environmental aspects; moreover, the analysis will focus on the global role of the Greek and of the Turkish air networks in a global harmonization for the benefit of all sides.

The last decade has witnessed the birth of a new movement of interest and research in the study of a new kinds of systems, the complex networks, i.e. networks whose structure is irregular, complex and dynamically evolving in time. This new field of research topics, triggered by two fundamental papers (Watts and Strogatz 1998) and (Barabási and Albert 1999), increased the interest in applying new concepts on the study of transportation networks using both *small world* and scale-free networks approaches.

The research on complex networks begun with the effort of defining new concepts and measures to characterize the topology of real networks. The main results has been the identification of a series of unifying principles that characterize social, information, biological and transportation systems (Barabási 2002). In particular, all of these systems appears to be built by a small number of "hubs" (nodes with higher connections than the others) and "weak ties", i.e. connections between long distance entities that makes all of these systems so close.

Only few studies have been developed so far in order to apply this theory on air transportation cases. Airport networks have been characterized in terms of *small world* ones, modelling and defining the importance of the hubs in the economy of global stability (Guimerà et al. 2005). More studies have been developed by means of complex networks on real air transportation cases, to estimate the connectivity and the possible growing up of particular kind of phenomena like aggregation and hubs (Bagler 2006). Moreover, a model was proposed for the identification of weighted complex networks properties, in effort to understand the statistical properties of real-world systems (Barrat et al 2004). Finally, air network of China was analysed for its topology and traffic dynamics (Li and Cai 2003).

An extended definition of the *small world* properties for weighted networks has been introduced (Latora and Marchiori 2001), in order to define if a network could be considered "*small world*" efficient in term of the capacity of changing information between nodes.

Small world networks seems to be more stable than other types of complex networks. This study analyses the air link networks of Greece and Turkey, both locally and related to their mutual interactions, by means of a complex network approach; the local properties of the air connections could help to better describe the hubs efficiency related to the global behaviour of the whole air link network in the test case area. Moreover, a more general approach will be introduced, to evaluate the efficiency (Latora and Marchiori 2005) of a particular kind of air network in case of missing connections or hubs failures.

In the beginning of this paper, a briefly review of the *small world* phenomenon will be presented. After that a review of the structure of complex networks (scale-free and *small world*) will introduce the main part of this study: the *small world* analysis taken on the Greece Airport Network and on the Turkish one, in their own properties and related with the efficiency of the entire Aegean Area. General conclusions and further research indications are going to complete this part of the study.

2. THE SMALL WORLD PHENOMENON

In complex networks analysis, a *small world* network is a class of random graphs where most nodes are not neighbours of one another, but most nodes can be reached from every other by a small number of steps. S*mall world* networks are well known to be very stable and useful characterizing social, biological, and information network systems.

By the end of the 90’s, several studies (Watts 1999) have been made in order to evaluate the common properties that could tie different kinds of networks. It has been found that social interactions, biological protein connections, the world wide web and other types of networks present almost the same properties of being extremely closed despite their apparently randomness or disorder structures. This fact allows the system to be very stable, and permits to evaluate where and in which conditions the system could be able or not to absorb failures or faults.

There are several properties that are commonly associated with *small world* networks: typically there is an over-abundance of hubs nodes in the network with a high number of connections (known as high degree). These hubs serve as the common connections mediating the short path lengths between other edges. By analogy, the *small world* network of airline flights has a small mean path length because many flights are routed through hub cities. Therefore *small world* theories are able to solve various kind of connectivity, efficiency and stability problems, and in general could improve the well organization of networks, in a relative simple way. Moreover, air networks are an evolving structure, in which every day new airports or new flights improve the connections through the region and, at the same time, failures or missing flights could affect its structure as well. For these reasons, the air system has to be analysed and studied in a different way than it has been done so far; it is evolving in time, and all of its parts are important to the global efficiency of its network; *small world* and complex networks theories seem to perfectly fit to this study's topic.

3. COMPLEX NETWORKS: STRUCTURE

Complex networks refers to systems (as well as the mathematical graphs structures) dynamically evolving in time. Most social, biological, and technological networks (as well as certain network-driven phenomena) can be considered complex by virtue of some special topological properties (e.g. social network, computer network, neural network, epidemiology). Such structures appear to be much more ordered and simple than it seems to be.

In contrast, simple networks have none of these properties, and are typically represented by graphs such as lattices or random graphs. The two most well-known examples of complex networks are those of *scale-free* networks and *small world* networks. Both are specific models of complex networks put forward in the late '90s by physicists. However, as network science has continued to grow in importance and popularity, other models of complex networks have been developed, and its structures arise in very different contexts and situations: transportation cases are one of these new fields of applications.

In the mathematics formalism (e.g. Watts and Strogatz 1998), a generic network is represented by an undirected (or directed) graph G = (N,L) consists of two sets N and L. The elements of $N = \{n_1, n_2, ..., n_N\}$ are the nodes of the graph G, while the elements of $L = \{l_1, l_2, ..., l_N\}$ are its links (or edges). The number of nodes and edges are denoted by N and K, respectively.

A central concept in graph theory is that of the reachability of two different nodes of a graph. In fact two nodes, and therefore two airports in this case, that are not adjacent may nether less be reachable from one to another. The so called *walk* from node i to node j in an alternating set of nodes and edges that connects the two nodes, and its length is defined as the number of edges one have to follow to reach one node to the other.

For this study's purposes, it is useful to define a *path*, which is a walk in which no node is visited more than once. In the airport network case, it will be useful to evaluate the maximum number of flight that a traveller have to change to reach his destination. Moreover, the *shortest path* (or *geodesic*) is the minimal length between two nodes, so the shortest way that connects two different airports (in number of flight changes).

A graph can be expressed by means of its adjacency matrix A(a_{ij}), whose elements take the value 1 if an edge connects vertices i and j, 0 otherwise. This is a symmetric matrix for undirected graphs, which are the ones considered and analysed in the rest of the paper.

4. COMPLEX NETWORKS: MEASURES

After defining the structure and the main properties of a complex network, it is useful to present the numerical characteristics of these types of systems. There are four basically instruments to be evaluated in order to characterized the connectivity of an air network: the node degree, which represents the number of no-stop flights departing or arriving at an airport; the shortest path length, that measure the minimum number of flights that a traveller have to change to reach one node of the network from every other one; the clustering coefficient which give a measure of how two airports connected to another one, are connected between them as well. Finally, the efficiency of a network measures how efficiently the airports are connecting between them, both in a global than in a local scale, characterizing how the system answer on case of airport failures or missing connections.

4.1 Node Degree and Degree Distribution

The degree, or connectivity k_i of a node, is defined as the number of edges incident with the node, in term of its adiacency matrix:

$$k_i = \sum_{j \in N} a_{ij} \; .$$

The most basic topological characterization of a graph G can be obtained by its degree distribution P(*k*), defined as the probability that a node chosen uniformly at random has degree *k*. This will be useful later to characterized the behaviour (in terms of connectivity) of different kind of air network scenarios.

4.2 Shortest Path Length and Diameter

As said in the previous paragraphs, shortest path plays a fundamental role in transport and communication within a network. It is useful to represent all the shortest path lenghts of a graph G as a matrix D in which the entry d_{ij} is the length of the geodesic from node *i* to *j*. The maximum value of d_{ij} is called the *Diameter* of the network.

Another useful measure of the typical separation between two nodes is the so called *characteristic path length*, define as the mean of shortest path length over all couples of nodes:

$$L = \frac{1}{N(N-1)} \sum_{i,j \in N, i \neq j} d_{ij} \; .$$

4.3 Clustering

The *clustering coefficient*, also known as transitivity, is a typical property of connected networks. It considers if two nodes connecting to a third one, are also connected between them. Considering e_i the number of edges in a subgraph G_i, the local clustering coefficient c_i is defined as the ratio between e_i and $k_i(k_i-1)/2$, the maximum number of edges in G_i.

The clustering coefficient of G is so defined:

$$C = \frac{1}{N}\sum_{i \in N} e_i ,$$

and, by definition, c_i and C values goes from 0 to 1.

4.4 Efficiency

This measure has been developed (e.g. Latora and Marchiori 2005) as a natural extension of the *small world* definition for the traffic capacity of a network. The efficiency measures how efficiently the nodes exchange information, considering the harmonic mean of the geodesic length. For this study's purposes, it is useful introducing the measure of efficiency related with particular kind of damages of the network.

Starting from the infrastructure *S*, the resulting network obtained from a generic hypothesis of failures (e.g. missing connections) has been defined as *DAMAGE (S, d)*. The index *d* is related to the generic event in case of a damage of the network. The importance of *d* in term of efficiency has been defined as follows, where Φ is the function representing the so called Performance of the network:

$$\frac{\Delta\Phi}{\Phi} = \frac{\Phi(S) - \Phi(DAMAGE(S,d))}{\Phi(S)} .$$

By means of these two measures, in the following analysis it will be possible to predict the efficiency of the global air system under fixed hypothesis and scenarios. According to the previous studies, it is possible defining the Performance of these types of networks as the inverse of the characteristic path length *L*, to measure how efficiently the nodes exchange information (i.e. flights).

5. COMPLEX NETWORKS: TOPOLOGY

Many kind of real systems are made by a large number of interconnected dynamical units. The first approach to capture the global properties of an air network system is to model a real graph, in which nodes represents airports, and edges no-stop flights between them. The same approach related to other types of network shows, during the last years, that despite the inherent difference, most of the real networks are characterized by the same topological properties, like the small characteristic path length and an high clustering coefficient.

All of these common properties helped this research to analyse the Southeastern Europe Air Network as a typical complex system, and to provide useful information about its structure. The air network studied in this paper will configure as a complex network having both of the two common properties of these systems: it is both *small world* and scale-free.

5.1 Small World Networks

There are two common features that make different kind of complex networks *small world*: the characteristic path length L and the clustering coefficient C. S*mall world* networks are highly clustered, like regular lattices, while having small characteristic path length, like random graphs.

In random topological networks, C and L are relative small compared to the ones related with regular networks; on the other side, non-random networks could be defined as structures having regular behaviour like the so called physics 'lattices' networks. Regular networks have got high values of both clustering coefficient and characteristic path length. By definition, the behaviour of *small world* networks is nor random neither completely ordered; it is something between them.

In this study's topic, the above parameters L and C are going to be evaluate in order to define if the test case networks could be related to *small world* systems. The s*mall world* behaviour could help the air network provider to analyse the actual configuration of flight and to design various stable future scenarios related to complex networks properties.

5.2 Scale-Free Networks

Approaching to the study of real complex networks, researches expected to find the common properties of homogeneity of every graph structures; this means that almost all nodes in a network should be topologically equivalent, i.e. each of all possible link is present with equal probability in the graph, with a degree distribution which follows a binomial or Poisson law. However, real-world databases shows that most of real networks display a power law relationship, where the probability $P(k)$ that a node connects other k nodes is proportional to $k^{-\gamma}$, where the exponential coefficient value goes from 2 to 3.

These kind of networks have been named scale-free networks, because they have the property of having the same functional form at all scales. In such systems, some nodes act as "highly connected hubs" (high degree), although most nodes are of low degree. Scale-free networks' structure and dynamics are independent of the system's size *N*, the number of nodes the system has. A network that is scale-free will have the same properties no matter what the number of its nodes is.

6. THE AIR NETWORK MODEL

After defining the main characteristics of complex networks, in the following paragraphs the test case model, from which the analysis derive, will be presented. The analysis have been taken first locally on the Greek and the Turkish networks, then considering them as a single homogeneous air system. Several scenarios will be described in the global case, in the scheduled scenario and then hypothesizing some failures on links or airports, to provide useful information about the global response of the network.

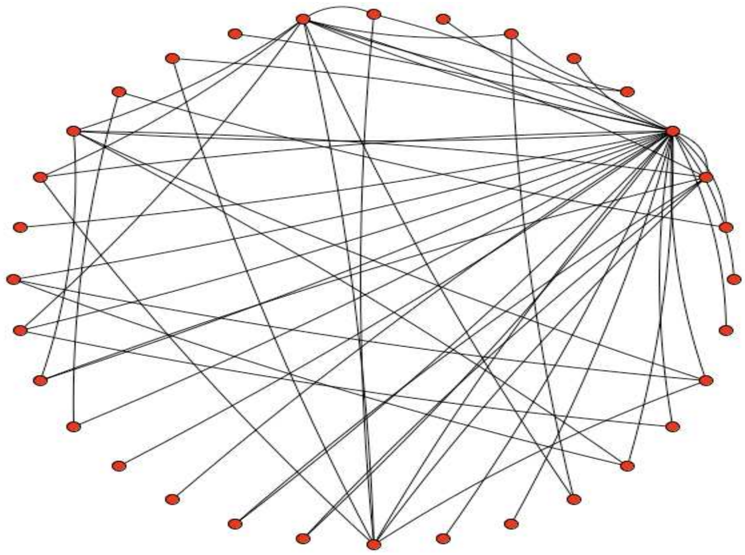
6.1 The Greek Air Network

The Air Network of Greece has got the fundamental role of building good connections through its region, especially between many Aegean islands and the continent. In the summertime the great traffic demand requests a major connection system between tourists areas, while in other months it should replace the sea services, not always available.

In this study it has been considered the Olympic Airlines network, which is the state-run flag carrier and the largest airline in Greece. It operates scheduled services both to domestic and to foreigner cities, and its network arises from the two main airports of Athens International Airport (ATH) and Thessaloniki International Airport (SKG) to a set of other thirty minor airports on all over the region, including Rhodes (RHP) and the ones of the Aegean islands. Figure 1 shows the Greece air network while Figure 2 represent the same system as appears as a classic circular layout; this kind of representation is a lattice based layout algorithm where the nodes in the network are arranged in a circle. The connections between the nodes depend on the structure of the network being visualized. It is a very simple layout algorithm which gives an good overview of the number of nodes and edges in a network.

FIGURE 1: Greece Air Network

FIGURE 2: Greece Air Network. Circular Layout



6.2 The Turkish Air Network

The Turkish Air Network is the second system analysed; its closeness to the Aegean area makes it the natural partner of the Greek Air Network to predict a global air behaviour in the Southeastern Europe. Turkish Airlines is the national airline of Turkey based in Istanbul. It operates a network (Figure 3) of scheduled services to 103 international and 28 domestic cities, serving a total of 134 airports, in Europe, the Middle East, Central Asia, the Far East, Africa, and the United States. The airline's main base is Atatürk International Airport (IST) in Istanbul. Other main airports in the region are Ankara International Airport (ESB) and Izmir (ADB). The domestic Turkish Airlines timetable has been implemented in the following analysis to predict, as well as the previous Greek one, general topology characteristics and complex networks behaviour (scale-free and *small world*).

