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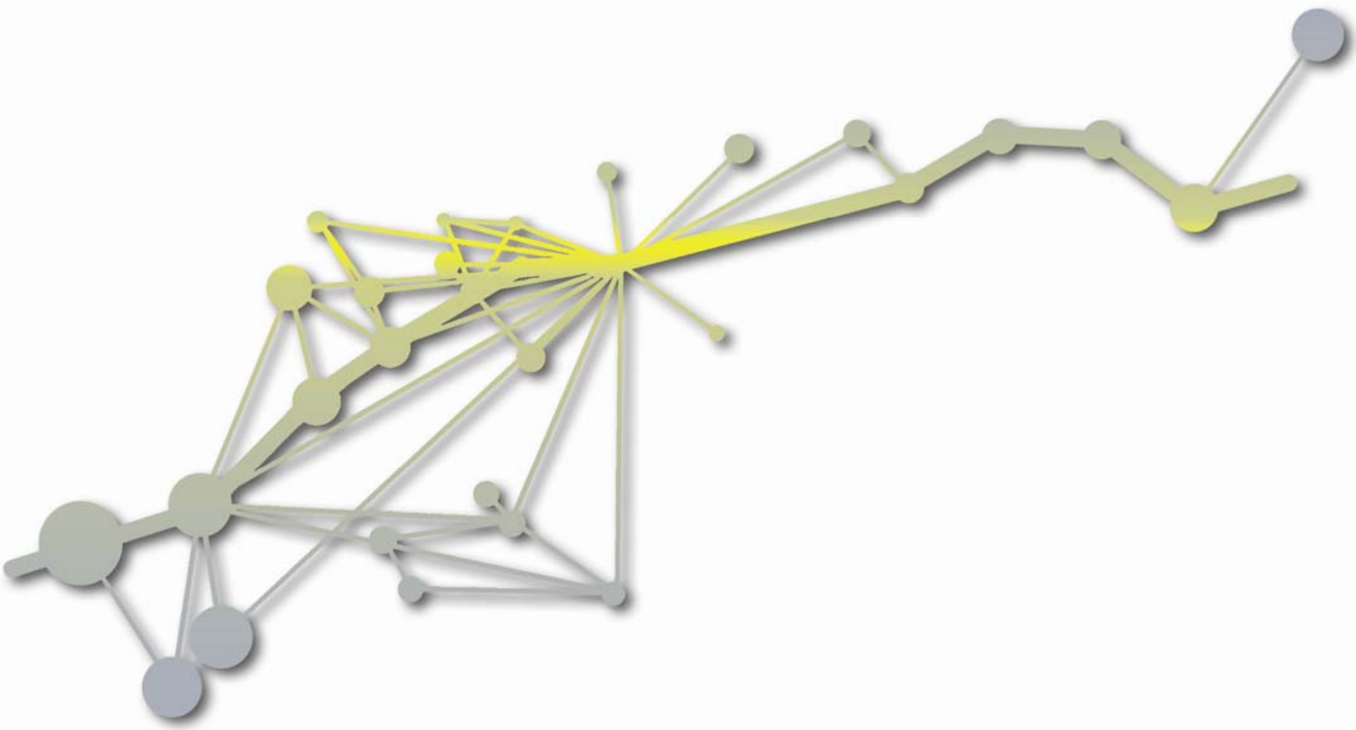
An assessment of Egnatia Motorway's impacts on polycentric development



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This report investigates the polycentric spatial development in the Zone of the Regions crossed by the Egnatia Motorway. Based on socio-economic and accessibility indicators monitored by the Observatory of Egnatia Odos SA, the report assesses the impact of the motorway (and its vertical axes) on polycentricity in Northern Greece.

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KEY WORDS

Polycentricity, Egnatia Motorway, spatial impacts, indicators, connectivity.

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SUMMARY

The Egnatia Motorway constitutes the main road corridor for transport and communication in Northern Greece, and one of the main road corridors connecting Europe and Asia, while its vertical axes link the main axis with the countries in South-Eastern Europe. In national level, the Egnatia Motorway plays a crucial role regarding the spatial organisation and regional development. It constitutes the new crucial component towards the perspective of a transition from the traditional Greek spatial development model –- which is based on the alignment of the road axis Patra – Athens – Thessaloniki – Evzonoi (PATHE) and the dominance of the two metropolitan centres -- to a new supplementary model. Furthermore, modern policies and spatial development objectives on a national and European level aim at a polycentric structure of the urban centres' network. Therefore, polycentricity is of vital importance as a target-model of spatial development and several studies in the relevant international literature attempt a quantified investigation of the concept by applying specific methodologies and indicators.

This report presents a methodology for the assessment of the impact of the Egnatia Motorway – Vertical axes system on polycentricity. The methodology formulates and, in principal, is based on the necessary theoretical background, which is structured in accordance with the assumption that the level of a polycentric spatial development (polycentricity) is a condition that concerns both the size and the location of centres (*morphological polycentricity*) and the relationships among them (*functional polycentricity*).

In order to examine the impact of the Egnatia Motorway – Vertical Axes system in both these directions, the level of polycentricity is assessed before and after the operation of this system through the calculation of indicators that concern the population, the GDP, the population living in a 50km-zone around urban centres, the accessibility and the trips between urban centres.

In general, the changes caused by the Egnatia Motorway – Vertical Axes system in morphological polycentricity - a concept that describes the size and location of centres and, typically, is difficult to be altered - are minor and cannot be characterised as being either positive or negative. On the contrary, significant are the impacts of the Egnatia Motorway – Vertical Axes system on the functional polycentricity of the network of urban centres in Zone IV.

As concerns morphological polycentricity, the size of urban centres (population and GDP) is not changed in a way that would render the current monocentric model (having as its centre the city of Thessaloniki) any difference. In parallel, though, an improvement is recorded in the balance of cities' sizes, (except for Thessaloniki), which is due to the positive changes of the GDP of smaller and more regional Prefectures. Furthermore, the changes that concern the population located in 50km-zones around urban centres show that the potential of smaller and regional urban centres to develop by providing services to the population of their greater areas is increased.

The most significant conclusion drawn, however, pertains to the contribution of the transport system examined to functional polycentricity. According to modern spatial planning, polycentricity greatly depends on connectivity, i.e. the frequency and form of flows among the various "centres". Based on these parameters, the Egnatia Motorway (with its vertical axes) improves accessibility and increases mobility among urban centres thus directly contributing to functional polycentricity in its Impact Zone.

The above observation is supported by this study in two ways: First, the improvement of connectivity provided by the system leads to a significantly improved accessibility for all the cities located in the Impact Zone. Accessibility presents the highest percentage increase in smaller cities, which are the most remotely located in relation to the traditional development road axis PATHE. Inequality among urban centres becomes, therefore, smaller as far as their accessibility is concerned. Second, flows among urban centres are increased [an increase which, in principal, is expressed by an increase in the average annual average daily traffic (AADT)] in a way that, although the balance of flows in the area is not improved, special functional polycentricity is affected, in particular as a function of the size of trips that are significantly increased (e.g. from Thessaloniki to the major urban centres in Epirus and Thrace).

The research identifies a system of urban centres that have the potentials of connectivity and of developing functional relationships. This system of urban centres covers all Northern Greece – either by including adjoining centres (e.g. Ioannina-Igoumenitsa, Kozani-Veroia, Xanthi-Komotini-Alexandroupoli) or by including the connections between the major city of Northern Greece, (the city of Thessaloniki), and the more remote dynamic cities (in the Regions of Epirus and Eastern Macedonia-Thrace). The identification of this system proves that modern transport infrastructures can contribute to the creation of new forms of spatial organization. The degree of this contribution, nevertheless, also depends on the spatial policies and the way these are implemented.

The changes incurred by improved connectivity can also affect the polycentricity model applied between the major and minor urban centres of a Region revealing interconnections involving medium-sized towns, a fact that implies the potential of a new organization and positioning of activities and services.

Furthermore, it is useful to examine in the future the contribution of the Egnatia Motorway-vertical axes transport system to the polycentricity in the cross-border area of Southern-Eastern Europe, a parameter that can significantly contribute to a more balanced development in the area and an improvement of competitiveness and cohesion with the rest of the European space.

Finally, data of crucial importance in further elaborating the study on polycentricity in all the aforementioned spatial fields should be derived from relevant Origin-Destination surveys, which will record the frequency and characteristics of trips – flows. These data will be related to spatial organization issues, in order to record more accurately the main trends. Such surveys will also be useful in regional spatial planning, which will be updated through the revision of Regional Frameworks of Spatial Planning and Development.

Abbreviations

A.U.Th.	Aristotle University of Thessaloniki
CSF	Community Support Framework
EC	European Commission
EM	Egnatia Motorway
ESDP	European Spatial Development Perspective
ESPON	European Spatial Observatory Network
EU	European Union
FUA	Functional Urban Areas
GDP	Gross Domestic Product
GFSPSD	General Framework for Spatial Planning and Sustainable Development
MD	Municipal District
MEPPW	Ministry for the Environment, Physical Planning and Public Works
NODS	National Origin-Destination Survey
NSSG	National Statistical Service of Greece
NUTS	Nomenclature des Unités Territoriales Statistiques
OECD	Organization for Economic Cooperation and Development
PIA	Potential Integration Area
PPS	Purchasing Power Standard
PUSH	Potential Urban Strategic Horizon
SACTRA	Standing Advisory Committee on Trunk Road Assessment
SEMSON	South Eastern Mediterranean Spatial Observatory Network
UA	Urban Agglomeration
WATh	Wider Area of Thessaloniki
EU	European Union
TEN	Trans-European Networks
TEN–T	Trans-European Transport Network
TINA	Transport Infrastructure Needs Assessment

1. Introduction

Modern policies and spatial development objectives adopt the idea that certain forms of spatial organisation are more preferable than others, and, in particular, that polycentric distribution of people, activities and infrastructures is better than a monocentric one. This view governs the European Spatial Development Perspective (ESDP: European Spatial Planning Perspective, EC 1999), according to which polycentricity is aimed at through the networking and complementarity between cities. Today, the concept of polycentricity plays a fundamental role in European regional policy and constitutes a priority for spatial development in Europe (EU, 2007: 4).