6.3 The Global Aegean Air Network

Once built every single network by nodes and edges, several scenarios could be hypothesised to predict both the future behaviour of the Global Aegean Air Network and the efficiency of its connections in case of failures. The actual connections between Greece and Turkey operated by the two flag carriers are between Athens and Thessaloniki to Istanbul, in both directions (Figure 5).

FIGURE 3: Turkey Air Network

FIGURE 4: Turkey Air Network: Circular Layout

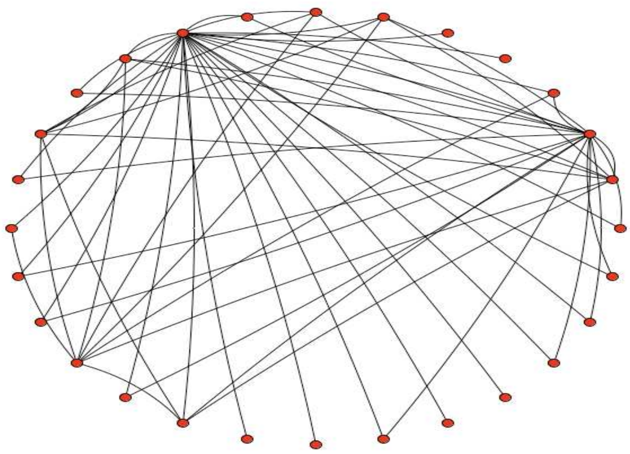
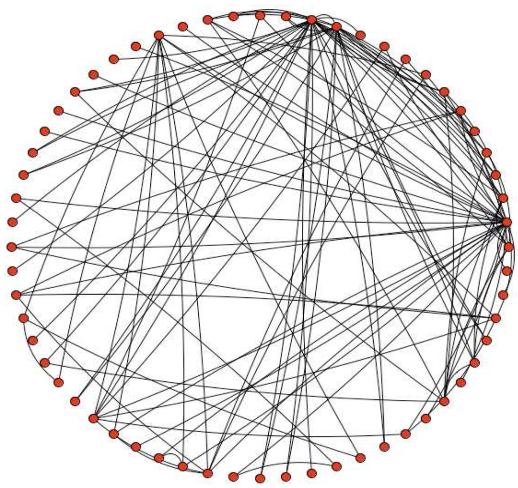


FIGURE 5: Actual Aegean Air Scenario: Circular Layout

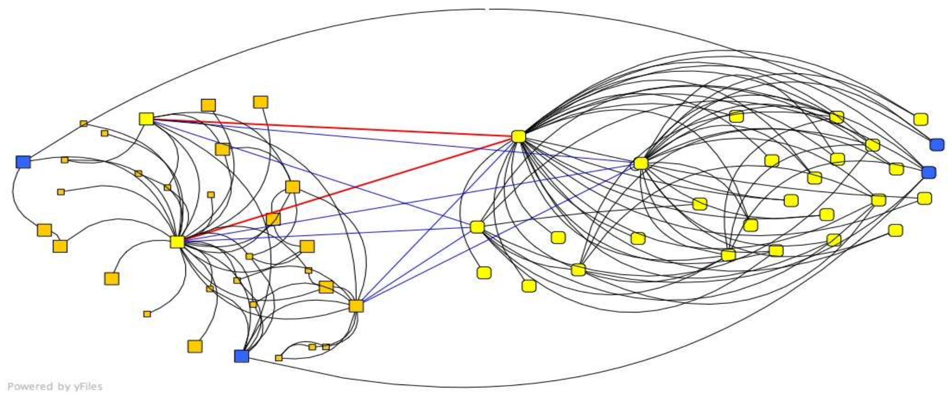


The analysis on different kind of global networks connections allow the air network provider to predict how the stability of the system responds in case of traffic demand improvements, or if new connections designed to follow the demand could or not help the system to decrease the distances (in terms of number of flight changes) through the network. Several different scenarios have been analysed in the following results paragraphs in order to predict the future expansion and stability of the Aegean air connections; scenarios are growing up in this way (Figure 6):

- Scenario 0: actual connections (red links);
- Scenario 1: The two main Greek hubs Athens and Thessaloniki have been connected by no-stop flights to Ankara, which is the capital city of Turkey and the most connected airport in Anatolia, after Istanbul (blue links);

- Scenario 2: other main airports of Greece and Turkey are Izmir and Rhodes. In this hypothesis they have been connected to other Aegean hubs, Athens, Thessaloniki Istanbul and Ankara, respectively. This scenario has been built up with the aim of study the behaviour of a network with full connected hubs (blue links);
- Scenario 3: because of the geographical closeness of the main Aegean hubs, it is trying to connect also four of the most faraway airport between them (Corfù, Agri, Iraklion and Van), to the aim of verified if the system could be more close than the one based almost only hubs connections (blue nodes).

FIGURE 6: Hub Connections



7. RESULTS

The models of the air networks have been built by means of the yEd open-source graph editor. It is a sub-project of the yFiles Software (www.yworks.com) written in Java, which allow the user to built a mathematical graph of nodes and edges, easy to be exported on .xml format on other applications. The Greek, the Turkish and the global network scenarios have been mathematical described by the above tool. Each node has been connected with each other by a link representing a connection by a no-stop flight service operated by the two national Olympic and Turkish Airlines (in each country). Therefore, analysis have been conducted with the help of different complex network algorithms.

Results are going to be shown in three different parts: in the first one it has been verified if each network could be considered as *small world*, showing the course of *L* and the diameter of the network in different scenarios.

In the second part it will be shown the scale-free properties of the network, by means of node degree distribution.

In the last part there will be introduced the Efficiency measures related to the hub connected scenario, in case of possible failures.

7.1 *Small World* Properties

The local air networks have been analysed together with the other scenarios. By definition, the behaviour of *small world* in real networks is often associated with the presence of clustering, denoted by high values of *C*. For this reason, to characterize a *small world* network it could be useful to show in a table the values of *L*, *C* and of the diameter for local networks and for the three different scenarios of connections improvements (Table 1).

TABLE 1: Small World Properties

Network	*N*	*K*	*C*	*L*	D
Greece	32	55	0,63	2,07	4
Turkey	28	60	0,72	1,89	3
Sc 00	60	117	0,67	2,53	5
Sc 01	60	119	0,67	2,52	5
Sc 02	60	123	0,67	2,42	4
Sc 03	60	125	0,64	2,41	4

The first columns represents the different scenarios analysed, along with the number of nodes (airports) and edges (no-stop flights) of every network.

The results show the *small world* behaviour for the analysed air networks; in particular, except the behaviour of the Turkish network, which shows a very small value of *L* compared to the other ones, the global network scenarios show almost the same properties; the distances between the Southeastern air system nodes is almost the same in every scenario. For this reason is difficult to improve its efficiency, because of the evaluation of the probability that a passenger can travel from each node to another one of the network in a given number of steps, showing the course of L (Figure 7).

For any pair of nodes connected, it has been possible to find the global role and the integration of a new flight link in the whole network. As appears in the results, the integration of the two local network into one single system allows to cut the mean distance between nodes. On the other hand, several improvement of the connections didn't help the system to decrease the mean path length between airports. Moreover, the third scenario which connects four geographical remote airports along with all hubs, is not able to cut the mean distance between two random choices nodes.

In term of clustering, this networks are characterized by the presence of connections between almost any two nodes within them, and this topological structure doesn't concur, from the point of view of the complex nets, more margins of improvements.

On the other hand, the value of the diameter of the network (i.e. the length of the longest shortest path between pairs of nodes) is not constant for each scenario; the length of five steps in the actual connecting scenario is equal improving the edges from main Greece hubs to Turkey main airport (both Istanbul and Ankara). It decreases to four steps in the second scenario (with all hubs connected) and, unexpectedly, in the third as well, where it has been connected airports at the borders of the network. Therefore the ideal situation of a passenger who have to reach any airport of the network from another one in as few as possible steps, is in contrast with the common idea that improving links between any kind of airports could help a better organization of the air traffic.

7.2 Scale-Free Properties

The second analysis on the local networks have been conducted in term of node degree distribution of the airports; Figure 8 shows the scale-free properties of each network. It has been diagrammed (in logarithmic scale) the number of nodes having a given degree over the probability that a node is connected to one another. As with all systems characterized by a power law distribution, the most notable characteristic in a scale-free network is the relative commonness of vertices with a degree that greatly exceeds the average. The highest-degree nodes are hubs, and are thought to serve specific purposes in their networks, although this depends greatly on the domain.

As the Figure 8 shows, despite some incoherent state of the Greek network (due to the limited number of nodes), the course of all networks follows the same power law course.

FIGURE 7: Distribution of Shortest Path Length

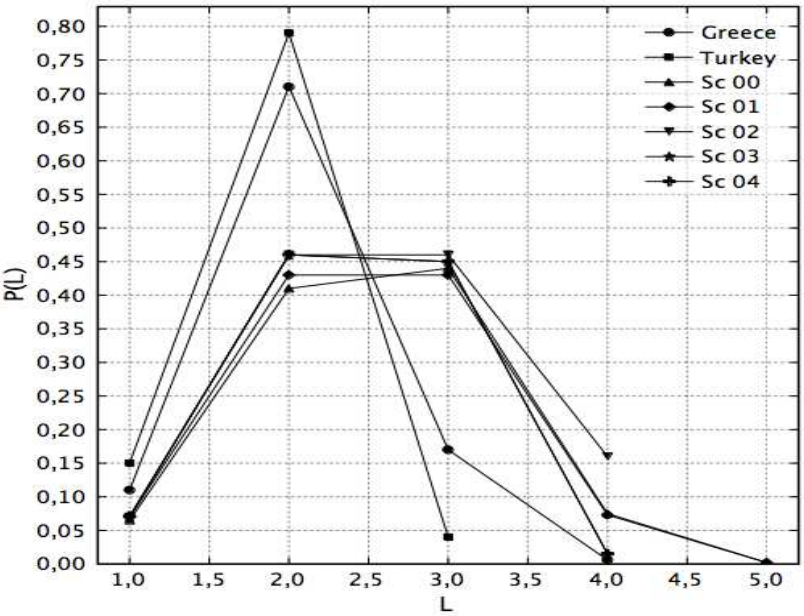
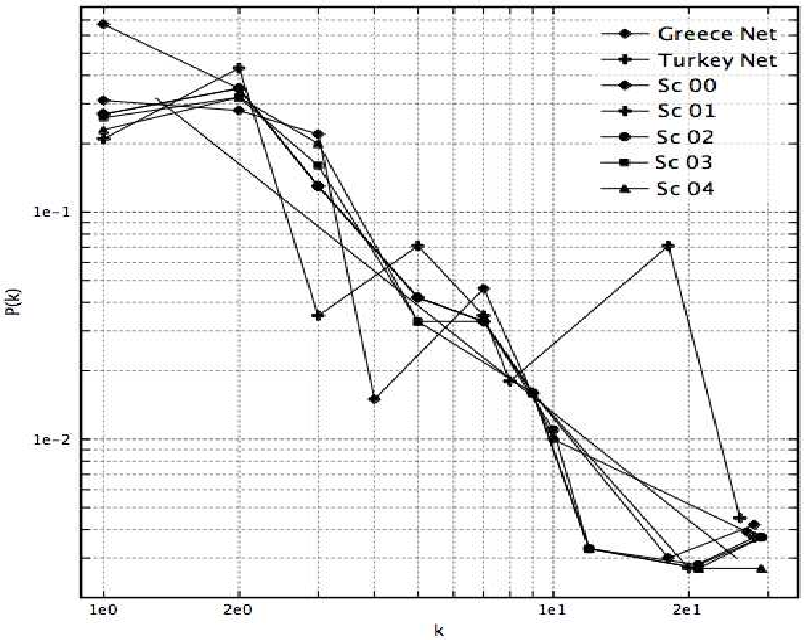
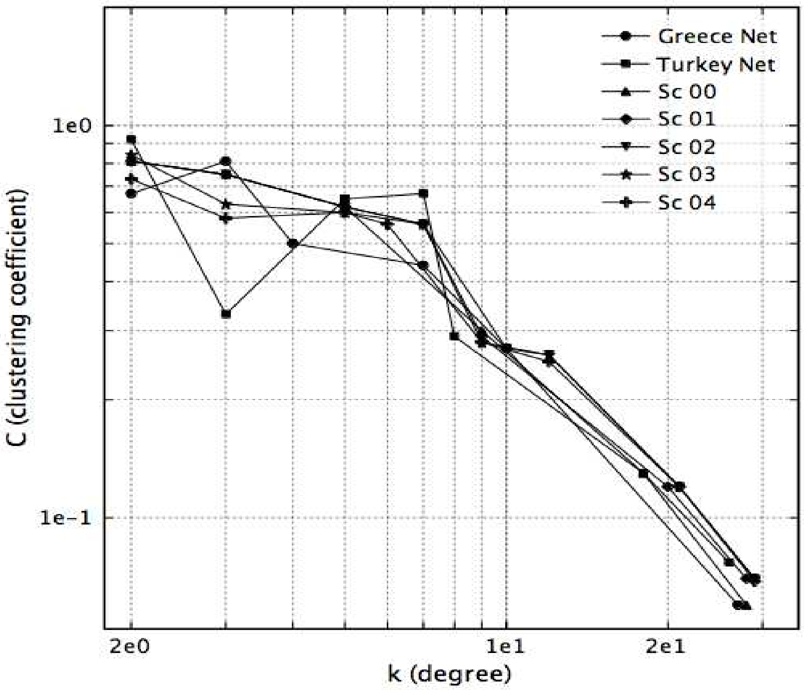


FIGURE 8: Scale-Free Distribution



Another important characteristic of scale-free networks is the clustering coefficient distribution, which decreases as the node degree increases. This distribution also follows a power law (Figure 9). That means that the low-degree nodes belong to very dense and connected sub-graphs of few airports, and those sub-graphs are connected to each other through hubs, in a sort of tree structure.

FIGURE 9: Distribution of Clustering Coefficient



The common properties of different air connections scenarios show that an air network of this kind (*small world* and scale-free) is not so easy to improve, i.e. its topological structure makes it so stable and difficult to be changed.

The Aegean air system is so a good topological structure, able to get a stable behaviour despite the few actual no-stop flight links between the Greek and the Turkish flag carrier programs. By the way, it has been seen that one of the typical characteristic of these types of complex networks is the over abundance of hubs but this is their “Achille's heel” as well; in fact, the system is stable until a failure of one of its hubs. At that point, most of airports becoming unconnected, and the all system collapses.

In the final paragraph it will be presented the last analysis to measure the effective robustness of these kind of networks, in case of failures.

7.3 Efficiency

The network structure and function strongly rely on the existence of paths between pairs of nodes. When nodes or links are removed (i.e. there is an airport or connection failure), the typical path length will increase and some locations become disconnected.

On the other hand, the improvement of new connections to follow the travel demand have to be strongly related with the effective rate of benefit for the global network.

As the previous analysis reported, the structure of *small world* networks (as the Southeastern Europe system is) is very stable and fixed in itself. It is not possible definitively improving it, if not connecting all pairs of nodes. On the other hand, if we choose a few major hubs and take them out of the network, it simply falls apart and is turned into a set of rather isolated graphs. Thus hubs are both the strength of scale-free networks and their Achilles' heel.

In the following analysis it will be presented the results related to the deactivation of a connection, to the aim of evaluate its importance in the global economy. In particular it has been analyzed the previous Scenario 2, because of it takes into account the all region Hubs (Istanbul, Ankara and Izmir in Turkey; Athens, Thessaloniki and Rhodes in Greece).

It has been removed each link connecting the above locations, with the aim to define which is the most vulnerable in the global air network economy, in case of its damage. Table 2 shows the results in function of the above described “Performance” measure: the expected Athens – Istanbul link is the one with the most critical performance in case of its failure, follow by an efficiency decrease by the Rhodes – Istanbul connection. This method is useful to predict some global behaviour of the system because of, despite the common thoughts, it is not always the most connected link the more vulnerable in the whole network economy.

Finally the same analysis could be taken in case of a hub failure; airports often have to be closed due to several reasons, even if for a short time, causing cascading delays or cancellations of flights. If one of the this air system's hubs have to close, it means that at least one airport become disconnected to the rest of the system. This fact dramatically increases the value of the shortest path length.

TABLE 2: Failure Analysis on Hubs connections

	Damaged Link	$\Delta\Phi / \Phi$
1	Athens – Istanbul	3,01
2	Rhodes – Istanbul	0,83
3	Athens – Izmir	0,50
4	Thessaloniki - Ankara	0,44
5	Izmir - Athens	0,16
6	Rhodes - Ankara	0,10
7	Izmir - Thessaloniki	0,02
8	Thessaloniki – Ankara	0,02

By contrast, in a random air network, in which all nodes have roughly the same number of connections, deleting a random node is likely to increase the mean-shortest path length slightly but significantly for almost any node deleted. In this sense, random networks are vulnerable to random perturbations, whereas *small world* networks are robust. However, *small world* networks are vulnerable to targeted attack of hubs, whereas random networks cannot be targeted for catastrophic failure.

8. CONCLUSIONS

In conclusion, a *small world* approach seems to be a new right method to evaluate typical air networks properties as such as connectivity, stability and hubs efficiency. *Small world* and complex network theories can help the air service provider to define which links are the most vulnerable in case of its failures. The results showed that the connections departing from the nodes with higher degree are not always the most vulnerable; it depends on the global economy of each edge.

Meanwhile, the Southeastern Europe network has got all the typical complex networks characteristics: it is both *small world* and scale-free. This means that the system is very difficult to be improved by more air links between its airports, and more connections make the travel distances through the network very slowly decreasing.

Finally, this method helps the study of the harmonization of the whole Southeastern Europe and Middle East airport network, not only by means of typical transportation topic, but also by the possible spin-off of the topological structure for social and economical behaviours, within and beyond the countries.

The research is now directed in several ways, to the aim of improving the definition of efficiency modelling a weighted network of flights, to take into account more transportation aspects as such as travel times, travel demand and available seats on each route.

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THE EXPERIENCE AND THE ROLE OF PAN-EUROPEAN CORRIDOR X IN THE INTEGRATION OF TRANSPORT NETWORKS IN THE EAST MEDITERRANEAN AREA

M. Miltiadou, Ch. Taxiltaris, G. Mintsis and S. Basbas
Department of Transportation and Hydraulic Engineering
Aristotle University of Thessaloniki,
Thessaloniki, Greece

Abstract. In this paper, the experience and the role of Pan-European Corridor X in the implementation of the EU Transport Policy are presented. More specifically, the members of the Technical Secretariat of the Steering Committee for Corridor X appose scientific, technical and procedural activities, which contributed to the embedding of a Pan-European multimodal transport Corridor and feed its development perspective in Southeast Europe. Then a brief description of the existing and future situation of Corridor X is given, being results of the systematic following of all the activities concerning the development of the Corridor since the establishment of the structures of Corridor X, and consist the documentation of the key-role of the Corridor in the wider area. Finally, and based on the experience gained after several years of operation and intensive activation, and within the framework of the revision of the Pan-European Corridors and Areas and the setting of the new policy guidelines, the concept of the structures of Corridor X for the implementation mechanism of the South Eastern Priority Axis is presented.

1. INTRODUCTION

The Pan-European Transport Corridors and Areas were defined in the previous decade, at the Pan-European Transport Conferences of Helsinki and Crete. On the basis of the respective declarations, the European Commission and the participating countries' authorised Ministers for Transport signed Memoranda of Understanding for the development of the Pan-European Corridors. For the coordination and implementation of those Memoranda respective Steering Committees have been constituted, and to their support Technical Secretariats have been established. Various studies have been elaborated for the documentation and prioritisation of projects, as well as for the examination of the development potential of the transport sector.

Meanwhile, extensive planning exercises have been carried out by the European Commission, in order to define the Trans-European transport networks for the Member States and the accession countries. The last exercise was carried out in 2005 by a High Level Group, which had been established following the ministerial seminar of Santiago de Compostella in June 2004. The aim of the exercise was the revision of the Pan-European Networks after the enlargement of the European Union, and its result was a proposal of the Commission to the European Council and the Parliament of five Priority Axes (actually regional networks) in January 2007; one of those axes refers to the wider South Eastern European region, which links the EU through the Balkans and Turkey to the Caucasus and to Caspian Sea, to Egypt and the Red Sea.

Hereinafter, the structures of Pan-European Corridor X and the results of their work are presented. Reference to other structures, initiatives and organisations active in the region the evolutions on European Transport Policy is made, and finally an implementation mechanism for the South Eastern Europe Priority Axis is proposed.

2. PAN-EUROPEAN TRANSPORT NETWORK INITIAL DEFINITION

The Prague Declaration on all-European Transport Policy of the First Pan-European Transport Conference in 1991 for the development of an efficient all-European Transport System foresaw the indication of the most important transport routes linking the European countries and regions to be considered for improvement and modernization.

The Second Pan-European Transport Conference in Crete in 1994 declared that a starting point for future work on coherent infrastructure development at Pan-European level was the report on a set of indicative guidelines, which covered the main infrastructure corridors for the various transport modes. Nine Corridors were defined then, while a tenth was added, Corridor X, during the third Pan-European Transport Conference in Helsinki in 1997 to cover the region of the former Yugoslavian countries, and mainly the today's Serbian Republic.

The overall objective of the Helsinki Declaration was to promote sustainable, efficient transport systems (taking into account technical and interoperability aspects in order to facilitate movements at border crossings), which meet the economic, social, environmental and safety needs of European citizens, help to reduce regional disparities and enable European business to be competitive in the world markets. Among other sub-objectives, one was to promote rehabilitation or reconstruction of problematic links, giving at the same time priority to measures able to better exploit the existing infrastructures.

3. PAN-EUROPEAN CORRIDOR X DEFINITION

Pan-European Corridor X is the traditional route linking South Eastern Europe with Central Europe, which had served transportation in the area for many decades. Before the 1990's this Corridor was fully operational and more or less developed in terms of road and rail infrastructure. The crisis in the region of former Yugoslavia caused a significant drop in traffic along the Corridor and also influenced its physical and operational status with damaged and neglected infrastructures and facilities, and three new international borders along the Corridor, between the four former Yugoslavian countries.

The multimodal Pan-European Transport Corridor X (Main Axis and four branches), as defined by the third Pan-European Transport Conference in Helsinki in 1997, connects Salzburg, Ljubljana, Zagreb, Belgrade, Nis, Skopje, Veles and Thessaloniki; Graz with Maribor and Zagreb (Branch A); Budapest with Belgrade (Branch B); Nis with Sofia [to Istanbul via Corridor IV (Branch C)]; and Veles with Florina [and via Egnatia with Igoumenitsa port (Branch D)]. It refers to the road, rail and interconnection points for inland waterways, air, maritime, intermodal and in particular combined transport infrastructure, including ancillary installations such as signalling, the installations necessary for traffic management, access links, border crossing stations, service stations, freight and passenger terminals and warehouses along the Corridor. The alignment of the Corridor is described in more detail in **Table 1** (represented in **Figures 1** and **2** in **Chapter 6** for roads and railways, respectively).

TABLE 1: Corridor X main characteristics and alignment

Concerned countries: Austria, Bulgaria, Croatia, F.Y.R. of Macedonia, Greece, Hungary, Slovenia, Serbia	
Transport modes: Railways	2.528km
Roads	2.300km
Inland waterways	n.a.
Airports	12
Sea- & River- ports	4
Alignment	
<u>Main Axis: Salzburg - Ljubljana – Zagreb – Beograd – Nis – Skopje – Veles – Thessaloniki</u>	
Railway	Salzburg – Villach – Jesenice – Ljubljana – Zidani Most – Dobova – Zagreb – Novska – Vinkovci – Beograd – Nis – Skopje – Veles – Thessaloniki
Road	Salzburg – Villach – Karawanken – Ljubljana – Bic – Krska Vas – Obrezje – Zagreb – Beograd – Nis – Skopje – Gradsko – Thessaloniki
<u>Branch from Graz (Branch A)</u>	
Railway	Graz – Sentilj – Maribor – Zidani Most
Road	Graz – Sentilj – Ptuj – Gruskovje – Zagreb
<u>Branch from Budapest (Branch B)</u>	
Railway	Budapest – Kunszentmiklos – Tass – Kelebia – Novi Sad – Beograd
Road	Budapest – Szeged – Roszke – Subotica – Novi Sad – Beograd
<u>Branch to Sofija (to Istanbul) (Branch C)</u>	
Railway	Nis – Dimitrovgrad – Kalotina – Sofija
Road	Nis – Dimtrovgrad – Sofija
<u>Branch to Florina (Via Egnatia to Igoumenitsa port) (Branch D)</u>	
Railway	Veles – Bitola – Florina
Road	Veles – Prilep – Bitola – Florina

4. STRUCTURES FOR THE DEVELOPMENT OF CORRIDOR X

The initiative for the coordination of the activities for the development of Corridor X was taken by the International Affairs Division of the Greek Ministry of Transport and Communications. Recognizing the economic, commercial and geopolitical importance of the Corridor for the stability, cooperation and the development in the Balkans, several meetings were organized with all parties involved and sharing the same interest for the revitalization of Corridor X, in view of preparing and signing of a Memorandum of Understanding (**MoU**) by the Ministers of Transport of the Corridor's countries. After two constructive preparative meetings of delegations of the countries concerned and representatives of the European Commission (**EC**) and other international organizations in 1998 and 1999, the Ministers of Transport of the participating countries signed the MoU for Corridor X on March 15th 2001 in Thessaloniki.

The MoU of the Pan-European Corridor X (Steering Committee, 2001) aims at the cooperation for the development of main and ancillary infrastructure on the multimodal Corridor X, which should include maintenance, reconstruction, rehabilitation, upgrading and new construction of infrastructure, as well as its operation and use with a view to fostering the most efficient and environmentally friendly transport modes. Furthermore, the cooperation aims at perceiving and defining prerequisites and conditions for the most efficient use of funds and know-how provided by public and private sources.

The MoU includes the general rules on studies to be carried out according to best practices and to the requirements of the private sector and the international financial institutions, which should be involved during the different stages of planning, implementation, operation and use of infrastructure. It also foresees the exchange of information concerning the development, use and operation of the Corridor, such as physical aspects, traffic flows, delays at cross borders etc.

Furthermore, the MoU foresees to the agreement upon a common set of technical standards necessary to secure optimal interoperability of all the sections of the Corridor, including the interoperability between transport modes. The border crossings and customs cooperation included in the MoU aims at the minimization of waiting times and the improvement of the conditions for long-distance transport.

The framework for private participation in the development, use and operation of the Corridor is intended for optimum private sector involvement through a dialogue with the private sector and the International Financial Institutions during the planning and realisation of projects, and the ensuring of the necessary legal and financial conditions.

The framework for the implementation of the MoU is the definition of priorities, budgets and time-plans for specific measures necessary for the development of the Corridor, based on the coordination work of the Steering Committee of the Corridor.

The Steering Committee, which is consisted of representatives of the eight participating countries and the European Commission, meets regularly once a year and it is permanently supported by a Technical Secretariat (**T.S.**), which has been assigned by the Greek Chair of the Steering Committee to the Department of Transportation and Hydraulic Engineering of the Faculty of Rural and Surveying Engineering of Aristotle University of Thessaloniki to support the Committee during the Greek Chairmanship, since January 2000.

5. THE ROLE OF THE TECHNICAL SECRETARIAT

The role of the T.S. had been to become active especially in the collection and evaluation of existing information and relevant studies with respect to Corridor X, such as the collection of the information concerning the state of infrastructure, traffic flows, waiting times at borders, specific maintenance, reconstruction, rehabilitation and upgrading investments, and the establishment of a geographic information system (G.I.S.) to demonstrate in a systematic and comprehensive manner the state of the Corridor at its various stages of development. Concerning the dissemination of the results, updated information about the status of the Corridor is available at the T.S. website.

The T.S. adopts, among other coordination and monitoring approaches, a methodology of an analytical and in depth data collection survey, which mainly includes: a) annual questionnaire-based surveys in all participating countries, b) extended on-site visits of expertise and meetings with members of the road and rail authorities and organizations in each country, c) collection of reports from various sources (e.g., international and national organizations etc.) about Corridor X, d) International cooperation, especially with other Corridors in the area, the EC – Directorate General Transport and Energy (**DG TREN**) and United Nations Economic Commission for Europe (**UNECE**) – Transport

Division. The exchange of information with the South East Europe Transport Observatory (**SEETO**), which is the Technical Secretariat of the Steering Committee for the implementation of the South East Europe Core Network defined by the Regional Balkans Infrastructure Study (REBIS, 2003) is also foreseen.