Transport policy and transport infrastructures are considered basic tools in achieving a polycentric structure in space. On a national level, spatial planning today, as expressed through the approved General Framework for Spatial Planning and Sustainable Development (GFSPSD), attempts to create polycentric structures through transport infrastructures. One of the "development axes" identified by the GFSPSD is the Egnatia Motorway. The Egnatia Motorway is also included in the Trans European Transport Network priority axis No7 (EC, 2005: 26). Spatial planning, both on a national and a regional level, assigns to the Egnatia Motorway a decisive role [Spatial Development Research Unit (SDRU)-Transport Engineering Laboratory (TEL), 2004: 275], because it improves the access between major and secondary urban centres and, therefore, constitutes a main component in the formation of specific urban networkings, thus contributing decisively to the structure of the network of settlements (ibid at p. 313).

The aim of this report is to investigate this contribution and, more specifically, to examine the impact of the Egnatia Motorway-vertical axes system on polycentricity. This research could be though as coming under the umbrella of a wider scientific question, i.e. "how can the impact of transport infrastructures on polycentricity be assessed?".

Similar questions have been processed by ESPON and several research programs, such as Polynet. In any case, the indicators used and the methodology applied are adapted to the special questions that each study is called to answer. In order to answer to this specific question, a methodology was formulated for the assessment of polycentricity, which drew from the relevant international literature and adapted this information to focus on the role of transport infrastructure. On the basis of this methodology, polycentricity is quantitatively assessed before and after the Egnatia Motorway and its vertical axes, as an indication of the spatial impact of the system Egnatia Motorway-vertical axes on polycentricity in the Zone of the Regions crossed by the motorway (Zone IV). Zone IV comprises the Regions crossed by the Egnatia Motorway, i.e. the Regions of Epirus, Thessaly, Western Macedonia, Central Macedonia and Eastern Macedonia & Thrace[1]. This zone includes 28 urban centres. Urban centres are the settlements with a population of above 10.000 inhabitants plus all Prefecture capitals, regardless of their population. In terms of population rating, one centre can be characterized as a metropolitan area, i.e. Thessaloniki, with a population of over 1mn inhabitants, two centres, i.e. Larisa and Volos, are rated as medium-sized towns with a population of over 100 thousand inhabitants, five have a population ranging from 50 to 100 thousand inhabitants and seven a population from 30 to 50 thousand inhabitants, while the remaining thirteen have a population of less than 30 thousand inhabitants (Observatory-Egnatia Odos A.E., 2009).

[1] see http://observatory.egnatia.gr/02_indicators/02_5_impact_zones.htm

The purpose of this report can be summed up in the following: (a) It provides a basis for the methodology to be applied in assessing polycentricity as an impact of transport infrastructures, (b) It contributes to assessing the Egnatia Motorway and Vertical Axes system as a spatial development tool, (c) It provides data that support spatial policies pertaining to the structure of the settlement network. The main data included in this Report come from the indicators monitored by the Observatory of the Egnatia Odos A.E. and are presented as a whole in the annual Indicator Result Reports (the latest one can be found in: Observatory-Egnatia Odos A.E., 2009) as well as at http://observatory.egnatia.gr/06_extras/6_1_results.htm.

The next chapter presents a theoretical examination of the concept of polycentricity and its relation with transport infrastructures. Then, the relevant international literature is reviewed in relation to the analytical framework and the indicators assessing polycentricity. The next chapter formulates the methodology used to examine polycentricity and applies it together with a quantitative analysis of the relevant indicators especially for the case of the Egnatia Motorway – Vertical Axes system (Chapter 3). Finally, on the basis of these indicators' results and statistical spatial processing, certain conclusions are drawn on the role played by the Egnatia Motorway and its vertical axes in the polycentric spatial development in their zone of influence (Chapter 4).

2. Polycentric spatial development and transport infrastructures

In the EU level, polycentric spatial development does not constitute a policy objective itself, but forms one of the means employed in achieving such objectives. It is considered that polycentricity can contribute to the economic, social and territorial cohesion (EC, 2006b: 20 and EC, 2007: 56), which constitutes one of the objectives of the Treaty of Lisbon (EU, 2007: 86) and the not yet ratified European Constitution (EU 2004: 99 and 374), as well as to the economic competitiveness, social justice and sustainable development (ESPON, 2005: 8 and ESPON, 2006 Part I: 12 and Part II: 138). Especially for South-Eastern Europe, it is strongly believed that the existing or emerging polycentric structures should be strengthened by improving the accessibility of medium-sized centres and counterbalancing the reduced accessibility of rural and isolated regions (Spiekermann και Wegener, 2006: 60).

Polycentricity has been also adopted by national policies. According to an ESPON[2] research, which was conducted to investigate the policies and planning of 29 European countries (EE27, Norway and Switzerland), 18 out of them are willing to adopt polycentric spatial organisation policies (ESPON, 2005: 19).

In Greece, reducing inequality between Athens and the rest of the country has been a spatial policy objective since the 60s (Angelidis, 2005: 114). Spatial policy in Greece was, therefore, always related to polycentricity, because it expressed a will to fight inequality between the centre and the rest of the country. More specifically, three successive policies can be identified as far as polycentricity is concerned: the "opposing cities" period towards the end of 70s, the

[2] The ESPON (European Spatial Planning Observatory Network) is a European programme of applied research, which was first financed in 2001 to study in a coordinated and systematic manner the spatial impacts of sectoral EU policies, so that it can form a scientific network of European spatial planning, as well as support the establishment of new regional development and territorial cohesion policies (www.espon.eu).

"open cities" policy in the years 1981-1996, and the policy of "polycentricity" in view of the European integration from 1997 to date (ibid):

With regard to the latest period, the most significant planning and political regulations aiming at polycentricity are expressed through the Regional and National Frameworks of Spatial Planning and Sustainable Development.

Regional Frameworks identify the need to construct a balanced and polycentric network of urban centres, the strengthening and improvement of the urban centres located in the Regions and, in conjunction with the development of integrated transport systems, the improvement of accessibility and cohesion, either directly (through achieving the general goals defining the spatial organization model adopted by each Region) or indirectly by adopting the ESDP principles.

The General Framework for Spatial Planning and Sustainable Development (GFSPSD) attempts the formulation of a polycentric structure with an urban network of growth poles, which is integrated into a matrix of development axes (MEPPW, 2008). Without making a clear reference to the interrelation between transport infrastructures and polycentricity, the GFSPSD considers that the completion of the development axes matrix requires the construction and completion of relevant infrastructure projects, which also involve major road axes (motorways); these axes coincide spatially with the development axes (ibid at p.31). In essence, the contents of the GFSPSD prove that the established planning focuses on supporting polycentricity through road transport infrastructures more than any of the periods after 1970.

On a European Union level, polycentricity is not clearly related to the policies concerning transport infrastructures. Typical is the fact that none of the most important documents referring to the EU policy for transport, such as the White Paper on transport (EU, 2002) and the Trans-European Transport Networks Reports (EC 2002, 2003, 2005, 2006a) makes a reference to polycentricity.

The ESDP (EC, 1999: 36) states that the improvement of interconnections both in national/transnational and regional/local networks is considered to be one of the policy goals for complementarity and cooperation between cities. The ESDP links polycentricity with development corridors stating that "corridors are an essential instrument of spatial development for the co-operation between cities." (ibid at p.65), an objective that –as previously mentioned- is intended at an even greater extend by the General Framework for Spatial Planning and Sustainable Developmen (MEPPW, 2008).

On a policy level for the whole of the EU space, the connection between transport infrastructures and polycentricity can be graphically represented as shown in Figure 1.

Figure 1. Connection between polycentricity and transport infrastructures

Transport infrastructures
⇩
Improved connection between cities
⇩
Complementarity-cooperation between cities
⇩
Polycentricity
⇩
Territorial cohesion – balanced development

Consequently, although the two concepts are not clearly interconnected in the relevant policy European documents, it can be easily concluded that there is an interdependence between polycentric spatial development and Trans-European Transport Networks[3]: Road infrastructures are considered as strengthening polycentricity or, vice-versa, polycentricity is one of the so-called "spatial storylines" that justify the presence and funding of Trans-European Transport Infrastructures (Peters, 2003). In any case, polycentricity together with mobility and, hence, transport policies and infrastructures, are "twin core themes" (Richardson and Jensen, 2000: 503). Mobility and cities as nodes in a polycentric spatial development model are two sides of the same coin (Richardson and Jensen, 2000: 512).

A more direct connection between polycentricity and transport is expressed on a local level and at a master plan scale, e.g. in Dublin and Munich plans (RTK, 2003: 124), but also in the researches studying the impact of transport policies and infrastructures. According to the prevailing scenario of ESPON (ESPON 3.2, 2006) regarding the territorial cohesion of Europe in 2030, the Regions of Southern Europe, mainly in Greece and Portugal, will benefit significantly from the Trans-European Transport Networks. However, the Trans-European Transport Networks put an emphasis on metropolitan areas and it is estimated that polycentricity on a national level in Southern Europe will be reduced (ibid). Major cities in remote areas will remain rather isolated, as far as their development is concerned, and will not benefit significantly from networking and co-operations (ESPON 3.2, 2006: 73). Similarly, the "ESPON Project 2.1.1: Territorial impact of EU transport and TEN policies" estimates the impact of Trans-European Transport Networks and concludes that they accelerate the reduction of polycentricity in the national urban networks, because they are mainly oriented towards the interconnection of major urban centres (ESPON 2004a: 20).

Consequently, it is easily understood that polycentricity will not necessarily be strengthened by the presence of transport infrastructures: transport infrastructures may support polycentricity on a specific spatial scale while reducing it in another. Furthermore, it is possible to be faced with the "pumping" or "tunnel" effect (see Lambrianidis, 2000:67), which means that the impact of a transport infrastructure on the development of a region may be negligible or even negative. In addition, although polycentricity is pursued as a spatial organization model, there is

[3] Trans European Transport Networks or TENs constitute the dominant EU policy as far as major transport infrastructures are concerned and were established by the Maastricht Treaty (1992).

criticism that argues that certain forms of polycentricity may lead to increased traffic volumes and increased transport demand, phenomena which in turn have subsequent environmental impacts and costs (ESPON, 2004b: 25 and Vickerman 2004: 11).