Furthermore, the T.S. has to bring out conclusions of the inventory of existing studies and suggestions for the terms of references of new studies concerning Corridor X in line with the international experience in this field and to examine conditions providing interoperability. The T.S. also assists the efforts of the concerned countries to attract assistance for the development of the Corridor by International Financial Institutions and the private sector. In the framework of those efforts, the T.S. has elaborated a traffic flows forecasting study (for both freight and passenger sectors) for the documentation of needs for new studies and respective projects for the development of the Corridor.

Last but not least, the T.S. is assigned to contribute to the optimization of the operations and procedures taking place at border crossings and the provision of improved conditions for access to the Corridor. Based on the results of a detailed survey of the T.S. on cross borders infrastructures and procedures in 2003, it was decided that the structures of Corridor X, apart from the Steering Committee and the Technical Secretariat, should – and have been – enhanced by a Working Group, which nowadays works towards the implementation of a Protocol signed in a Ministerial meeting in Corfu on June 16th 2006 for the improvement of border crossings along the Corridor.

Most of the activities mentioned above are horizontal for the Technical Secretariat (apart from ad hoc activities, such as the elaboration of Terms of References for new studies, the traffic flows forecasting and the cross borders survey) and obviously in accordance to the MoU provisions.

6. STATE OF PLAY OF THE CORRIDOR

6.1 Roads

The total length of the road Corridor X is 2.299,6km and at present consists of multilane motorways at a percentage of 61,5% and highways and other main roads at 38,5%. The road categories along the Corridor are presented in **Figure 1**.

FIGURE 1: Road category of sections of Corridor X

Source: European Commission (2005)

The main part of Road Corridor X linking Salzburg and Thessaloniki through the capitals of the former Yugoslav Republics is 1.451,4km long and consists of multilane motorways at a percentage of 81,4% of its length. The maximum permitted speed along the Main Axis is 120km/h at most of its sections, and generally the infrastructure is in good condition.

Extended upgrading projects are on-going or scheduled. It is foreseen that the percentage of multilane motorways will reach 90% of the Main Axis by 2008, with upgrading of all the Slovenian and Croatian sections to full motorway profile. The remaining sections of the main part of Corridor X in Serbia and F.Y.R.O.M. that upgrading is required are the Leskovac (Grabovnica) – F.Y.R.O.M. border (102,13km) and Tabanovce – Kumanovo (7,4km) and Demir Kapija – Smokvica section (33km) in F.Y.R.O.M.

Furthermore, the construction of the motorway between Leskovac and the F.Y.R.O.M. border is foreseen by 2012, with Greek financial assistance (21% of total construction cost) through the Hellenic Plan for the Economic Reconstruction of the Balkans (Hi.P.E.R.B.), as well as the construction of the Belgrade bypass. Recently, the negotiations of the F.Y.R.O.M with the World Bank ended up with an agreement for the financing of the Tabanovce – Kumanovo motorway, while financing of the Demir Kapija – Smokvica motorway is under negotiation, with potential involvement of the European Investment Bank, the European Bank for Reconstruction and Development, the EC Instrument for Pre-accession Assistance and the Hi.P.E.R.B.

Branch A, from Graz to Zagreb via Maribor, is 163,4km long and consists of multilane motorways at 55% of its length. This branch is foreseen to be fully constructed in motorway profile by 2012.

On Branch B, the 47,3% of the 352,9km are parts of the M5 motorway in Hungary. The construction of motorways on the rest of the branch in Serbia is foreseen by 2011, through a recently signed concession for the Horgos – Pozega motorway.

Branch C (191,8km) is consisted by highways at 71% and two-lane main roads at the rest of its length.

Finally, Branch D is 140,1km long and consists of highways and other two-lane main roads. Rehabilitation plan exists for the Greek part of the branch by 2007 and also on F.Y.R.O.M. sections, with no fixed horizon of implementation though.

Concerning all the Corridor, Main Axis and Branches, since 2001 246,96km of motorways have been constructed, out of sections of total length of 402km. The length of constructed sections corresponds to 61,4% and by the end of the year 2007 will reach 69,3% of planned transformation of highways to motorways (**Table 2**).

From the aforementioned perspectives it is concluded that by 2012 Road Corridor X will be constructed and operate in motorway profile at a great extend, and if this will be accompanied with realization of the plans of the improvement of infrastructure and facilitation at border crossings, Road Corridor X would be fully operational.

TABLE 2: Progress of motorways' construction along Corridor X since 2001

Part of Corridor X	**Country**	**Section**	**Total ler (km)**	**Constructed length (km)**		**Length of sections planned to be cons in 2007 (km)**	
Main Axis	Slovenia	Bic – Obrezje	75,5	54,4		7,9	
	Slovenia	Vrba – Naklo	20,9	4,3		3,7	
	Croatia	Velika Kopanica – Z Lipovac	53,56	53,56		-	
	Croatia	Zagreb – Bregana	13,0	13,0		-	
	Serbia	Belgrade bypass	45,33	16,8		-	
	F,Y,R,O,M,	Gradsko – Demir K Udovo – Gevgelija	75,5	42,5		-	
Branch A	Slovenia	Maribor – Gruskovje	38,8	2,4		0,6	
	Croatia	Krapina – Macelj	19,4	-		19,4	
Branch B	Hungary	Kiskunfelegyhaza – S Roszke	60,0	60,0		-	
Total			**401,99**	**246,96**	***A= 61,4%***	**31,6**	***B= 7,9%***
Grand Total			***A + B = 278,56km (69,3%)***				

6.2 Railways

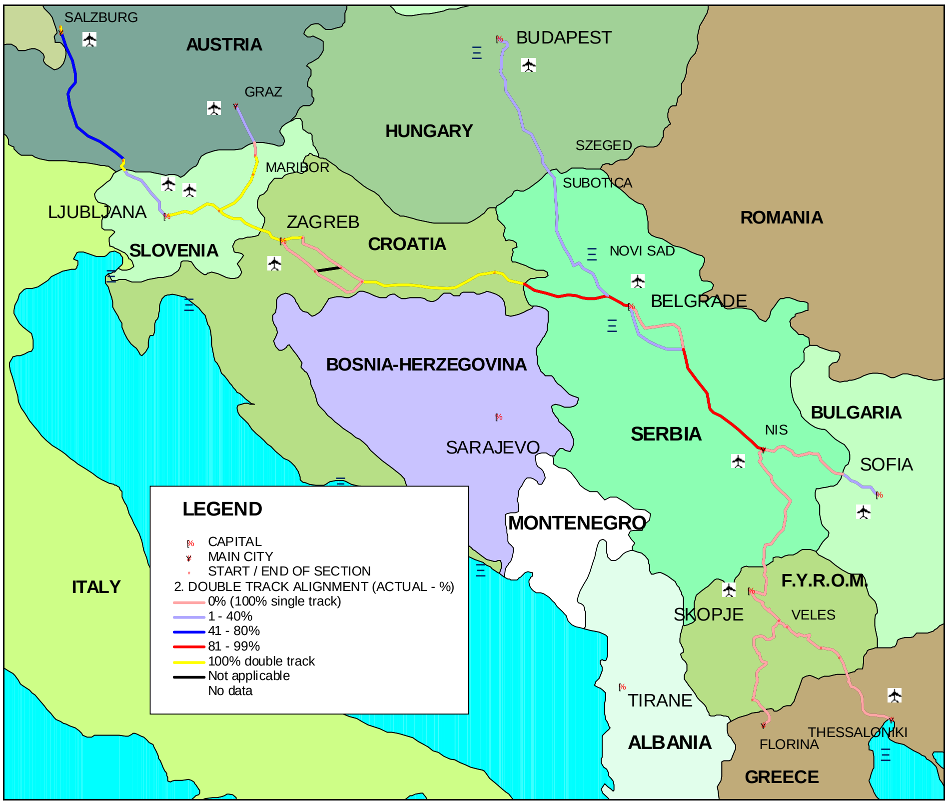
The total length of the Rail Corridor X is 2.528,21km and at present consists of single lines at a percentage of 64% and double lines at 36%. The 92% of the network is electrified.

The percentages of double tracks per section of the Corridor are presented in Figure 2.

The main part of Rail Corridor X, in accordance to the Road one, connects Salzburg and Thessaloniki and has a total length of 1.742,3km. It consists of single tracks at 55% of its length and it is fully electrified. Full doubling of tracks along the Austrian parts is foreseen in the next decade, as well as in Croatia and Serbia. The percentage of double tracks after the implementation of these projects sometime after 2010 will reach 64% of the Main Axis.

Branch A is 154,3km long and consists of 100% electrified lines and double tracks at a percentage of 70%. By 2015, doubling of the branch's lines is planned.

FIGURE 2: Percentage of double tracks per section of Rail Corridor X



Source: European Commission (2005)

Branch B lines are fully electrified and consist of single tracks at most of their length (96% of 305,6km). Serbian parts are currently being rehabilitated and upgrade plans exist for the Hungarian part of the branch but with no secure financing and therefore no exact time horizon of completion set.

The 161km of Rail Branch C are almost totally single (95%) and not electrified (90%). For 2010 the upgrade of the line in Bulgaria for speeds of 120-160km/h is planned, whilst the rehabilitation of the Serbian part of the branch is planned foreseen. The recent construction and operation of a joint rail cross border station at Dimitrovgrad at the Serbian/ Bulgarian borders is expected and anticipated to have a positive impact on the operational level of the branch.

Branch D has a total length of 165km and fully consists of single and not electrified lines. Modernization works on the Greek part of the branch have been completed and rehabilitation of the F.Y.R. of Macedonian parts is planned by 2007. Although in present the branch is not operating for international transport, the works of renewal of Mesonission cross border station in Greece has been completed.

Obviously, the progress presented on Corridor X mainly refers to the road sector and the border crossings will remain the main issue to be solved for the service of international traffic. On the contrary (Taxiltaris et al, 2005), and apart from the border crossings parameter, the railways, which are sufficiently developed only in Austria and Slovenia and in less extend in Croatia, face the challenge to overcome the general crisis of the sector especially in the Western Balkans countries.

7. EVOLUTIONS IN EUROPEAN TRANSPORT POLICY WITH REFERENCE TO THE WIDER AREA OF CORRIDOR X, THE SOUTH EAST EUROPE AND EAST MEDITERRANEAN

After the Transport Infrastructure Needs Assessment (TINA) exercise, which covered a wide European region consisted of the EU acceding countries, a Working Group of the EC set the strategic Network of South East Europe in 2001 (EC, 2001), covering those countries participating in the Stabilisation and Association Process. After the elaboration of the Transport Infrastructure Regional Study (TIRS, 2002) and the Regional Balkans Infrastructure Study (REBIS, 2003), the Core Transport Network of the Western Balkans has been defined for priority implementation under an MoU signed in June 2004. The sections of Pan-European Corridor X in Croatia, Serbia and in F.Y.R.O.M. are the backbone of that network.

In the mean time, in April 2004, and after a proposal of the 1st High Level Group chaired by Karel Van Miert a comprehensive plan of thirty (30) projects was approved by the EU for the improvement of the trans-European Transport Network (TEN-T) on its territory (EC 884/2004). That was challenged by the enlargement of the EU in 2004 with ten new member states (and 2007 with Bulgaria and Romania), fact which automatically resulted the embodying of big parts of the Pan-European Corridors to the TEN-T.

However, the TEN-T policy does not comprise connections of the EU with its neighbouring countries and its other trade partners and regions. At time being, Croatia, Turkey and F.Y.R.O.M. are candidate countries and the rest of the countries of the Western Balkans also have this potential. Concerning the rest of the EU's neighbours, a strategic document was developed in 2004, the "European Neighbourhood Policy" setting the terms of cooperation towards the strengthening of prosperity, stability and security of all parties concerned.

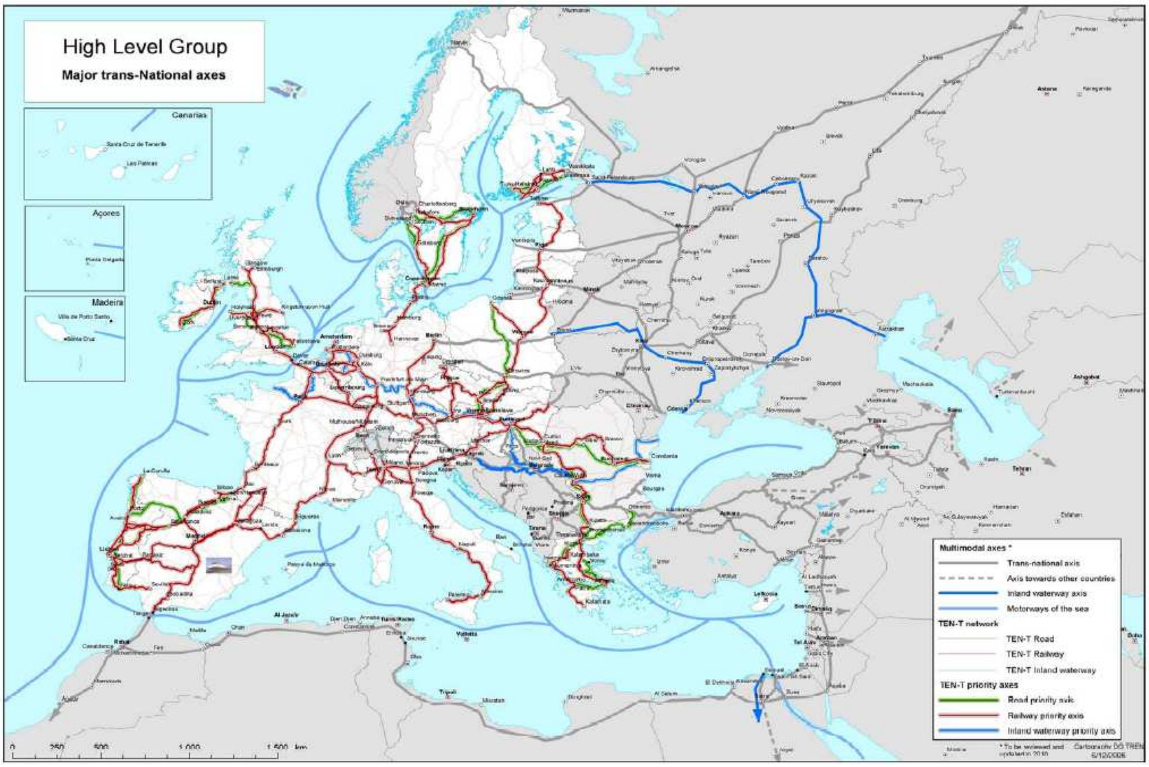
The European Neighbourhood Policy in the transport sector aims at ensuring that legislation, standards and technical specifications of the EU main trade partners are compatible with the European, and thus encouraging trade, sustainable growth and social cohesion, in the process of integrating neighbouring countries into the EU market.

For the implementation of the European Neighbourhood Policy in the field of transport, a 2nd High Level Group (**HLG**) was established in September 2004, aiming at revising the Helsinki Corridors and to extend the major trans-European transport axes to the neighbouring countries and regions. The HLG took into account the most recent international exercises that brought several neighbouring to the EU regions to a position of having defined a core network for development or of launching a process to identify priority transport axes and projects. Those with reference to the South East Europe (**SEE**) and east Mediterranean are the SEE Core Transport Network (already mentioned previously), the Euro-Mediterranean Regional Transport project launched by the MEDA programme in 2003, the TRACECA, the UNECE (TEM and TER) Master Plans and the Euro-Asian transport links examined by the UNECE and the UN Economic and Social Commission for Asia Pacific (UN-ESCAP).

Figure 3 presents the five major trans-National axes (Motorways of the Seas, Northern Axis, Central Axis, South Eastern Axis and South Western Axis), which according to the HLG (EC, 2005) would contribute to the promotion of international exchanges, trade and traffic between the EU and its neighbours, with provision of some branches with lower traffic volumes aiming at regional cooperation enhancement and integration in the long term. The proposed Priority Axes that concern the area of east Mediterranean are the South Easter Axis and the Motorways of the Seas.

The South Eastern Axis links the EU with the Balkans and Turkey and further with South Caucasus and the Caspian (Armenia, Azerbaijan and Georgia), the Middle East, Egypt and the Red Sea. In SEE it actually merges and extends Corridors IV and X, and adopts Corridors VIII, VII (Danube) and Branch C of Corridor V. Analytically this Priority Axis includes the following connections:

FIGURE 3: European Commission's proposed trans-National Axes



Source: European Commission (2005)

- Multimodal connection Salzburg – Ljubljana – Zagreb/Budapest – Belgrade – Nis, including the following connections:

– Sofia – Istanbul – Ankara – Georgia/Armenia – Azerbaijan (TRACECA)
– Skopje – Thessaloniki

- Multimodal connection Budapest – Sarajevo – Ploce
- Multimodal connections Bari/Brindisi – Durres/Vlora – Tirana – Skopje – Sofia – Burgas/Varna
- Inland waterways Danube and Sava
- Multimodal connection Ankara – Mersin – Syria – Jordan – Suez – Alexandria/East Port Said, including the following connections:

– Sivas – Malatya – Mersin
– Turkey towards Iran and Iraq
– Tartus – Homs towards Iraq
– Beirut – Damascus towards Iraq and Saudi Arabia
– Haifa – Israel border
– Jordan border – Amman towards Iraq and Saudi Arabia

- Multimodal connections Damietta – Cairo and beyond including the Nile river
- Multimodal connections from Armenia, Azerbaijan and Georgia towards North and South

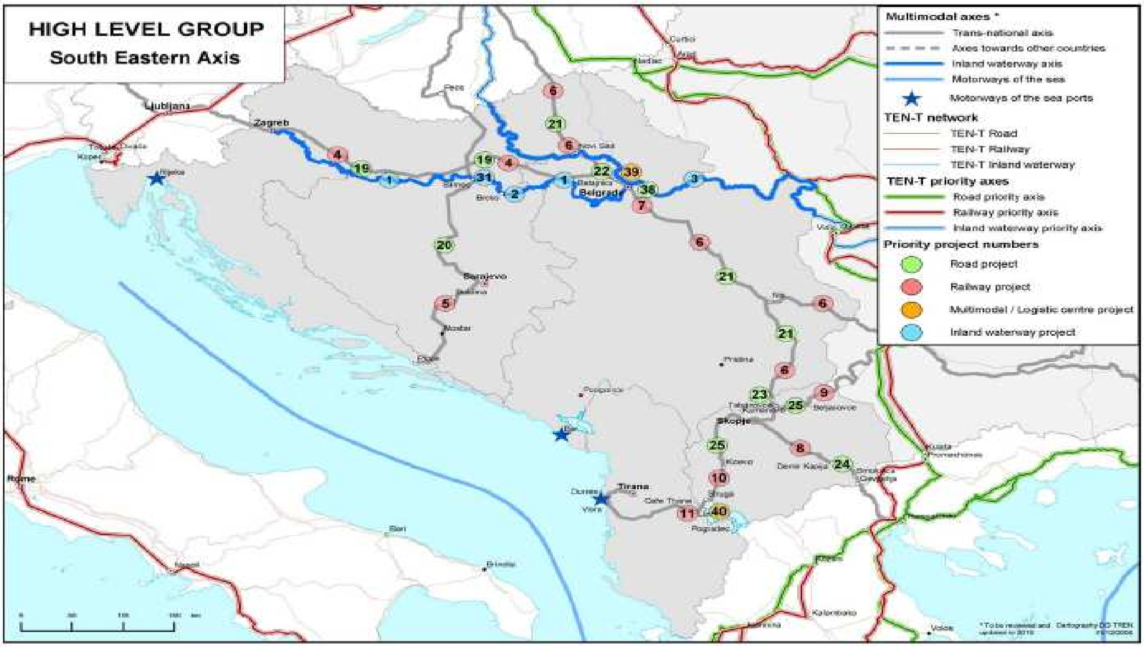
The Motorways of the Seas incorporate the four existing Pan-European Areas, including the Ionian and the Mediterranean Seas, with extension to the Red Sea through the Suez Canal. Maritime transport plays a crucial role in freight traffic between the EU and the neighbouring countries, particularly in the

Mediterranean, where direct land connections across the sea are scarce. For the improvement of the organisation of intermodal freight transport, special attention is given in the context of the implementation of the Motorways of the Sea (**MoS**) concept.

The MoS concept aims at introducing new intermodal maritime-based logistics chains in Europe, which should result a structural change in the transport organisation. These chains will be more sustainable, and should be commercially more efficient, than road-only transport. Hence, MoS would improve access to markets throughout Europe, and relief the extended road system, through the maximal use of the maritime transport resources in combination with better exploitation of rail and inland waterways, as parts of an integrated transport chain. The concept is based on high quality, frequent and regular maritime links between sea routes and a limited number of ports or port regions with sufficient capacity and with very good hinterland connections.

The HLG proposed a number of priority infrastructure projects classified according to their degree of maturity, which for the EC are considered indicative and should be thoroughly examined within master plans to be developed per axis, subjected to their strategic, economic, environmental and social impacts assessment. The above mentioned priority projects are presented in Figures 4, 5, 6 and Tables 3, 4, 5.

FIGURE 4: European Commission's proposed South Eastern Axis – Western Balkans region



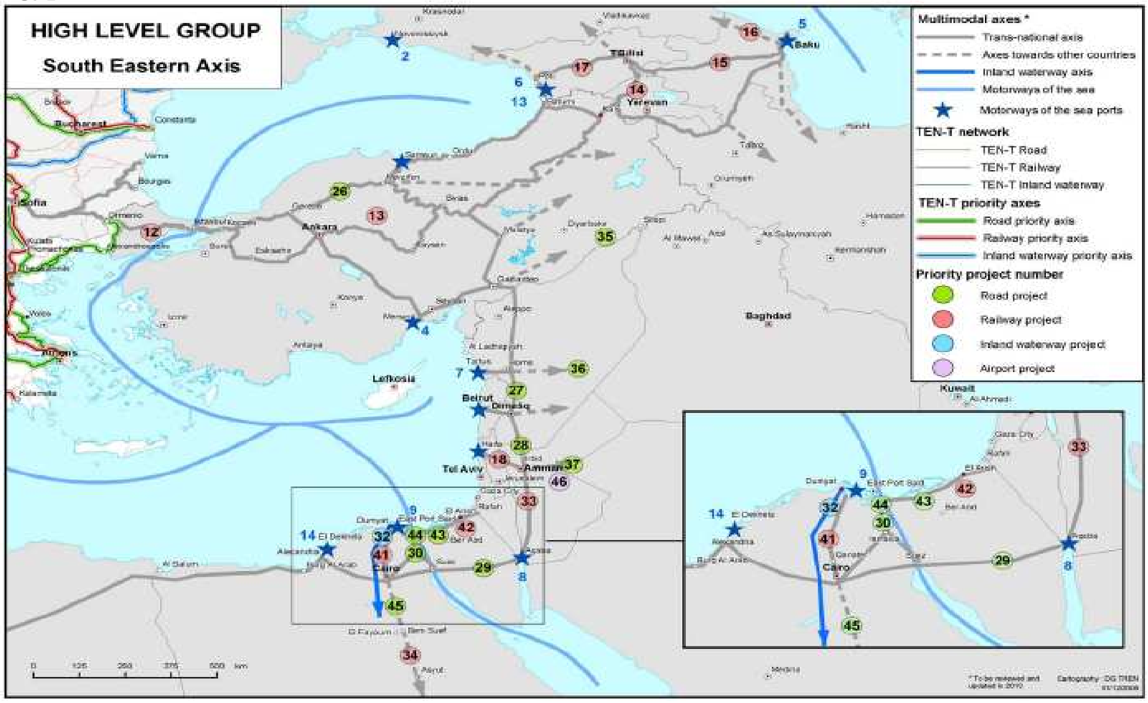
Source: European Commission (2005)

TABLE 3: European Commission's proposed priority projects – Western Balkans region

Projects of short to medium term		
Inland waterway		
Regional	1a	Reconstruction of the Sava river to the 1990 standard (phase 1)
Bosnia/Herzegovina	2	Reconstruction and modernisation of river port Brcko
Serbia	3	Development of Danube navigability (river training works, locks and removal of vessels sunken)
Rail		
Croatia	4	Upgrading of railway line Slovenia border-Zagreb-Serbia & Montenegro border
Bosnia/Herzegovina	5	Single track railway tunnel 'Ivan'
Serbia	6	Reconstruction and modernization of railway line Hungary border-Belgrade-Nis-Bulgaria/FYROM borders, including bridge over Danube in Novi Sad
Serbia	7	Reconstruction and modernization of railways within Belgrade railway node
FYROM	8a	Rehabilitation of the railway line Tabanovce-Gevgelija (phase I)
	9	Railway line Kumanovo-Beljacovce-Bulgaria border
	10	Railway line Kicevo-Stuga-Albania border
Albania	11	Railway line Lin-Qafe Thane-FYROM border
Road		
Croatia	19	Road upgrading Slovenia border-Zagreb-Lipovac-Serbia & Montenegro border
Bosnia/Herzegovina	20	Road upgrading on Croatia border-Saravejo-Mostar-Croatia border
Serbia	21	Road upgrading from section Hungary border-Belgrade-Nis-FYROM border
	22	Belgrade city road by-pass section Batajnica-Bubanj Potok
FYROM	23	Road upgrading Kumanovo-Tabanovce
	24	Road upgrading Demir Kapija-Udovo-Smokvica
	25	Road upgrading Albania border-Skopje-Bulgaria border
Projects of longer term interest		
Inland waterway		
Regional	1b	Reconstruction of the Sava river to a higher navigability class (phase 2)
Bosnia/Herzegovina	31	Reconstruction and modernisation of river port Samac
Rail		
FYROM	8b	Rehabilitation of railway line Tabanovce-Gevgelija (phase II)
Other major projects on multimodal axes, projects of regional or national interest		
Serbia	38	Gazela bridge
	39	Intermodal logistic platform in Belgrade
FYROM	40	Construction of the multi-modal terminal located in Struga

Source: European Commission (2005)

FIGURE 5: European Commission's proposed South Eastern Axis – Turkey, Caucasus, Middle East, Egypt



Source: European Commission (2005)

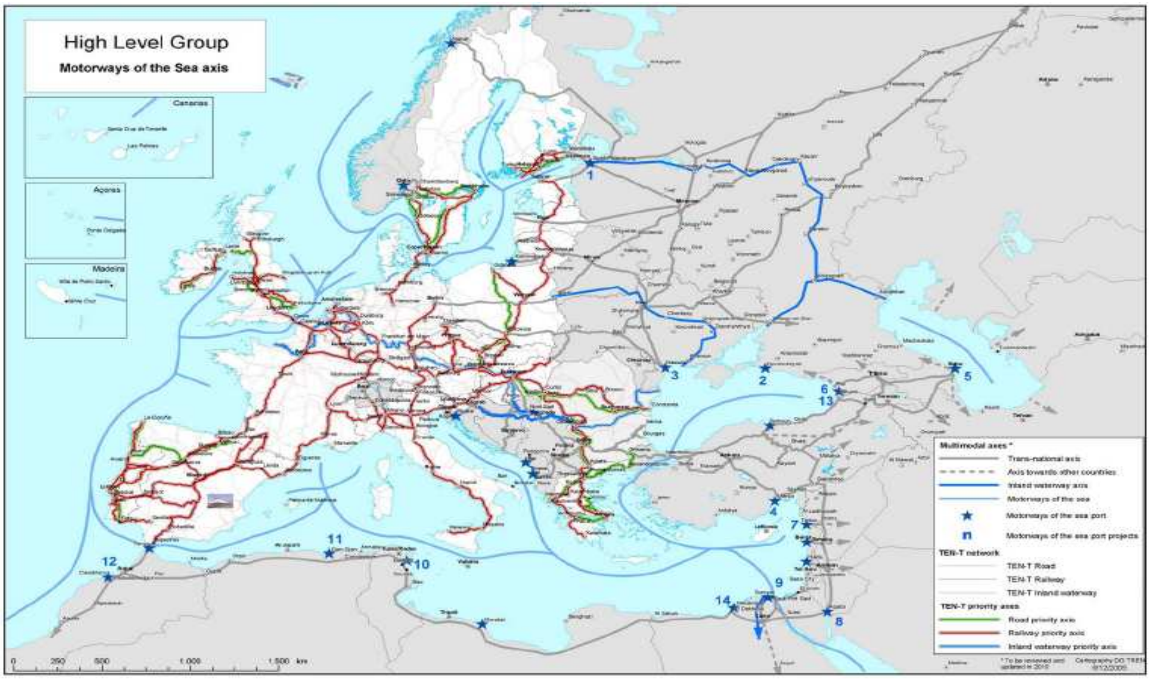
TABLE 4: European Commission's proposed priority projects – Turkey, Caucasus, Middle East, Egypt