For the above reasons, the impact of transport infrastructures on polycentricity is not easy to assess and needs to be further investigated and monitored. Especially in cases of infrastructures that are seriously considered in the formulation of spatial policies, such as the Egnatia Motorway and its vertical axes. The polycentric model adopted by almost all Greek regions cannot be implemented unless it is substantially supported by hierarchical networks and transport systems that ensure immediate access between the various centres of the network of settlements (SDRU-TEL, 2004: 185). Therefore, monitoring the balance of an urban network through the use of indicators that concern transport infrastructures and mobility-accessibility allows the prompt identification of possible polarisation phenomena (ibid at p. 275). Such an attempt first requires, however, a clarification of the concept of polycentricity in spatial development; this is attempted in the following chapter.

2.1. Polycentricity: A concept review

According to Davoudi (2003: 979), polycentricity is an old notion which can be found in various variations in the relevant literature of the early 20th century that pertains to the spatial structure of the urban networks of settlements and, in particular, in the work of urban sociologists of the Chicago School. Despite its widespread use, the concept remains elusive without a compact theoretical framework or a strict empirical analysis. On the contrary, polycentricity is an ambiguous and insufficiently defined concept (ESPON, 2007a: 10) and, therefore, it means different things to different people (Davoudi, 2003: 979). In Gløersen et al (2007: 418), it is considered to be a term with multiple meanings when used in policies (multifinality). These views are in accordance with the research conducted by Waterhout et al. (2003), which indicates the differences in the interpretation and use of the concept of polycentricity in various national spatial policies.

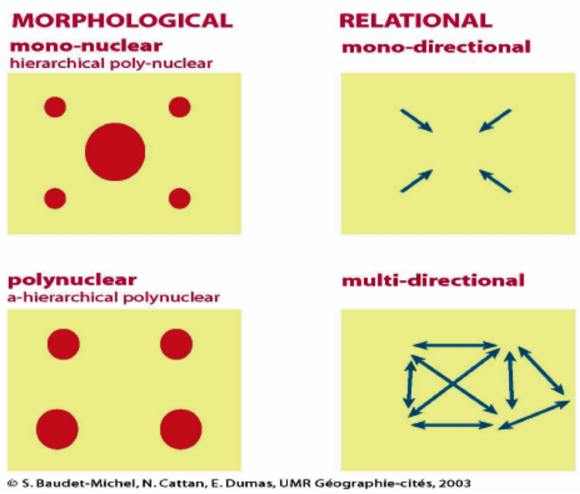
Gløersen (2005) defines polycentricity as follows: a) Using a normative definition, according to which the concept is about promoting balanced and multiscalar types of urban networks. The specific types of urban networks are more beneficial from a social and economic point of view both for the core areas and for the peripheries. b) Using an analytical definition, according to which polycentricity is a spatial organization of cities characterized by a functional division of labour, economic and institutional integration, and political cooperation. Krätke (2001: 107) defines a polycentric system as «a system in which a whole series of 'high-ranking' location centres exist side by side with a large number of small and medium sized towns and cities».

From another point of view, "polycentricity" means different things when applied at different spatial scales. Davoudi (2003) identifies three different scales to which the concept of polycentricity refers: a) the internal structure of a city (intra-urban scale), b) an urban region with multiple settlements (inter-urban scale) and c) an inter-regional scale, which are also defined as micro, meso and macro levels by ESPON (2005: 4). The spatial scale referring to polycentricity is very important, because when spatial scale changes, polycentricity goals may become inconsistent (Radvánszki, 2009: 318) For example, polycenticity on a EU level could mean strengthening the city of Thessaloniki, whereas on a Central Macedonia Region, achieving polycentricity would require a totally different approach.

2.2. Polycentricity aspects and processes

Polycentricity, in general, is based on two complementary aspects: the first concerns morphology, i.e. the distribution of urban centres in a specific territory (number of cities, hierarchy, distribution in space), and the second concerns the relations between urban areas, i.e. the flow and cooperation networks (Figure 2). As far as morphological polycentricity is concerned, ESPON (2005: 45) identifies two extreme patterns of urban networks, the mono-nuclear pattern, with one dominant city and several peripheral/dependant centres, and the poly-nuclear one, with no dominant city and centres of similar size. Similarly, relational or "functional" polycentricity, according to Green (2004), can be either mono-directional or multi-directional. In the first case, all relations tend to move towards one centre, while, in the second, relations do not follow a specific direction.

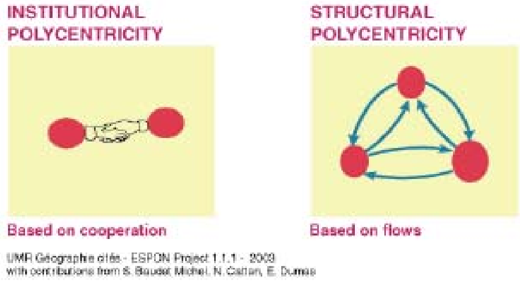
Figure 2. The aspects of polycentricity



Source: ESPON (2005): 45

In addition, according to ESPON (2005), two polycentricity development processes can be identified (Figure 3): a) institutional polycentricity, which is based on voluntary cooperation, and b) structural polycentricity, which is the result of a "spontaneous" spatial development. Institutional polycentricity concerns administrative/political or institution-driven cooperations among cities, while structural polycentricity contains the flows of goods, people, data, etc. among cities. This category includes the corresponding flows effected through road axes.

Figure 3. Processes to achieve polycentricity



Source: ESPON (2005): 45

2.3. Polycentricity assessment studies

2.3.1. ESPON studies

On a European level and for many years, polycentricity in an urban network has been investigated in a well-documented and systematic manner by the European Spatial Observation Network (ESPON). ESPON reports refer to indicators and methodologies applied to measure polycentricity, while they assess the TEN impacts on polycentricity as an interconnection among Functional Urban Areas (FUAs)[4].

In particular, Report 1.1.1 "Potentials for polycentric development in Europe" (ESPON, 2005) introduced the calculation of polycentricity on a European Union level. In this Report, ESPON measures polycentricity in the European space using a composite indicator that takes into account three dimensions: the size, the location and the connectivity of "centres". The Report assumes that the connectivity of urban centres can be measured in two ways; either by measuring the actual interactions (such as flows of goods, services, people, telecommunications, etc) or the system's potential for interactions (such as the potential accessibility, the level of road/air connections, etc). In a later ESPON report (2007a, 216-231), Report 1.1.1 was considered as putting a great emphasis on the morphological aspect of polycentricity at the expense of the relations between cities, as relating to a great extend polycentricity with spatial adjacency and commuting, and, finally, as adopting a rather traditional Christallerian approach.

The ESPON Report 2.1.1 "Territorial Impact of EU Transport and TEN Policies" (ESPON, 2004a), the method applied in ESPON 1.1.1 to measure polycentricity was incorporated into the SASI model[5] in order to assess the impacts of various transport scenarios on the polycentricity of urban networks in each member-state. Initially, the analysis started with a systematic and structured selection of links between cities in the hierarchical polycentric network of the European FUAs. Then followed the measurement of the impact on polycentricity by examining whether the TENs policy contributed to the strengthening of interactions between FUAs (ESPON, 2004a: 102). The main conclusion of this report for polycentricity as an effect of the TENs is that although they contribute to accessibility and growth in the peripheral areas of the European Union, they improve even more the accessibility in the central regions which already have a relatively high income (ESPON 2004a: 30).

Similar conclusions are drawn in the ESPON Report 1.1.3 "Enlargement of the European Union and the wider European Perspective as regards its Polycentric Spatial Structure" ESPON (2006), where a special reference is made to polycentricity in Greece: (a) A large part of the funds received (originating from the Cohesion Funds and Natural Resources) were allocated to the improvement of, mainly transport, infrastructures. Even though significant transport projects were implemented in the peripheral regions of the country, minor was the impact of the overall transport system on the restructuring of the urban system. (b) The percentage of the Attica region population in the total country population remains very high, especially in relation to the percentage prior to the country's accession in the European Union and the implementation of

[4] In general, Functional Urban Areas, FUAs, are spatial units around urban centres, which are functionally connected with them, in particular as far as daily commuting and access to services is concerned. They are enlarged urban areas that are defined by a city-core and the boundaries that result from the geographic range of daily trips and flows towards adjacent, core-dependent areas.

[5] The SASI (Socio-Economic and Spatial Impacts of Trans-European Transport Networks) model simulates the socio-economic and spatial impacts of transport systems in Europe (Wegener και Bökemann (1998)

the cohesion policies. The most dynamic operations/activities remain in Athens (and in Thessaloniki). (c) Peripheral centres benefit from a limited decentralization of productive activities. They were benefitted from the changes made in the administrative restructuring, which was effected in order for local governments to have the opportunity to implement European programs. (d) Finally, the peripheral urban networks have not been strengthened enough. Therefore, progress towards a more polycentric territorial system is relatively small (ESPON, 2006, Part II: 24-25).

The ESPON Report 1.4.4 stresses that a polycentricity study needs to take into account flows (ESPON, 2007b: 22). This Report does not aim at assessing polycentricity, but at investigating the available analysis data, methods and frameworks as far as all kinds of flows are concerned. Taking into account the spatial dimension, there are four types of transport flow indicators: nodes-related indicators, links-related indicators, service-related indicators and origin-destination indicators. They can be applied on a macro-level (flows between countries), on a meso-level (flows between regions) and on a micro-level (flows between municipalities) (ESPON 2007b: 35). Together with the indicators for the measurement of polycentricity used in the rest of the ESPON reports, the Report 1.4.4 (ibis at p.67) indicates as an indicator for the measurement of flows the total number of trips generated and attracted by trip purpose and mode in NUTS 2 (Regions).