Projects of short to medium term		
Rail		
Turkey	12	Railway line Istanbul-Cerkezköy-Bulgaria border
	13	Railway line Ankara-Sivas
Armenia	14	Railway line Gyumri-Ayrum
Azerbaijan	15	Railway line Baku-Georgia border
	16	Cabining of the optical cable on railway line Baku-Yalama
Georgia	17	Railway line Poti/Batumi-Azerbaijan border
Israel	18	Ha'emek railway (from Haifa up to Jordanian border)
Road		
Turkey	26	Road upgrading Gerede-Merzifon
Syria	27	Road upgrading Turkey border-Jordan border, including the branch Tartus-Homs
Jordan	28	Irdib ring road
Egypt	29	Road upgrading Alexandria-Cairo-Suez-Taba (Israel border)
	30	Road upgrading Ismailia-East Port Said

Projects of longer term interest		
Inland waterway		
	32	Upgrading transportation through the River Nile (up to Cairo)
	33	Construction of railway line Syria border-Amman-Aqaba
	34	Signalling system and station infrastructure Beni Suef-El Minya-Asyout
	35	Road connection Sanhurfa-Silopi
	36	Road connection Homs-Tanf-Iraq border
	37	Road construction Amman-Iraq border
Other major projects on multimodal axes, projects of regional or national interest		
	41	Electrification of Shebin El Qanater-Damietta railway line
	42	Railway line Bir El Abd-Rafah
	43	Upgrading of coastal road Rafah-Damietta-Alexandria-El Saloum
	44	Road tunnel under Suez Canal
	45	Burg Al Arab-Aswan western desert road
	46a	Airport – supporting air cargo
	46b	Airport – expansions, rehabilitation and modernisation

Source: European Commission (2005)

FIGURE 6: European Commission's proposed Motorways of the Seas



Source: European Commission (2005)

TABLE 5: European Commission's proposed priority projects – Motorways of the Seas

Projects of short to medium term		
Russia	1	Port of St. Petersburg (Ust-Luga + railway terminal)
	2	Port of Novorossyisk (upgrading + logistic centre)
Ukraine	3	Port of Illyiehevsk (container terminal)
Turkey	4a	Port of Mersin (capacity increase, phase 1)
Azerbaijan	5	Port of Baku (railway handling etc,)
Georgia	6	Port of Poti
Syria	7	Port of Tartus
Jordan	8a	Port of Aqaba (master plan, capacity increase, phase 1)
Egypt	9	Multipurpose platform East Port Said Port
Tunisia	10	Deep water port in Enfidha
Algeria	11	Port of Djen-Djen
Morocco	12	Container terminal of Mohamedia port
Projects of longer term interest		
Turkey	4b	Port of Mersin (capacity increase, phase 2)
Jordan	8b	Port of Aqaba (capacity increase, phase 2)
Georgia	13	Port of Batumi
Egypt	14	Extension of existing breakwater and new platform of El Dekhela Port

Source: European Commission (2005)

Concerning the coordination framework for the implementation of the new policy guidelines, extensive dialogue with the different stakeholders took place since the delivery of the HLG report through the public consultation process, through which the EC concluded to propose a "strong binding document" [COM(2007) 32 final]. That binding document would ensure the commitment of the participating countries to implement the appropriate measures timely stemming from the respective Action Plans of a Priority Axis.

The EC proposes that a possible coordination framework could foresee the establishment of a three-level structure for the implementation and monitoring of the Priority Axes (EC, 2007): On the higher level, the strategic decisions regarding the coordination framework, the axes, infrastructure projects and horizontal measures would be taken through Ministerial Meetings, based on proposals of the

Regional Steering Groups. Regional Steering Groups would be responsible for the coherent implementation of the axes and measures at technical level, ensuring agreed common methods for strategic and project level assessment and monitoring. Finally, a Secretariat would provide administrative and technical support.

The process foreseen by the EC proposal is the performance of exploratory talks with the neighbouring countries concerning their interest and level of commitment that they are willing to undertake within the proposed coordination framework. Following that outcome, the EC would make recommendations and proposals to implement the policy and coordination framework.

8. PROPOSAL FOR AN IMPLEMENTATION MECHANISM OF THE SOUTH EAST EUROPE PRIORITY AXIS

The EC has recently launched a process by creating four workshops to examine the problems and propose solutions related to the implementation of the Priority Axes in the EU and in the neighbouring regions: More specifically, the workshops shall deal with the a) the differences of approach inside and outside the EU; b) the optimum geographical coverage (or how to handle very long axes); c) the promotion of “non infrastructure” measures; and d) the strengthening of cooperation and monitoring. At time being the structures of Corridor X are leading the fourth workshop and its members participate in the rest of the workshops.

However, the position of the structures of Corridor X concerning the implementation of the Priority Axes has already been defined.

As a principal it is considered that the structure of the authorities responsible for implementing each Priority Axis, on the basis of a document to be signed by the interested countries and the EU, should incorporate the existing structures of the Pan-European Corridors. It is considered fundamental to take advantage of the experience, know-how, the cumulative data and the studies that have already been realized in most sections of the new Priority Axes.

Furthermore, exploiting the best practices concerning mechanisms already in operation, such as for the Pan-European Corridors, the SEETO and the Energy Treaty, the structures of Corridor X concluded to an analytical proposal, where, in broad lines, it is proposed that a proper mechanism for each Priority Axis should consist of the following bodies:

- **A Steering Group:** Political body consisted of representatives of the authorised Ministries of the countries participating in each Priority Axis and the European Commission, responsible for the implementation of the Binding Document.
- **A Regulatory/ Administrative Unit:** Regulatory, administrative and technical unit, co-financed by the European Commission and the participating countries, responsible for the administrative and secretarial support of the Steering Group, the coordination of the activities to implement the approved by the Steering Group Action Plan of the respective Priority Axis and the regulation and coordination of the activities of sectorial Technical Secretariats.
- **Sectorial Technical Secretariats:** Their actions are regulated and coordinated by the relevant Regulatory/ Administrative Unit and they are financed by the budget allocated to the Regulatory/ Administrative Unit, donors and ad-hoc contributions, responsible for the implementation of the action plan on a Corridor/ Sector of the Priority Axis. The Sectorial Technical Secretariats would be existing structures of Pan-European Corridors included in the Priority Axis and new structures for the new Corridors/ Sectors defined by a Priority Axis.

Indicative organisational schemes are illustrated in Figure 7 for the South Eastern Priority Axis, applicable after adjustments on any other Priority Axis, as well as in Figure 8 for the whole system of the Priority Axes. In the case of the Motorways of the Sea, it should be noted that it is the EC intention to appoint a Coordinator as in the case of some TEN-T projects.

FIGURE 7: Typical Priority Axis implementation mechanism proposed by the Corridor X structures (applicable in the case of SEE Priority Axis)

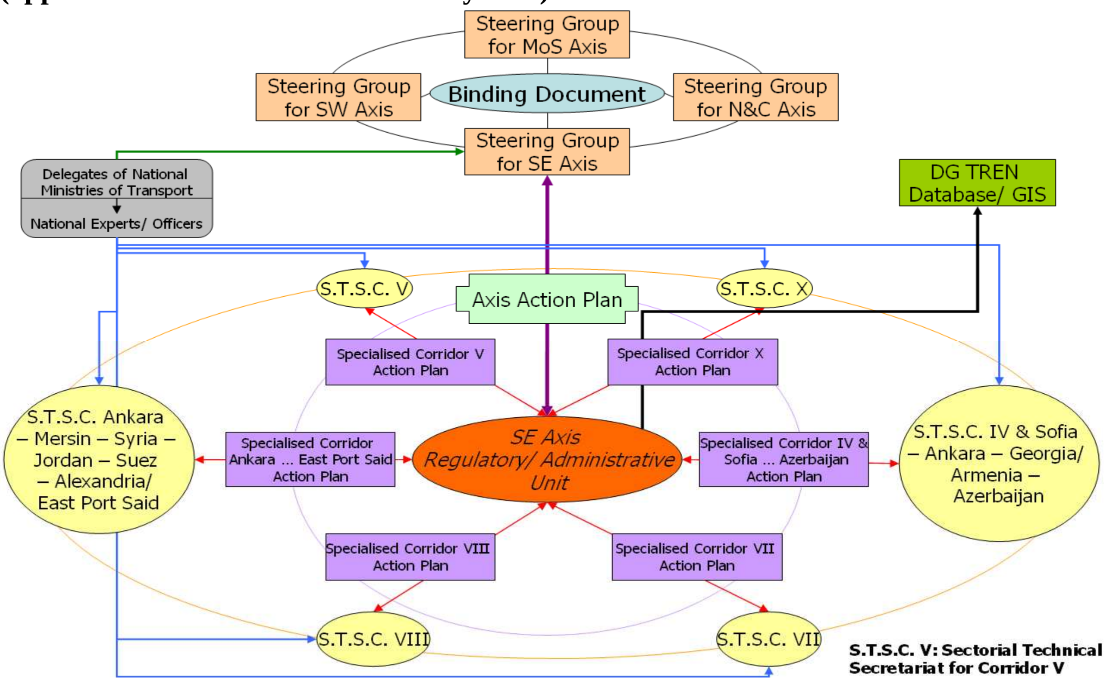
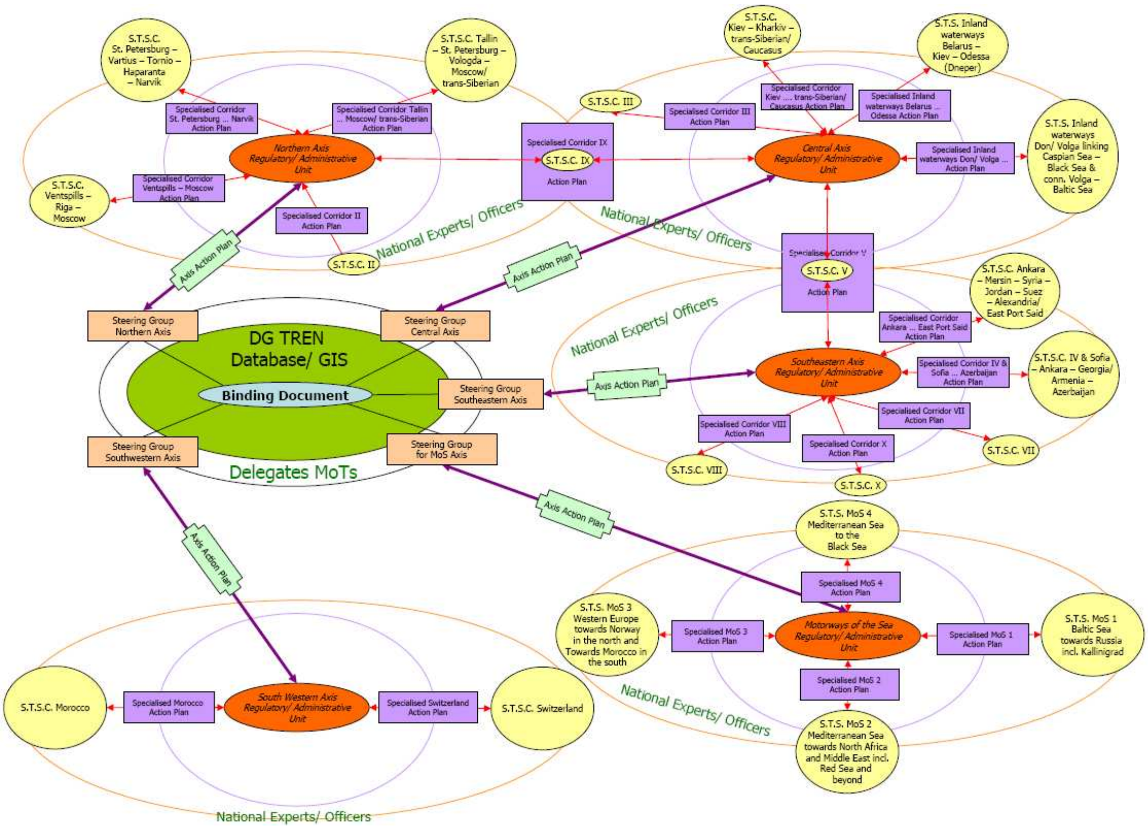


FIGURE 8: Generalised Priority Axes implementation mechanism proposed by Corridor X structures



Finally it should me mentioned that a study has been assigned by DG TREN titled "Analytical support framework to monitor the implementation of the infrastructure and "soft" measures proposed by the High Level Group TEN-T Northern Axis" (TEN-NAxis), and its outcome is expected with high interest. The aim of this study is to set up - as a pilot for the Northern Axis – the analytical support framework that would enable monitoring the implementation of the measures proposed by the EC with provision that the methodology and principles of the analytical framework to be easily extended to the other Axes.

9. CONCLUSIONS – PERSPECTIVES

What has been described in the above as structures and achievements of Corridor X could comprise a model for other Corridors, as well as for the new Priority Axes. It should be mentioned though (Taxiltaris et al, 2005) that the projects implemented are not due such to the existence of composed trans-national structures, as to the will of Corridor X's countries separately and their financial potential. That of course is a result of the existing framework of MoUs that is more or less based on voluntary basis.

Therefore, the role of Corridor X’s structures is to an extend encouraging to the efforts for development of the Corridor per country, but mainly is a mechanism able to present, with the appropriate technical tools, the real picture of the Corridor at every turn, and also the perspectives of the Corridor in function with fermentations, decisions, initiatives – often solitary, but also placed in the framework of a de facto overall unified plan. Hence, the Corridor X’s structures on the one hand comprise an observatory of the progress of the implementation of the Corridor, and on the other a basis for documentation of the existing situation and the development planning.

Corridor X is the backbone of the Core Transport Network of the Western Balkans and remains a priority for the EU, as it is fully incorporated in the South Eastern Priority Axis and is the gateway of the Western Balkans to the Aegean through the Thessaloniki port and to Turkey and the Adriatic-Ionian through its Branches C and D respectively and through the Egnatia Odos Motorway. Corridor X structures are in coordination and have cooperation with other organisations and initiatives active in the SEE (SEETO, SEECP High Performance Railway Network, etc.) and have an active role in the process of defining a model implementation mechanism of the Priority Axes, while it is certain that they will be fully integrated in the new mechanisms; that is the direction given by DG TREN: to fully exploit and built on the expertise of the existing structures of the Pan-European Corridors.

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THE TRANSPORT SYSTEMS IN THE EU AND TURKEY

Ayse Uyduranoglu-Oktem
Department of Economics
Istanbul Bilgi University
Istanbul, Turkey

Abstract. The transport systems contributes indispensably to the economic and social development of a country at both national and international level. Since the founding aim of the European Union (EU) is to enable the free movement of goods and people and to maintain an internal market across the EU, it is inevitable to adopt a common transport policy in both the EU member countries and candidate countries. Ensuring inter-modality and the development of Trans European Network-Transport (TEN-T) are some of the priorities of the common transport policy adopted by the EU. Accordingly, in the pre-accession and the post-accession period, Turkey will receive financial assistance from the EU in order to expand and revitalise its railway network, and to link its overall transport network to that of the EU to contribute to the development of TEN-Ts.

Keywords: Common transport policy, combined transport, inter-modality, sustainable transport, TEN-T, Turkey.

1. INTRODUCTION

Transportation is an essential component of daily life and economic growth. Rising population rate and exponential surge in economic activities bring about an increasing demand for transportation. On the other hand, an imbalanced growth in various transport modes causes some problems such as inefficient use of some modes, and high transportation cost, not to mention environmental problems. Aware of the role of an efficient transportation system in the development of countries, the EU aims at achieving a common transport policy within the Union as well as in candidate countries. Being a candidate member itself, Turkey is re-structuring its transport policy to incorporate the rules of the EU transportation system. The aim of this paper is to compare the transport system in the EU with that in Turkey. Section 2 provides brief information on the evolution of the EU common transport policy. Section 3 offers an account of the Turkish experience in developing its transport system. Section 4 provides a conclusion.

2. THE COMMON TRANSPORT POLICY OF THE EU

Economically speaking, the transport sector has a very crucial place within the EU framework. It accounts for about 7 per cent of the EU's GDP and for 5 per cent of employment in the EU (Commission of European Communities, 2006). The need for a common transport policy in the EU is of utmost importance to achieve the use of more sustainable modes, to fuel competition among transport operators, and to attain better integrated infrastructure. Such a policy will boost the competitiveness of the EU's economy at the international level, and contribute to the social cohesion of the Union.

The history of the common transport policy dates back to the establishment of the European Economic Agency in 1957, which was the first step taken towards the EU. The Treaty of Rome recognised the need for the adoption of a common transport policy. Thus, the importance of an effective transport system was acknowledged as early as the Treaty of Rome. In the Part Three of the Treaty, Articles 74-84 drew a general framework for the EU common transport policy. Cabotage rights, known as the transport of goods within one country by a haulier from another country, common rules for transportation between member countries and improvement in transport safety were determined as the objectives of this policy (Pitsiava-Latinopoulou et al, 2006). Despite the fact that the objectives of the common transport policy were determined by the Treaty of Rome, it took almost thirty years to shape the common transport policy in the EU. In 1983 the European Parliament sued the European Council for not acting on the common transport policy. In 1985 the European Court of Justice decided that the Council was neglectful in not fully acting on the common transport policy (Economic Development Foundation, 2004). After the decision of the European Court of Justice, the European Union enacted legislations, which aimed at achieving ‘inter-modality’ across the EU.

Up to date, the European Commission has published a number of documents on the EU’s transport policy framework. These documents determine the priorities of an effective transport system and point out the weaknesses of the existing transport system across the EU. White Papers on transport can be enumerated among these documents. The White Paper published in 1985 focused on the completion of the internal market and set out the guidelines for the common transport policy (Commission of European Communities, 1985). This document placed an emphasis on the importance of development of infrastructure and improving safety. The White Paper adopted by the Commission in 1992 mainly revolved around the importance of coherence in transport policy at the EU level, opening of transport markets and fair competition between modes (Commission of the European Communities, 1992). The White Paper in 1998 commented on the unfair payment of various modes for infrastructure use in search of sustainable development (Commission of the European Communities, 1998). The White Paper submitted by the Commission in 2001 set out new objectives for the common transport policy, especially for achieving sustainable transport, including 60 measures to fulfill the objectives in question (Commission of the European Communities, 2001). Eventually, the Commission recently published another White Paper on transport to underscore that measures announced by the previous White Paper would not be sufficient to achieve sustainable transport, and to announce further measures to fulfill the objectives of the transport policy of the EU (Commission of the European Communities, 2006).

The EU’s continuous enlargement will not only endow its citizens with the opportunity of travelling across new borderless territories, but also accelerate the movement of goods among the member countries. It is expected that the growth in freight transport and passenger transport will increase by around 50 per cent and 35 per cent respectively between 2000 and 2020 in the EU-25 (Commission of the European Communities, 2006). Priorities of the common transport policy at the EU level including the new member countries are twofold: the development of TEN-T[13] and sustainable transport. The Treaty of Maastricht signed in 1993 introduced the concept of TEN-T with the vision of eliminating cross-border 'bottlenecks'. A report by the European Commission (2005) provides detailed information on the forthcoming TEN-T projects, their costs and funding as well as their environmental benefits. In 2004, the European Commission revised guidelines and financial regulations with a list of 30 priority projects for the development of TEN-Ts. When realized, they would not only eradicate cross-border 'bottlenecks,' but also supplement those policies designed to cope with increasing transport related CO_2 emissions. According to statistics, CO_2 emissions from transport are expected to be 38 per cent greater in 2020 than today. If these 30 priority projects are successfully devised and implemented, a fall by 4 per cent will be witnessed in such hazardous emissions.

Inter-modality or combined transport, known as one characteristic of a transport system where at least two different modes are used to complete a door-to-door transport sequence, is also listed among the priorities of the EU common transport policy. The aim of inter-modality is to achieve sustainable transport by shifting demand from road transport to transport by rail, sea and inland water. As contemporary data shows, road transport dominates transport by accounting 44 per cent of freight transport and 79 per cent of passenger transport in total transport activities (EEA, 2007). To realize inter-modality, the EU first launched Pilot Action for Combined Transport (PACT)[14] in 1992. 146 projects benefited from PACT between 1992 and 1999. Later on, Marco Polo I inter-modality programme was introduced for the period of 2003-2007. Finally, the European Commission proposed Marco Polo II programme for the period of 2007-2013 in 2004. It is expected that every 1 € in grants to Marco Polo II programme will culminate in 6 € in terms of social and environmental benefit (http://ec.europa.eu/transport/marcopolo/index_en.htm). Another programme, which aims at increasing the use of inland water for freight transport in the EU, is called Navigation and Inland Waterway Action and Development in Europe (NAIADES). The implementation period for the NAIADES Action programme covers the years 2006-2013.

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[13] In 1996 the European Parliament and Council adopted Decision No: 1962/96/EC for the development of the Trans European Network-Transportion to interlink the transport networks of all member countries and of candidate countries to one another.

[14] Countries outside the Union may also benefit from PACT, Marco Polo I programme and Marco Polo II programme as long as they fulfil the objectives of combined transport. But at least one member state must involve in projects.

3. PRIORITIES OF THE TRANSPORT SYSTEM IN TURKEY

Transport activities have an increasing trend in Turkey and, as expected, they simultaneously play an essential role in the development of the country. A comprehensive report by TUSIAD (2007) offers an account of the transport sector in Turkey, indicating that the sector has shown a dramatic change over the years. Until 1950s, railway transportation was the dominant mode for both passenger and freight transport. It amounted to 40 per cent of passenger transport and 55.1 per cent of freight transport until the 1950 general election (TUSIAD, 2007). The right-wing Democratic Party emerged from the election as victor and, adopting populist policies, opted for investing more in road transportation. Inadequate investment in railway transport resulted in increasing market share in favour of road transport, which became the dominant mode in national transport system. Today, 95 per cent of passenger and 90 per cent of freight transport are realised by road transportation in Turkey (State Planning Organisation, 2001). This high rate of dependency on road transportation raises grave concerns about sustainability, while threatening the competitiveness of the country at the international level.

Following the granting of candidacy status to Turkey by the Helsinki Summit of the European Council in December 1999, negotiations for full membership were opened in 2005. The progress reports by the European Commission on Turkey are regarded as very crucial documents on the country's path along the accession process. These documents demonstrate the progress made by Turkey in line with the Acquis expressed in the Treaties, the secondary legislation, and the policies of the EU. Unfortunately, the 2007 Progress Report, like the previous reports, indicates the weaknesses of the Turkish transport system, and expresses the measures the country should take to internalise the common transport policy of the EU (Commission of the European Communities, 2007).

To be integrated into the EU common transport policy, policy makers in Turkey are incessantly re-structuring the transport system. Since 1963, national policies of Turkey are predetermined in five-year development plans. The 9th National Development Plan (NDP) prepared by State Planning Organisation (SPO) covers seven years from 2007 to 2013 in order to be in line with the EU budgeting and financial assistance programming. The 9th NDP sets out priorities for Turkey in terms of development. Accordingly, for the purpose of enhancing Turkey's competitiveness, it is indispensable to improve transport infrastructure. The fundamental aim of the transport system in Turkey is defined by the 9th National Development Plan (State Planning Organisation, 2006) as follows:

“Establishment of rapid and safe transport infrastructure that will increase the competitive power of the country”

This document also determines the priorities of the transport system of Turkey under four headings:

1- Establishment of an efficient transport system
2- Improved safety and security
3- Integration with European and neighbouring countries
4- Environmental and financial sustainability

Official documents,[15] which constitute the framework of transport policy in Turkey, recognise the importance of linking the transport system of Turkey with TEN-Ts and of increasing the share of railway and maritime transport for freight and passenger in total transport. The overall objective of transportation in the coming years can be summarised as improving the transportation infrastructure considering safety and inter-modality on future TEN-Ts, while maintaining an efficient and balanced transportation system.

The European Council recently decided to increase the amount of financial support to Turkey, a sum of which would be spent for harmonizing its transport framework with that of the EU. The EU Regulation No: 1085/2006 set the Instruments for Pre-Accession (IPA).[16] The aim of the IPA[17] is to provide financial assistance for candidate and potential candidate countries for the period of 2007-2013. The transport sector is one of the sectors where IPA funds will be utilised to contribute to regional development. Transport related projects account for 30-35 per cent of total regional development funds provided by the IPA. IPA funds will serve to support and widen the pre-existing transport infrastructure. In a similar vein, the aim of Transport Infrastructure Needs Assessment (TINA) is to determine those initiatives, which must be undertaken to interlink candidate countries' transport networks to the transport networks of the EU. The list of projects needed to connect the

[15] The 9th National Development Plan and Strategic Coherence Framework (SCF) are the most important ones.

[16] With the introduction of IPA the EU abolished PHARE (Polland and Holland: Asssistance for Restructuring their Economies), SAPARD (Special Accession Programme for Agriculture and Rural Development) and ISPA (Instrument for Structural Policies for Pre-Accession) as of 2007. These funds were used to provide financial assistance for candidate countries on the convergence to the EU.

[17] There are five different compenents, which will receive financial support from IPA. These are transition assistance and instutition bulding compenent, regional and cross-border co-operation component, regional development component, human resources development component and rural development component. Transport takes place under regional development component.

Turkish and EU transport networks will be determined in line with the evaluation of TINA. Put differently, TINA sets the basis according to which IPA funds would be distributed to relevant projects. Maritime and railway transport are under focus since they play an essential role in achieving sustainable transport. Turkey has borders with Bulgaria, Greece, Iran, Iraq, Syria, Georgia, Armenia and Azerbaijan. Due to its advantageous geostrategic position, Turkey can play a significant role in connecting the EU to the Middle East and the Caucasus countries.[18] After the EU enlargement, the transport ministers of the member countries met in Spain in 2004 with the aim of linking TEN-Ts with the transport networks of neighbouring countries. As a result of this meeting, a High Level Group was established to work on priority projects. Five priority projects were determined by the Group, and the south-east corridor, which will link the EU member countries with the Middle East through Turkey, was declared as being one of the major transport corridors.

4. CONCLUSION

Turkey is constantly re-viewing its transport policy to be in line with the EU transport acquis. Transport policies of Turkey are attracting remarkable attention from the EU due to the strategic geographical position of Turkey. Hence, Turkey has received and will continue to receive a considerable amount of financial assistance to strengthen its railway and port infrastructure during the pre-accession period. As a result of the improvement of infrastructure, the transport network of Turkey will significantly contribute to the extension of TEN-Ts towards the Central Asia and the Middle East. This will lead the EU to increase its competitiveness at the international level to fulfil the objectives of the Lisbon Strategy. In return, Turkey will derive benefit from the shifted demand from road transportation to railway and maritime transportation in achieving sustainable development.

[18] After the collapse of the Soviet Union, a number of new countries were established. Some of these countries are known as the Caucasus countries. These countries are Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

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AN EXPLORATION OF ROAD SAFETY PARAMETERS IN GREECE AND TURKEY

George Yannis, Alexandra Laiou, Sophia Vardaki and George Kanellaidis
Department of Transportation Planning and Engineering
National Technical University of Athens
Athens, Greece

Abstract. Given that several regions of Greece and Turkey have higher road accident death rates than any other European region, the objective of this research is the exploration of the underline parameters, which contribute to this phenomenon. On that purpose, road accident fatalities are co-examined with basic macroscopic parameters affecting road safety, like population and vehicle fleet and lognormal models are developed for Greece, Turkey and three selected groups of EU countries. The application of the models developed showed clearly that not only the rapidly increasing motorization level in both countries but mainly the highly risky two-wheeler traffic constitute main contributing factors to the increased road fatality rates in the two countries. The proposed calculation of the dimensionless elasticity for each examined parameter was found as a simple but appropriate technique for the direct comparison of different cases of parameters and models. The results of this research could be proved beneficial for the identification of specific measures addressing the underlying road safety issues in Greece and Turkey, like the increased motorcycle traffic.

Keywords: road fatalities, road accidents, motorcycles, lognormal, elasticity.

1. INTRODUCTION

Road accidents have become one of the major causes of death in many countries and road safety is regarded as an issue of public health. In 2004, more than 43.000 persons were killed in almost 1.3 million car accidents which occurred in the EU. About 1.8 million persons were injured, 285.000 of them seriously (CARE, 2007).

The road safety level differs a lot among the members of the European Union and the candidate countries. Three main groups can be distinguished, based on the number of persons killed per million registered passenger cars. It is noted that this ratio was chosen because of incomplete and partially non-harmonised data on the actual transport performance (expressed in passenger - kilometers). North-west countries perform best with Sweden, United Kingdom and the Netherlands having the lowest number of persons killed per million passenger cars in 2004. Countries in southern Europe (Spain, Italy, Portugal and Greece) display a clearly lower road safety level. Finally, eastern countries (members and candidates) have the highest values of the examined ratio (Bialas-Motyl 2007, ETSC 2006).

During the last decade most of the European countries have achieved an important improvement on their road safety level. In Greece and Turkey the number of persons killed per million registered passenger cars has decreased by over 50 percent in ten years (Akgüngör, 2007). Nevertheless, there is still need for further improvement in both countries. Focusing on the individual regions of the EU-25, it appears that 7 out of the 10 most dangerous regions during 2004, are located in Greece. Respectively, 18 out of the 20 most dangerous regions in the candidate countries are located in Turkey (Bialas-Motyl, 2007).