2.3.2. Other approaches

The oldest studies conducted to assess polycentricity were the ones by Steward (1959), Haggett, (1965), and Chorley and Haggett, (1967). These studies focus on the measurement of polycentricity based on the size of cities and they use as a measurement indicator the corresponding populations. Size and spacing of centres are the focal point in Sandberg and Meijers (2006), which apply the ESPON 1.1.1 methodology to define polycentricity in the EU countries, in order to investigate its relation to regional disparities.

In the last decade, an increased interest has been recorded in approaching polycentricity based on the flows. For example, Green (2004) creates an indicator to measure polycentricity in a region (General and Special Functional Polycentricity Indicator), which is based on the flows from and to each FUA in the region. The indicator takes into account the density of the flows (Δ), which equals the number of flows between the "centres" divided by a maximum number of flows that could exist between them. This indicator was used in Polynet program[6], which assesses polycentricity in a group of regions in the EU. The data used as flows are the number of commuters between the centres of a region.

Limtanakool et. al. (2007), taking into account the distribution of flows in space even more seriously, suggest a flow analysis framework that examines three dimensions: the strength of interaction, the symmetry of interaction and the structure of the network; based on these three aspects, they form a framework for the analysis of urban networks.

[6] The program "POLYNET: Sustainable Management of European Polycentric Mega-City" concerns polycentricity in regions of Northern-Western Europe. It forms part of INTERREG IIIB and was implemented through the collaboration of nine scientific groups from the United Kingdom, Ireland, Belgium, Germany, the Netherlands, and Switzerland (see http://www.polynet.org.uk/).

Hall and Pain (2006) examine the polycentricity of a networked polycentric mega-city-region, which is spread in 8 different Regions[7] of the European Union, most of them being located within the Pentagon area. As far as their perception of polycentricity is concerned, it is important to mention that these Regions are examined as a uniform polycentric system, although they are not characterised by a spatial continuity. This is a totally different approach from the one adopted in the ESPON Report 1.1.1 (2005), i.e. potential for polycentricity based on proximity. The study conducted by Hall and Pain aims more at designating the «mega-city region» as an urban phenomenon of the 21st century and at proposing policies for this kind of regions rather than measuring polycentricity. However, in order to achieve this aim, the study examines polycentricity on various spatial levels. A special emphasis is put on how the sectoral structure of labour changes in space and on how businesses interact and communicate.

From a different point of view, the Spatial Planning Observatory in Southeast Mediterranean Area (SEMSON) investigates polycentricity in Southeast Mediterranean Area performing an empirical analysis in the following fields: (a) the abandonment trends of certain geographical areas, such as mountainous, rural and border ones, (b) accessibility between the major urban networks and the urban-rural space at a national and regional level, (c) the existing urban governance systems in relation to the decentralisation process, (d) the role of the Metropolitan areas and other important urban centres in relation to the existing and perspective transport network, and (e) hierarchies of the urban system and urban spatial concentration (ibid at p.21).

2.3.3. Measurement indicators

In ESPON Report 1.1.1 [ESPON (2005)], connectivity between centres (accessibility), the size of centres (GDP and population) and the location of centres (the size of the FUAs service areas) are equally used to produce a composite indicator for measuring polycentricity. In ESPON Report 2.1.1 [ESPON (2004a)], the impact of the TENs on polycentricity is assessed by combining indicators that concern mass, competitiveness, connectivity and development trend of the FUAs. In these fields, the following indices were selected respectively: estimated population density in 2021, estimated Gross Domestic Product (GDP) per capita in 2021, estimated multimodal accessibility in 2021, and difference in GDP/capita between 2021 and 2001. Each indicator is measured at the NUTS 3 (Prefectures) spatial level and computed from the results of the SASI model. Then, for various transport policy scenarios, the composite indicator of "development potential" is calculated, which is the geometric average of the values of the four aforementioned indicators. The indicator is used to compare the impacts of the alternative transport policy scenarios on the development potential at a NUTS 3 level. By analyzing the spatial model of these impacts, the study assesses the potential for polycentric development, as briefly described in the previous chapter 2.3.1.

In the "1st Spatial Egnatia Motorway Impacts Report" (Spatial Development Research Unit-Transport Engineering Laboratory, 2004 and Egnatia Odos A.E. Observatory, 2005), the corresponding indicators used for the assessment of the urban balance and networking are population change, population density, urban hierarchy, city gravity and urban networking

[7] The study concerns the Regions of South East England, the Bassin Parisien, Central Belgium, the Dutch Randstad, RhineRuhr, Rhine-Main, Northern Switzerland and Greater Dublin.

(annual average daily trips between urban centres). Other Observatory indicators[8] that could contribute to the assessment of polycentricity are the benefited population (SET01), the work force (SET03), the accessibility of transport modes (SET06), the accessibility of industrial areas (SET07), the accessibility of sites of cultural and tourist interest (SET08), the composition of employment by industry sector (SET14) (since it may concern possible cooperations between cities), the urban land-use changes (SET16), the industrial and commercial land-use changes (SET17), the business location (SET19), and the pressure for land-use changes (ENV07).

Similarly, the SEMSON thematic Report [SEMSON, (2007)] on polycentricity records the following indicators: (a) urbanization, which is calculated as the total population of the urban poles, of each region, over 20.000 inhabitants against the total population of the region, (b) urban spatial concentration, which is calculated as the total population of the urban poles of each region (the urban poles are classified according to their population >20.000, 50.000, 250.000, 1.000.000), and (c) «polycentricity», for which the formula of calculation is not stated. As indicated in the relevant indicator specifications (SEMSON, 2007: 63-66), these indicators do not correspond to any of the ESPON indicators.

Following a more modern approach, Hall and Pain (2006), and Green (2004), in their various reports for the Polynet program, record as indicators: (a) the daily commuting between counties, (b) the number of work positions (people employed) in each county, and (c) the number of people employed per sector in each county.

2.3.4. Functional *vs*. morphological

The above examination of the relevant international literature shows that there is a tendency to move from the morphological dimension of polycentricity to the functional one. Namely, polycentricty is now examined less and less in relation to the size and location of urban centres and more and more as a function of their networking and complementarity. This trend is due to the corresponding development recorded in the polycentricity policies and the way in which the concept is defined in the field of spatial planning (Geppert, 2009). Modern trends in polycentricity policies are summarised by Sandberg and Meijers (2006: 7) as follows: "Rather than the traditional redistributive policies of the 1960s and 1970s, polycentric development policies emphasise the building on endogenous potential, developing regional organizing capacity, equal treatment rather than equality and a nodal approach rather than a zonal approach".

In reality, morphological polycentricity is very different from the functional approach of the concept. If an urban pole has many functions and dense and powerful flows are created from it towards other very small centres, this system is monocentric according to size-oriented polycentricity, but polycentric according to relational polycentricity. In addition, problematic seems to be the measurement of polycentricity on the basis of commuting. The largest the commuting, the less the jobs or economic services in the area exporting the work force, which excludes it from being characterized an "urban centre". Furthermore, the number of commuters does not necessarily express the degree of complementarity between two centres. It is possible, for example, a large number of factory workers to be commuting on a daily basis from a city to

[8] For the results and the methodology used to calculate indicators see http://observatory.egnatia.gr/results_en.htm

another without this leading to a complementarity between the functions of the two cities, as opposed to the commuting of fewer people, e.g. two businessmen which have entered a cooperation agreement between the two cities. As it is underlined in the recent literature, networking between cities does not necessarily mean improvement of polycentricity (Meijers, 2008: 1319), and the unequivocal preference for connectivity between settlements and creation of development corridors entails the risk of the emergence of further spatial disparities (Sýkora et al, 2009: 238). Consequently, the examination of both of polycentricity aspects is deemed imperative. It is this approach that is adopted in this report, the methodological particularities of which are presented in the following chapter.

3. Assessment of polycentricity in the Egnatia Motorway Impact Zone

3.1 Methodology

The area for which polycentricity is measured is the territorial unit of the regions crossed by the Egnatia Motorway and its vertical axes (Zone of Influence IV: Epirus, Western Macedonia, Central Macedonia, Eastern Macedonia and Thrace, Thessaly)[9]. Therefore, this research concerns polycentricity on an interregional level (meso-level, according to ESPON 2005: 4, or inter-region scale, according to Davoudi, 2003: 987). In essence, this research examines changes in polycentricity of an urban network that is closer to the “mono-nuclear pattern” (ESPON, 2005: 45-46) having as its pole the city of Thessaloniki, and focuses on the structural processes of polycentricity development, which are related to spatial development. It should be noted that this research does not take into account any institutional processes of polycentricity development, such as co-operations between government bodies or administrative actions that may have affected the degree of polycentricity of the urban network (e.g. Kapodistrias program[*]), since they are not related to the impacts of road infrastructure on polycentricity.

For the purposes of this Report, polycentricity is measured for the network of the cities within Zone IV, which includes all urban centres of a population of over 10.000 inhabitants, as well as the cities of Igoumenitsa and Polygyros, which, despite the fact that their population is lower, are capitals of Prefectures and constitute administrative and functional centres in their wider area[10].

[9] EGNATIA ODOS A.E. has undertaken, in conjunction with the main axis, the management of the design and construction of three main Vertical Axes, out of the nine (9) servicing it.
These are the following:
A. Siatista-Ieropigi/Krystallopigi (Albania-Paneuropean Corridor VIII) of a total length of 72km.
B. Thessaloniki-Serres-Promachon (Bulgaria-Paneuropean Corridor IV) of a total length of 96km.
C. Ardanio-Ormenio (Bulgaria-Paneuropean Corridor IX) of a total length of 124km.
Since July 2006, EGNATIA ODOS A.E. has undertaken the design and construction of two more Vertical Axes:
A. Komotini-Nymfaio-Greek-Bulgarian Borders (Bulgaria-Paneuropean Corridor IX)
B. Xanthi-Echinos-Greek-Bulgarian Borders (Bulgaria).

[*] TN: A program for the merging of local authorities in Greece.