Previous studies have shown, since long, (Smeed 1949, Adams 1987) that the examined ratio is correlated with the density of car ownership and the population. Countries with high ratios like Turkey and Romania are characterised by low passenger car density. The percentage of motorcycles in the total fleet is also a parameter with an important effect on road fatalities as two-wheeler riders are at increased risk in relation to passenger car drivers (Yannis et al, 2005b, Spyropoulou et al, 2005). As far as population is examined, an increase of the population is usually related to a decrease of the accident risk (Bialas-Motyl 2007, Isildar 2006).

The objective of this research is the exploration of the basic parameters affecting road safety performance in Greece and Turkey and the comparison of road safety trends between these two neighbouring countries but also in relation to three selected groups of EU countries.

On this purpose demographic and vehicle fleet parameters were selected and the impact of each one of them to the number of road fatalities was explored. A lognormal model was developed for each country or group of countries. Dimensionless elasticities were used for the direct comparison of all model parameters, in order to identify differences and similarities in road safety performance in the countries examined.

2. METHODOLOGY

Five cases were explored in this research. These were: the cases of Greece and Turkey individually and the cases of the rest members of the E.U. divided in three groups. The group of "North-West Europe" included Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, Sweden, the Netherlands and the United Kingdom. The group of "South Europe" consists of Spain and Italy. Finally, Cyprus, Czech Republic, Latvia, Lithuania, Poland, Slovakia, Slovenia and Romania form the group named "New members". It is noted that Finland, Portugal, Bulgaria, Estonia, Hungary and Malta were not included in the research because of lack of the necessary exposure and accident data.

The road safety level of each country or group of countries is expressed by the number of road fatalities per year. The parameters examined are the population, the total number of registered vehicles and the percentage of motorcycles in the total fleet.

Data used in the analysis come from international databases as well as from National Statistical Services when necessary. Demographic and vehicle fleet data for all countries were extracted from the Eurostat database. Data on vehicle fleet were available only for years 1985-2004. Finally, data on fatalities come from the IRTAD (period 1985-1990) and from the CARE database (period 1991-2004). National statistics were also used in order to fill in the gaps. Data cover years 1985-2004 for Greece and Turkey, 1985-2004 for North-West and South Europe and years 1991-2004 for the new members. After collecting all the necessary data, a new database was created and used for the statistical analysis.

In order to develop a statistical model which would describe the road safety level for each case, several types of models were investigated. Lognormal regression was finally selected for its simplicity but also for its adequateness for such international road safety comparisons. Five models were finally developed, each one referring to one of the countries and group of countries examined. The statistical significance of the relationship between the dependent and the independent variables was assessed by calculating the R^2 value (Mc Carthy P.S., 2001). For each independent variable, the t - value was also used as a measure of the statistical significance of each parameter (Leech et al, 2005).

In order to make possible the comparison between countries, focus was given to the estimation of the responsiveness and sensitivity of the dependent variable with respect to changes in each independent variable. On this purpose, the elasticity of each dependent variable was calculated (Washington et al, 2003). Visual presentation of results was also used for the better understanding of the impact on road safety of the macroscopic parameters examined.

3. MODEL DEVELOPMENT

During the development of each lognormal regression model, three independent and one dependent variable were used. The independent variables were: the number of registered vehicles (motorcycles are not included), the percentage of motorcycles in the total fleet and the population of each country or group of countries. The logarithm of road fatalities per year in each case was examined as the dependent variable. Lognormal model was selected because of the more adequate depiction of the road fatalities' time series. All five models were developed according to the following model structure:

$$y = 10^{a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3} \tag{1}$$

where y: log(fatalities)

x_1 : the number of registered vehicles

x_2 : the percentage of motorcycles in the total fleet

x_3 : the population

The results of the lognormal regression for all cases are shown in Table 1.

TABLE 1: Lognormal regression results for all cases.

	GREECE			TURKEY			NORTH-WEST EUROPE			SOUTH EUROPE			NEW MEMBERS		
	coeff.	t-value	elasti-city	coeff.	t-value	elasti-city	coeff.	t-value	elasti-city	coeff.	t-value	elasti-city	coeff.	t-value	elasti-city
	2,476	1,287	-	4,519	9,510	-	7,671	8,030	-	8,471	6,365	-	0,474	0,151	-
total num. of regist. vehic.	-1,40E-07	-6,461	0,029	8,07E-08	1,497	0,026	1,53E-09	0,822	0,111	-1,29E-09	-0,664	0,082	2,55E-09	0,282	0,057
(%) motor-cycles in total fleet	0,033	1,410	0,042	0,034	2,287	0,291	-0,039	-2,808	0,153	0,046	2,884	0,153	0,011	1,010	0,040
population	8,29E-08	0,389	0,279	-2,7E-08	-2,027	0,112	-1,31E-08	-2,847	0,636	-4,81E-08	-3,108	0,836	3,29E-08	0,948	1,509
R^2	0,777			0,791			0,940			0,780			0,747		

In North-West Europe, R^2 value was calculated equal to 0,940. This value indicates a rather high statistically significant relationship between the dependent and the independent variables. For the rest of the cases, R^2 values are lower though acceptable.

All five models were depicted on one chart (Figure 1). For each case both curves for actual and model values of fatalities were drawn.

The elasticity of each dependent variable was calculated based on the formula:

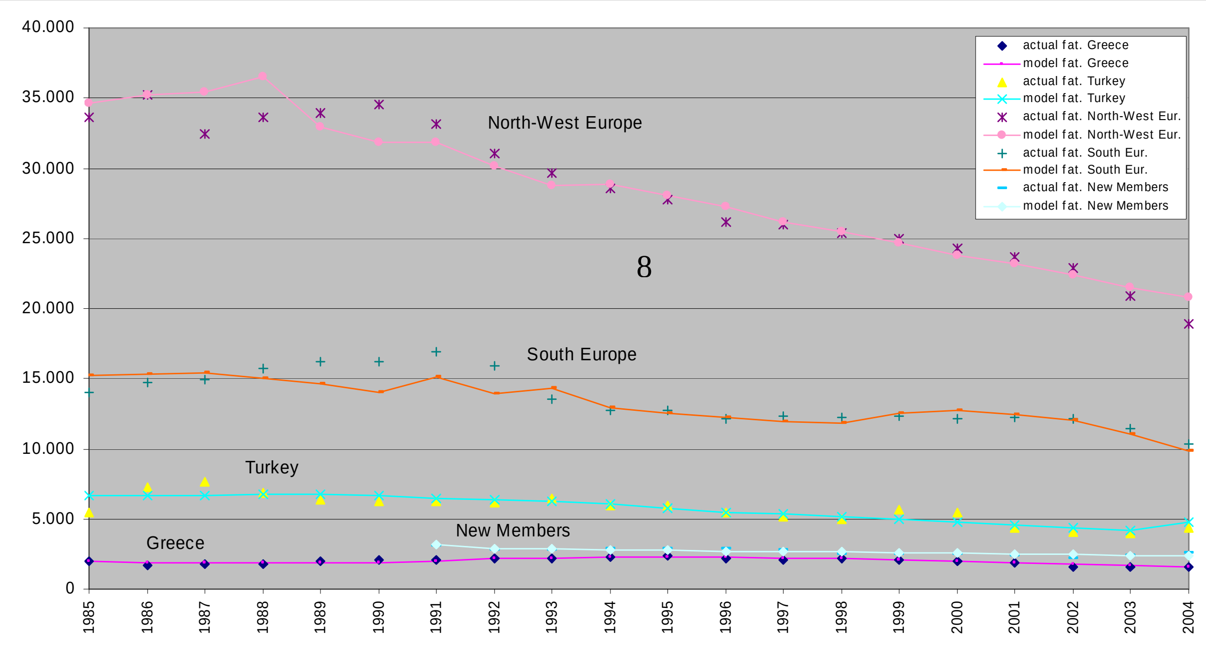
$$e_i = \frac{\Delta Y_i}{\Delta X_i} \cdot \frac{X_i}{Y_i} \qquad (2)$$

where X_i: the average value of each variable x_i

Y_i: the average value of log(fatalities)

Elasticity is useful because it is dimensionless unlike any estimated coefficient of regression parameter, which depends on the units of measurement of each parameter. In this way, it is possible to express quantitatively the impact of each independent variable on the dependent. In combination with the sign (±) of the coefficients it is also possible to identify whether an increase in each independent variable results in an increase or a decrease in the independent one.

FIGURE 1: Actual and model values of fatalities.



4. MODEL APPLICATION

Based on the above elasticity calculations, the five models can be further explored and compared to each other through the comparison of elasticities calculated for each case. The kind of impact that each independent variable has on the dependent variable can be identified by the sign (±) of the corresponding coefficient in each model.

In the case of Greece elasticity values are: e_1 = 0,029, e_2 = 0,042 and e_3 =0,279. These results show that the population is the variable which affects the number of road fatalities most but the percentage of motorcycles in the total fleet has also a great impact on road fatalities. An increase in the total number of registered vehicles results in a decrease in road fatalities, while an increase in the percentage of motorcycles or the population result in an increase. Specifically, a 1% increase in the population and in the motorcycles percentage result in a 0,279% and 0,042 increase respectively in the number of road fatalities. A 1% increase in the total number of registered vehicles results in a 0,029% decrease in road fatalities.

While examining the case of Turkey, it was concluded that the percentage of motorcycles in the total fleet is the one with the greatest impact on road fatalities as elasticity values were found:e_1 = 0,026, e_2

= 0,291 and e_3 = 0,112. Considering the way each independent variable affects the dependent, the results show that an increase in the total number of registered vehicles or in the percentage of motorcycles in total fleet has as consequence an increase in road fatalities while an increase in population results in a decrease. Specifically, 1% increase in the percentage of motorcycles and in the total number of registered vehicles causes respectively 0,291% and 0,026% increase in the road fatalities, whereas a1% increase in population causes 0,112% decrease in road fatalities.

The following step was the examination of the three groups of European countries. The first case was the North-West Europe. The elasticities were found: e_1 = 0,111, e_2 = 0,153 and e_3 = 0,636. In this case, population has the greatest impact in road fatalities. In this case, an increase in the total number of registered vehicles causes an increase in road fatalities. On the contrary, an increase in the percentage of motorcycles or in population causes a decrease in road fatalities.

In the case of South Europe, the population has the greatest impact on the number of road fatalities, followed by the percentage of motorcycles in the total fleet and the total number of registered vehicles. Specifically, the elasticity values for population, the percentage of motorcycles in the total fleet and the total number of registered vehicles were calculated equal to 0,836%, 0,153% and 0,082% respectively. The coefficients in this model indicate that an increase in the total number of registered vehicles or the population has as consequence a decrease in road fatalities, while an increase in the percentage of motorcycles in total fleet results in an increase of the road fatalities.

Finally, in the new members of E.U., increase of any of the three variables results in increase of the number of road fatalities, with the population being the variable with the greater impact. Elasticity values were calculated e_1 = 0,057, e_2 = 0,040 and e_3 = 1,509.

In total, it seems that population is the variable which affects most the number of road fatalities in all cases except in Turkey, where the highest impact comes from the percentage of motorcycles. In contrast, the total number of registered vehicles seems to be the variable with the smaller impact on road fatalities. Furthermore, it was found that the increase in the percentage of motorcycles leads to the increase of road fatalities in all cases except in the developed countries of the North Western Europe.

Furthermore, from the comparison of the elasticities for each case it was found that in Europe of 15 (Greece, North-Western and Southern Europe) there are similarities concerning the order of variables based on the impact each one has on road fatalities; in order of importance: population, percentage of motorcycles and vehicle fleet.

5. CONCLUSIONS

Greece and Turkey perform worse in road safety among the European countries, with most of the most dangerous regions for the year 2004, being located in these two countries. The objective of this research was the exploration of the basic parameters affecting road safety performance in Greece and Turkey and the comparison of road safety trends between these two neighbouring countries but also in relation to three selected groups of EU countries. On this purpose, lognormal regression was applied to vehicle fleet and demographical data. A lognormal model was developed for each case and elasticity values were calculated for each variable. The examination of all cases was based on the comparison of elasticity values within and between groups.

The proposed calculation of the dimensionless elasticity for each examined parameter was found as a simple but suitable technique for the purposes of this research, allowing the direct comparison of different cases of parameters and models. A single model for all cases should have been more accurate but definitively more difficult to develop and well more complicated to analyse, especially when all countries and groups of countries have not the data available for the same period. Furthermore, using elasticities was found adequate for the comparison of the basic road safety parameters not only between the two countries in question but also in relation to the selected broader groups of European countries - and not with each one country separately that a single model would impose.

The examination of Greece and Turkey, individually, revealed that there are some important road safety similarities between the two countries. In both cases, an increase in the percentage of motorcycles in the total fleet results in an increase in road fatalities, as expected for the less developed countries with high percentage of motorcycle traffic (Yannis et al., 2005a). Consequently, successful road safety measures implemented for years in the North Western European countries may not be the most appropriate for the Southern countries and research should focus on measures addressing properly the motorcycle traffic risk particularities of these countries.

It was also shown that road safety in Greece and Turkey has more similarities with road safety in the Southern countries than with the other groups (North-Western, New members) of EU countries. Another interesting finding was that population does have an important impact on road fatalities' trends in all EU countries - with the exception of Turkey - demonstrating as expected that road safety is primarily correlated to basic macroscopic socio-economic developments of the modern societies.

The results of this research revealed the role of basic parameters for the road fatalities' macroscopic trends, a very useful information for all decision makers designing the national road safety policies (Kanellaidis et al., 2005). Common characteristics of neighbouring countries may dictate similar road safety performance, a useful hint for all those who attempt to identify future road safety trends and propose countermeasure policies. It is obvious that among the parameters examined, some can be more useful for the design of policies and countermeasures (vehicle fleet, motorcycle percentage) and some others are useful mainly for macroscopic estimations (population).

Certainly, road safety trends can be attributed to various parameters, some of which can be modeled explicitly (population,. vehicle fleet, motorcycle percentage, etc.), while others may be handled indirectly due to lack of the necessary data (traffic, driver behaviour etc.). Further research comprising more parameters, more complete time series data and exploration of alternative and/or more complex models could be proved beneficial for the identification of future road safety trends through the respective performance of neighbouring countries. Especially for the parameter "population" it would be useful to examine various behavioural aspects of different population groups (pedestrians, older drivers, etc.) and their safety impact in the various countries with different road user behavioural patterns.

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