[10] The urban network for which polycentricity is examined contains more centres than the FUAs indicated by the ESPON for Greece, because it includes urban centres of a smaller size. Small urban centres should be included in the studies concerning the spatial organization of an urban network, irrespective of whether they

In order to assess the impact of the Egnatia Motorway and its vertical axes on polycentricity, the indicators that express the polycentricity of the urban network under study are measured at two points in time: before the commencement of the motorway construction and today. The majority of the indicators used are the same or similar to the ones used in the ESPON Project 1.1.1 (2005). In the cases where indicators change, the purpose is to adapt them to the objective of this research, which is to assess the impacts of a transport infrastructure. These indicators are the following:

Size indicators:

(a) GDP
(b) Population

Location indicator:

(c) Population within a distance of 50km

Connectivity indicators:

(d) Accessibility
(e) Trips

These indicators are calculated and presented separately without creating a composite polycentricity indicator as in the case of the ESPON Report 1.1.1 (2005), for the following reasons:

- The data on the various magnitudes refer to different points in time and, therefore, it is not possible to combine them into one single indicator for a specific time.
- Due to the different interpretations of the concept of polycentricity, it is impossible to objectively weigh each magnitude of a composite indicator.
- By examining each indicator separately, the conclusions drawn are more specific as far as the direct or indirect impacts of road infrastructures on polycentricity are concerned.

There follows a description of the methodology followed for the calculation of each of the indicators used.

3.1.1. Indicators

Size indicators: (a) GDP and (b) Population

In calculating these indicators, the ESPON (2005) approach is followed, according to which the size of the Functional Urban Areas (FUAs) is expressed by their GDP and population. Since no GDP data exist for the cities, the study takes into account the GDP data for the smallest possible territorial unit within which the cities in question are located, as in the case of other studies (ESPON, 2004a and SEMSON, 2007). For the GDP and the population, a linear regression of the absolute value of the size of each city and of the corresponding location of the city in the size rating is performed. The city that is classified first in the size rating is excluded from this linear regression. The regression slope constitutes an indicator of the equidistribution of the GDP or the population. Apart from this, the study calculates the primacy rate of the city that is first in

are defined as FUAs by ESPON or not, and their role can be very significant in mono-nuclear urban networks (Sýkora and Mulí0ek, 2009).

the rating scale. This is done by dividing the size (GDP or population) of the city that is first in the rating by the hypothetical value the size of the city would acquire if it followed the linear regression. In the hypothetical situation of an absolutely polycentric system, the regression slope would have a zero inclination and the primacy rate will be one, both for the GDP and the population, which would mean that all Prefectures have the same GDP and the same population. The more the regression slope increases, the more dependant are the sizes' values from the rating position and the larger the disparities between Prefectures, while the higher the primacy rate is, the greater the difference between the largest and the rest of the Prefectures.

Location indicator: (c) population within a distance of 50km

The polycentricity of an urban network is, inter alia, a function of the location of settlements in space. The operation of the Egnatia Motorway and its vertical axes changes the road network and the distance (in km) between settlements. Namely, it changes, in a way, the "locations" of urban centres, due to the changes that emerge in the distance between them and in the areas serviced by these centres. In order to measure these changes, the study uses the indicator that expresses the population around the urban centres, which is directly serviced by their functions and lives in an area that allows commuting. It assumes that this population includes the permanent population of the Municipal Departments (MDs), which in order to be connected with the urban centre require a distance of less than 50km to be travelled along the road network. The methodology followed is, therefore, the one used for the indicator "benefited population" monitored by the Egnatia Motorway Observatory[11].

The improvement in accessibility due to the operation of the Egnatia Motorway increases the benefited population of urban centres and strengthens their functional position in the urban network thus affecting polycentricity. In an ideal form of polycentricity in terms of the location of urban centres, all urban centres would have the same benefited population, i.e. they would service an area of the same population size. The gini coefficient of the benefited population expresses how far the sample of the current benefited populations is from this ideal situation. The smaller this population is, the better the equidistribution of the sample.

Connectivity indicators: (d) accessibility and (e) trips

With regard to connectivity, polycentric spatial development is expressed by the potential accessibility of cities. For its measurement, the study uses the method followed by Shürmann et al (1997) for the SASI model, which was also used in another study for the assessment of accessibility as a result of the operation of the Egnatia Motorway (Tranos, 2005). Population is used as an activity function, and travel time as an impedance function. The formula used is, therefore, the following:

$$A = \sum_{s} W_s^a \exp(-\beta c_{rs})$$

where:

A: The accessibility of a city *r*

[11] See http://observatory.egnatia.gr/factsheets/fs_2007_en/fs_SEB1_2007_en.pdf

W: The population of a city *s* in the urban network. This study uses the permanent population of the 2001 census.

c_{rs}: The travel time between the city *r* and the city *s*. In this study, this is measured in minutes.

α, β: Parameters. In this research, α=1 and β=100.

Any change in accessibility constitutes a direct effect of the Egnatia Motorway and an important indicator for the measurement of connectivity. The Gini coefficient expresses how far accessibility of urban centres is from equidistribution. In theory, it would be zero if all cities had the same accessibility. Except for the calculation of the Gini coefficient, a linear regression of the accessibility of cities (before and after the operation of the Egnatia Motorway) with the population of cities is performed. The inclination of the regression slope shows how dependant is accessibility of a city from its population. A decrease in the inclination of the regression slope means that the accessibility of a city becomes independent from its population.

Connectivity also concerns the actual flows between cities, which correspond to the networking and cooperation between them. In the relevant international literature, flows between cities may concern telephone and electronic communications, business cooperations, sectoral structure of labour, etc (Hall and Pain, 2006). In this study, flows concern the annual average daily trips of vehicles. This was decided for two reasons: (a) any change in the number of trips is, to a great extend, due to the operation of new road axes and, therefore, any change in polycentricity recorded by the study will primarily be an impact of the Egnatia Motorway and its vertical axes, and (b) there are no other types of available primary flow data nor a competent body that records other kinds of flows (telecommunications, business relations, movement of goods and people) between cities in Greece.

The flow data on the situation "without" the Egnatia Motorway are the trips between Regions and come from the national Origin-Destination survey conducted in 1993, i.e. one year before the issuance of the JMD setting up the company Egnatia Odos AE, a point in time signifying the commencement of the project construction. These data precede the construction of the road, but this is a fact that renders their use in recording the situation "without" the Egnatia Motorway even more appropriate, since the impact of a transport infrastructure starts to emerge from the date its construction is announced (see "expectation effects", SACTRA, 1999: 224, Boarnet and Chalermpong, 2001).

Due to the lack of data on the trips after the completion of works, the flow data on the situation "with" the Egnatia Motorway concern the year 2006 and come from the model created with the use of the software VISUM by the Traffic Unit – Operations Department – Operations and Maintenance Division of EGNATIA ODOS AE. The origin-destination zones used in this model are different from the Regions used in 1993. For this reason, the zones in the VISUM model were combined to create the same origin-destination matrices both for 1993 and 2006. In these matrices, the origin-destination zones coincide with the Regions crossed by the Egnatia Motorway. Then, these matrices were cleared from non-reliable and non-comparable values for the years 1993 and 2006[12] and the final matrices used in the study were created to include 48 origin-destination pairs.

[12] The clearing of the matrices from non-reliable and non-comparable values, as well as the overall methodology applied in creating these matrices, was performed within the context of calculating the indicator

The data from the origin-destination matrices are used in the Special Functional Polycentricity method proposed by Green (2004 and 2007) and applied in researches conducted for the measurement of polycentricity (see Polynet program, Hall and Pain 2006, Pain 2006, Dewar and Epstein 2007, OECD 2007). On the basis of this method, it is possible to calculate the density of trips Δ in the examined urban network, which, in this case, is Δ=L/Lmax, where L the total number of trips between cities and Lmax the theoretical maximum number of trips. In this study, the Lmax is assumed to be the sum of the population of all the Prefectures crossed by the axis. In theory, Δ can be assigned values ranging from 0,001 to 1, where the value 1 would mean that for each inhabitant in the examined area there is one average annual daily trip to another city. Then, special functional polycentricity is calculated on the basis of the following formula:

$$P_{SF}(N) = \left(1 - \sigma_{\partial} / \sigma_{\partial max}\right) \bullet \Delta$$

$P_{sp}(N)$: the special functional polycentricity of the urban network N,

σ_{∂}: the standard deviation of the sample of trips,

$\sigma_{\partial max}$: the standard deviation of an urban network of two cities, where one presents zero trips and the other the maximum number of trips.

Δ : density of trips in the urban network.

The mathematical expression of the special functional polycentricity shows that, by applying this method, the polycentricity of an urban system is assumed to be the product of two factors, i.e. the dispersion of flows between the origin-destination pairs (factor 1- $\sigma_{\partial} / \sigma_{\partial max}$) and the density (factor Δ) of flows.

Three out of five indicators examined, i.e. the indicators population within a distance of 50km, accessibility and trips, concern the direct impacts of the Egnatia Motorway on the polycentricity of the urban network. The indications' specifications are presented on tables 2 and 3. The spatial units to which the data refer are shown on maps 1 – 3 and are the Prefectures in Zone IV, for which the size indicators are calculated (GDP and population), the urban centres in Zone IV for which the indicators population within a distance of 50km and accessibility are calculated, and the Prefectures and Regions crossed by the Egnatia Motorway, to which the data for the calculation of the special functional polycentricity (trips) refer.

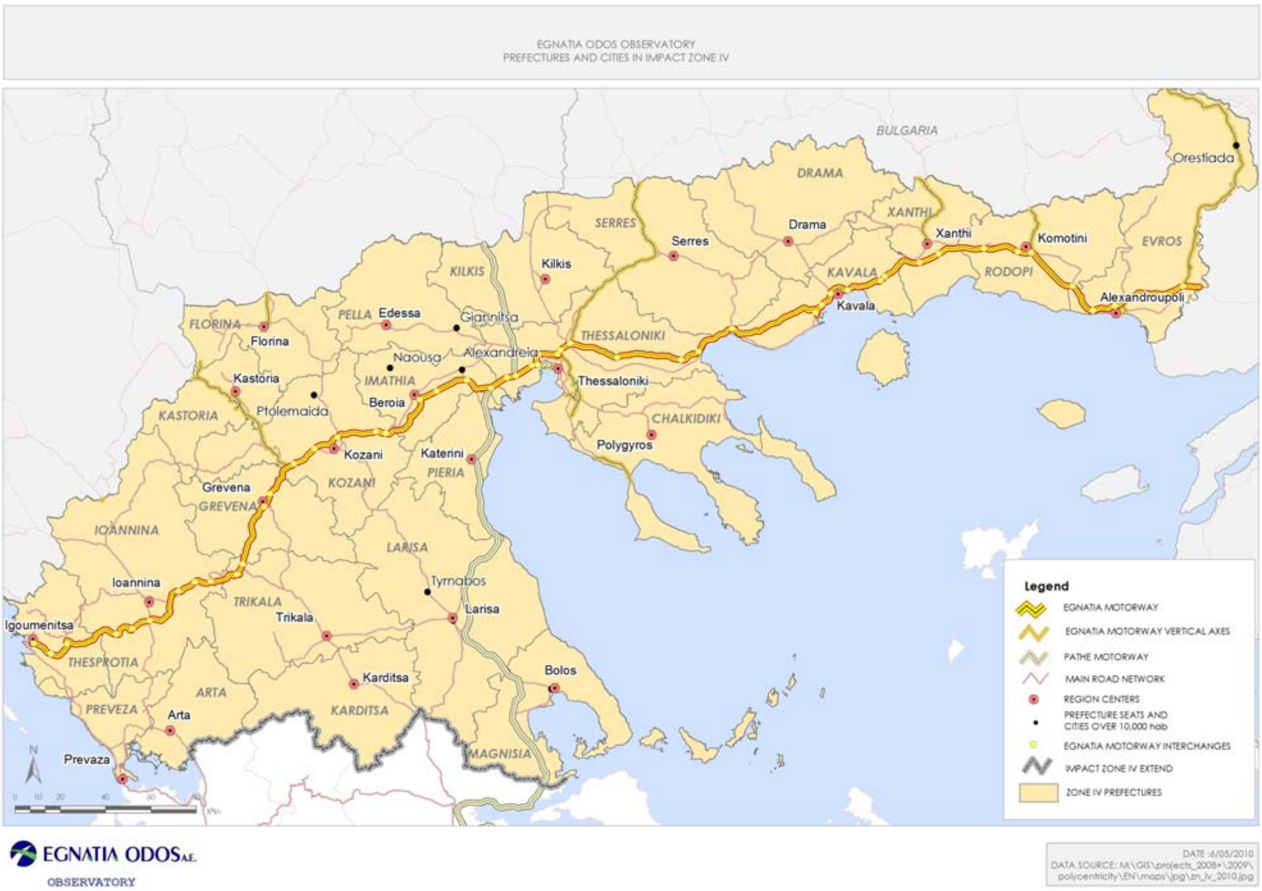
Table 1. Indicators for the measurement of polycentricity - methodology and sources

Description of polycentricity indicators	Morphological Polycentricity			Relational Polycentricity	
	1. Size index		2. Location index	3. Connectivity index	
	a) GDP	b) Population	c) Population in 50km distance	d) accessibility	e) Trips
Calculation	regression slope primacy rate	regression slope primacy rate	Gini coefficient	$A = \sum_{s} W_s^a \exp(-\beta c_{rs})$ gini coefficient και regression slope	$P_{SF}(N) = \left(1 - \sigma_{\partial} / \sigma_{\partial max}\right) \bullet \Delta$
Source of the indicator's methodology	Espon 1.1.1		Observatory - Egnatia Motorway AE (http://observatory.egnatia.gr/02_indicators/02_set01.htm)	Shürmann C., Spiekermann K. and Wegener M. (1997) "Accessibility Indicators", Berichte aus dem Institute für Raumplanung 39, Universität Dortmund.	Green N. (2004) General Functional Polycentricity: A definition. Polynet-working paper
Primary data source	Eurostat (Nuts3)		NSSG 1991 and 2001 Observatory - Egnatia Motorway AE	NSSG, 2001 Observatory - Egnatia Motorway AE	Origin - Destination service (1993) Egnatia Motorway SA, Department of Traffic- Operation Directorate-Operation and Maintenance Division of EGNATIA ODOS AE (2008) Eurostat (Nuts3 population)

Table 2. Indicators for the measurement of polycentricity - characteristics of indicators

Indicator	Territorial unit for which the indicator is calculated	Years for which the indicator is calculated	Range of indicator values
GDP (regression slope)	NUTS3	1997, 2006	> -100 and < 0 (in rad)
GDP (primacy rate of the first in the rating)	NUTS3	1997, 2006	> 0
Population (regression slope)	NUTS3	1997, 2006	> -100 and < 0 (in rad)
Population (primacy rate of the first in the rating)	NUTS3	1997, 2006	> 0
Gini coefficient of benefited population	settlements	2001, with/without the EM and vertical axes system	> 0 and < 1
Gini coefficient of Accessibility	settlements	2001, with/without the EM and vertical axes system	> 0 and < 1
Accessibility (regression slope)	settlements	2001, with/without the EM and vertical axes system	> -100 and < 0 (in rad)
Movements along the road network	regions	1993, 2006	-

Map 1. Spatial reference levels of indicators

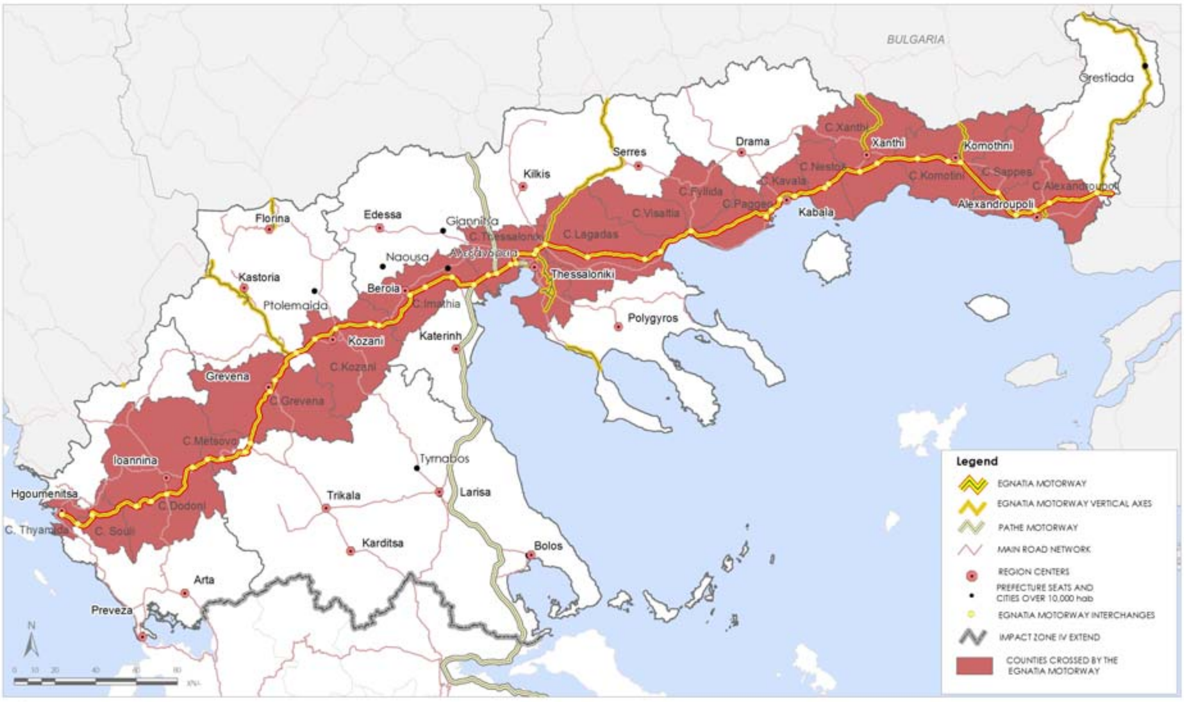


EGNATIA ODOS OBSERVATORY
PREFECTURES CROSSED BY THE EGNATIA MOTORWAY (ZONE II)

EGNATIA ODOS A.E. OBSERVATORY

DATE :6/05/2010
DATA SOURCE:M:\GIS\projects_2008+\2009\polycentricity\EN\maps\jpg\zn_II_2010.jpg

EGNATIA ODOS OBSERVATORY
COUNTIES CROSSED BY THE EGNATIA MOTORWAY



EGNATIA ODOS A.E. OBSERVATORY

DATE :6/05/2010
DATA SOURCE:M:\GIS\projects_2008+\2009\polycentricity\EN\maps\jpg\eparxies dieleushs_2010.jpg

3.2 Results

3.2.1. Population

The size indicator (population and GDP) is calculated by applying the methodology described in the ESPON report on polycentricity. The exclusive source of population data for the settlements in Greece is the NSSG censuses. These cover the time period up to 2001 and, therefore, they are not considered sufficient to depict polycentricity "without" and "with" the Egnatia Motorway. The calculations that concern population are hence performed with the use of data on the population of the Prefectures in Zone IV, which are published by Eurostat on an annual basis. The Prefectures in Zone IV are classified according to their size in the years 1997 and 2006 (Table 3).

Table 2. Rating of the Prefectures in Zone IV based on the average annual population, 1997 and 2006

1997			2006			Percentage change 1997 - 2006
Prefecture	Population (in thousands)	Position	Prefectures	Population (in thousands)	Position	
Thessaloniki	1,056	1	Thessaloniki	1,130.20	1	7.0%
Larisa	281.5	2	Larisa	285.1	2	1.3%
Magnesia	203.8	3	Magnesia	204.1	3	0.1%
Serres	192.8	4	Serres	189.6	4	-1.7%
Ioannina	159.4	5	Ioannina	175.2	5	9.9%
Kozani	153.2	6	Kozani	154.4	6	0.8%
Evros	148	7	Evros	149.1	7	0.7%
Pella	142.2	8	Pella	145.2	8	2.1%
Imathia	141.9	9	Imathia	144	9	1.5%
Kavala	139.7	10	Kavala	140.4	10	0.5%
Trikala	135.2	11	Trikala	131.1	11	-3.0%
Pieria	123.7	12	Pieria	128.1	12	3.6%
Karditsa	121.9	13	Karditsa	116.8	13	-4.2%
Rodopi	109.5	14	Rodopi	111.3	14	1.6%
Xanthi	100.8	15	Xanthi	105.9	15	5.1%
Drama	100.6	16	Drama	100.7	16	0.1%
Chalkidiki	96	17	Chalkidiki	100.1	17	4.3%
Kilkis	84.4	18	Kilkis	86.5	18	2.5%
Arta	74.7	19	Arta	71.4	19	-4.4%
Preveza	58	20	Preveza	57.5	20	-0.9%
Florina	53.8	21	Florina	54.3	21	0.9%
Kastoria	53.7	22	Kastoria	53.8	22	0.2%
Thesprotia	43.1	23	Thesprotia	42.7	23	-0.9%
Grevena	32.8	24	Grevena	31.6	24	-3.7%
Source: Eurostat, 2/2009						

Obviously, the area under examination is characterized by a clear dominance of Thessaloniki, as far as its population size is concerned, both for the years 1997 and 2006. In addition, the rating of Prefectures remains the same and no great changes are recorded in the population data. It's interesting to examine whether there is a trend, even a slight one, towards a more polycentric system or a more monocentric one.

The performance of a linear regression between the population of the Prefectures and their location in the aforementioned classification results in the indicator "primacy rate", which expresses the degree of primacy of the Prefecture with the highest population. The value of this indicator for Thessaloniki was 4.86 in 1997 and increased in 2006 amounting to 5.23. Namely, the population primacy of the Prefecture of Thessaloniki in relation to the rest of the Prefectures in the Zone appears to be increasing in the period 1997-2006.

The regression slope between the population of the Prefectures and their position in the rating appears to become slightly smaller in the years 1997-2006 (Figures 4 and 5), which means that the system has changed towards a more polycentric pattern. This trend is mainly due to the population increase evident in the Prefectures with relatively smaller, but not the smallest, size that are located exactly in the middle of the rating between positions 6 and 18, such as the Prefectures of Xanthi (5.1%), Chalkidiki (4.3%) and Pieria (3.6%). However, it should be noted that 6 Prefectures presented a decrease in their population in the period 1997-2006, two of them being in Thessaly (Trikala and Karditsa) and two in Epirus (Preveza and Thesprotia), while the greatest population increase was recorded in the Prefecture of Ioannina (9.9%) followed by the Prefecture of Thessaloniki (7%), both of them being in the first five positions of the rating.

Figure 4. Linear regression between population and position in the rating, 1997

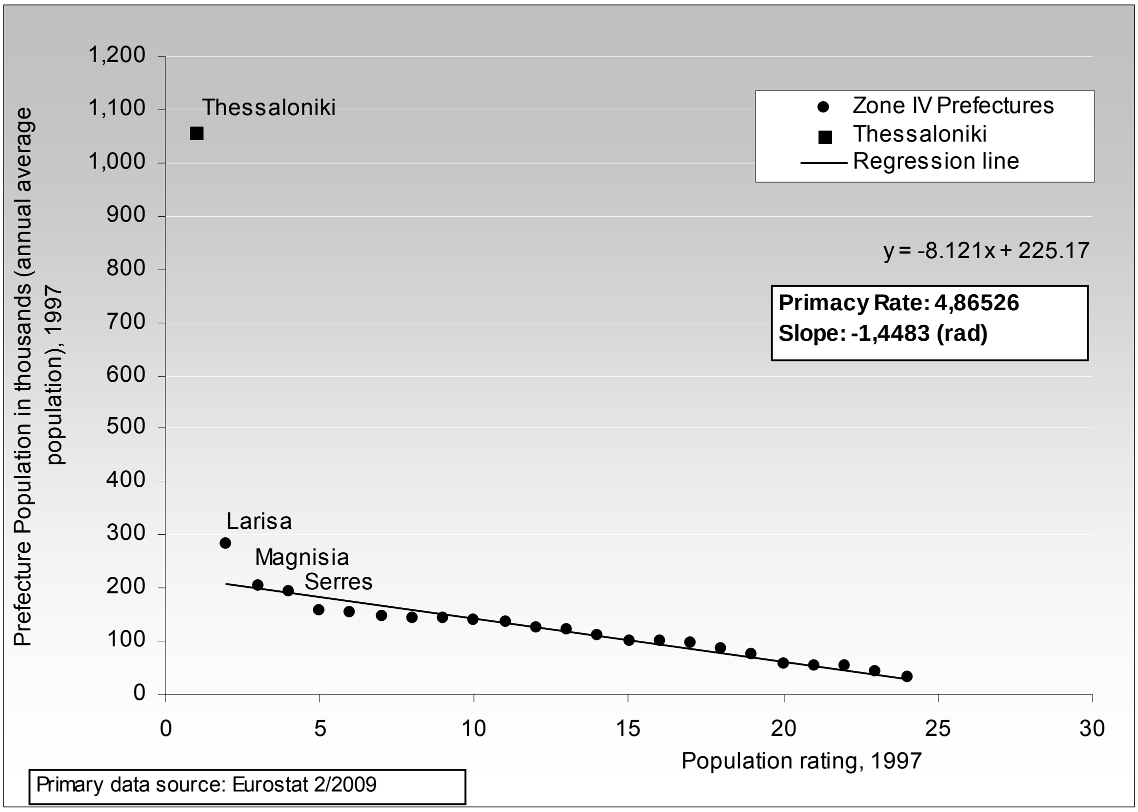
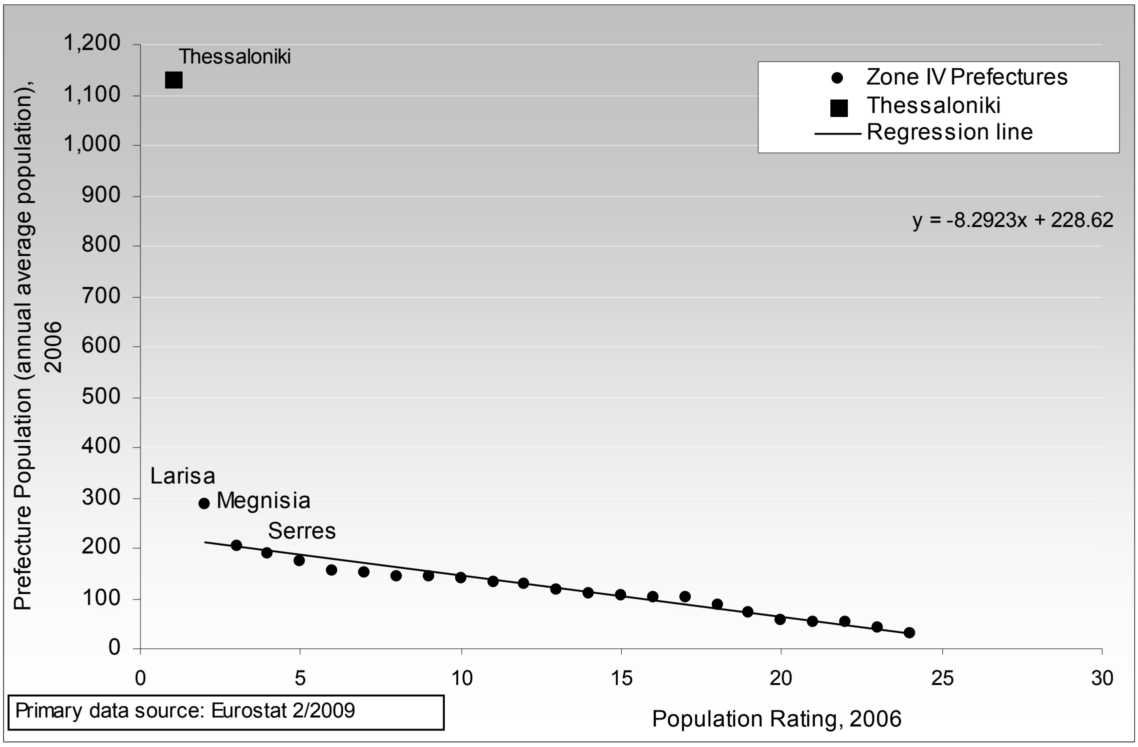


Figure 5. Linear regression between population and position in the rating, 2006



3.2.2. GDP

The Gross Domestic Product (GDP) is used to express the centres' size of the markets. Due to the lack of data on the GDP for urban centres or Municipalities, this indicator uses again the Prefectures as calculation territorial units. The methodology is the same as the one applied for population: Initially, the Prefectures are rated on the basis of their location hierarchy (table 4) and then follows a linear regression between the Prefectures' GDP and their location in this rating.

Table 3. Rating of the Prefectures in Zone IV on the basis of their GDP, 1997 and 2006

1997			2006		
Prefecture	**GDP in PPS[13]**	**Location**	**Prefectures**	**GDP in PPS**	**Location**
Thessaloniki	16,893.31	1	Thessaloniki	22,620.86	1
Larisa	3,664.72	2	Larisa	4,709.75	2
Magnesia	2,715.92	3	Magnesia	4,009.30	3
Serres	2,468.69	4	Ioannina	3,269.91	4
Ioannina	1,909.38	5	Kozani	3,051.10	5
Kozani	1,866.22	6	Evros	2,335.58	6
Evros	1,758.00	7	Serres	2,312.19	7
Pella	1,732.26	8	Kavala	2,233.91	8
Imathia	1,703.96	9	Imathia	2,195.99	9
Kavala	1,678.90	10	Pella	2,048.62	10

[13] According to Eurostat (Statistics in Focus, Theme 2, 56/2002), any cross-country comparisons of economic volumes based on the GDP of a certain year should use Purchasing Power Standards (PPSs). The same applies in this study in the case of cross-regional and cross-prefectural comparisons. It is assumed that a comparison using PPSs is preferable to one that is based on the euro, since its purchasing power may differ in different Prefectures.

1997			2006		
Prefecture	**GDP in PPS[13]**	**Location**	**Prefectures**	**GDP in PPS**	**Location**
Trikala	1,510.13	11	Pieria	1,760.82	11
Pieria	1,371.15	12	Trikala	1,757.16	12
Karditsa	1,358.20	13	Chalkidiki	1,755.58	13
Rodopi	1,293.85	14	Kilkis	1,676.48	14
Xanthi	1,099.18	15	Xanthi	1,520.68	15
Drama	1,076.87	16	Karditsa	1,384.41	16
Chalkidiki	988.74	17	Drama	1,366.19	17
Kilkis	963.80	18	Kilkis	1,277.66	18
Arta	690.37	19	Arta	940.88	19
Preveza	651.49	20	Preveza	888.10	20
Florina	649.37	21	Kastoria	845.29	21
Kastoria	620.87	22	Florina	840.40	22
Thesprotia	440.54	23	Thesprotia	688.07	23
Grevena	418.64	24	Grevena	541.85	24
Source: Eurostat, 2/2009					

Table 4. Percentage change in the GDP of the Prefectures in Zone IV

Rating position 1997	Prefecture	GDP percentage change in € 1997-2006 (in fixed 2000 values)
1	Thessaloniki	6.7%
2	Larisa	8.0%
3	Magnesia	26.2%
4	Serres	5.9%
5	Ioannina	35.8%
6	Kozani	4.7%
7	Evros	13.4%
8	Pella	0.6%
9	Imathia	6.7%
10	Kavala	13.9%
11	Trikala	13.1%
12	Pieria	12.0%
13	Karditsa	-8.6%
14	Rodopi	9.4%
15	Xanthi	12.7%
16	Drama	21.0%
17	Chalkidiki	-4.9%
18	Kilkis	29.5%
19	Arta	28.4%
20	Preveza	23.3%
21	Florina	9.5%
22	Kastoria	4.7%
23	Thesprotia	41.9%
24	Grevena	8.8%

The application of the linear regression results in a "primacy rate" indicator that expresses the degree of prevalence of the Prefecture with the highest GDP. In 1997, the value of this indicator for Thessaloniki was 6.217 and in 2006 increased to 6.30. Namely, as in the case of the population size, the prevalence of the Prefecture of Thessaloniki compared to the rest of the Prefectures in Zone IV, as far the size of the market is concerned, increases in the period 1997-2006. This phenomenon is related to the high rate of increase of the GDP in the Prefecture of Thessaloniki after 2000.

The regression slope between the GDP of the Prefectures and their position in the rating (Figures 6 and 7) is decreased from -1,56155 rad in 1997 to -1,56398 rad in 2006, which means that in the rest of the Prefectures in Zone IV the distribution of the GDP is improved. A high increase in the GDP are recorded in regional Prefectures (e.g. Thesprotia 41.9% and Ioannina 35.8%), which also profit the most from the improved accessibility resulting from the completion of the Egnatia Motorway.

With regard to the smaller in terms of population Prefectures crossed by the Egnatia Motorway, the changes recorded in the GDP are significantly greater than the increases in their populations, a fact which proves that, despite their small populations, these areas are improved as "economic centres".

Figure 6. Linear regression between the GDP of the Prefectures and their positions in the rating, 1997

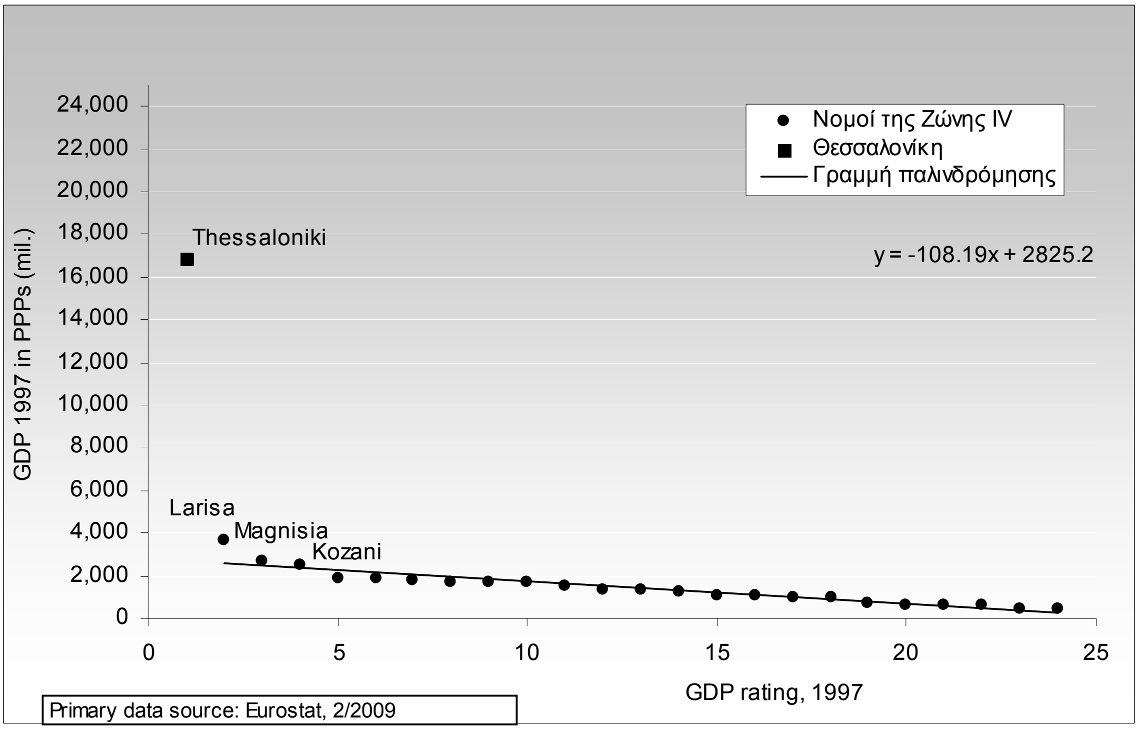
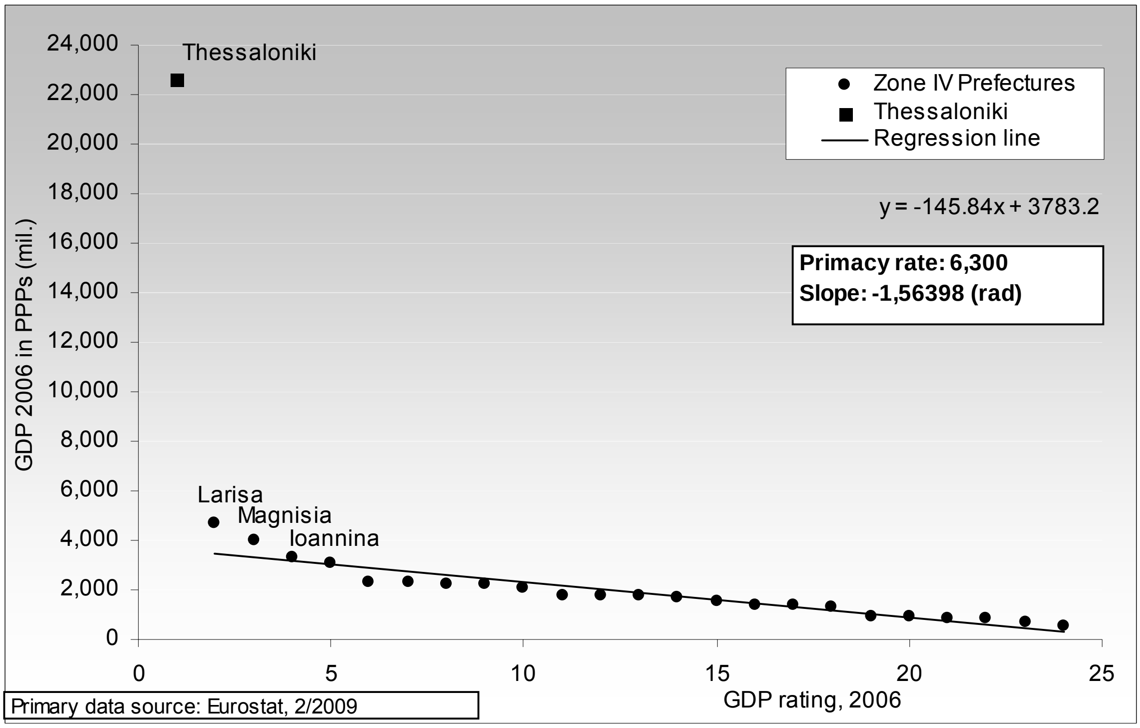


Figure 7. Linear regression between the GDP of the Prefectures and their positions in the rating, 2006



3.2.3. Population within a distance of 50km

With the operation of the Egnatia Motorway – vertical axes system, the population residing in a distance of 50km from the capitals of the Prefectures along the national and rural road network is changing, presenting significant percentage increase in the regional cities. The Gini coefficient expresses how much these populations differ from the equal distribution. In theory, this coefficient would be zero if all cities had the same population in a distance of 50km along the road network. This coefficient presents a decrease from 0,449 to 0,438, which shows that the operation of the Egnatia Motorway resulted in a trend towards balancing the populations residing in a distance of 50km from the cities. The most notable changes were recorded in the cities of Alexandroupoli (50.9% percentage increase), Komotini (32.8%), Grevena (13.7%), Igoumenitsa (11.6%) and Kastoria (8.9%). These changes show that the potential for development increases for the small and regional urban centres through the provision of services to larger, in terms of population, areas.

Table 5. Permanent population within a distance of 50km

City	Permanent population (2001) within a distance of 50km from the city "without"the Egnatia Motorway	Permanent population (2001) within a distance of 50km from the city "with" the Egnatia Motorway	Change (%)
Orestiada	73,769	73,769	0
Alexandroupoli	94,502	142,591	50.89
Komotini	170,321	226,199	32.81
Xanthi	258,756	259,416	0.26
Kavala	328,549	334,791	1.90
Drama	272,988	273,454	0.17
Serres	208,255	210,186	0.93
Thessaloniki (WATh)	1,249,242	1,258,631	0.75
Polygyros	135,803	137,075	0.94
Kilkis	958,374	993,052	3.62
Giannitsa	1,055,815	1,056,151	0.03
Alexandreia	1,196,049	1,197,694	0.14
Veroia	428,999	436,566	1.76
Naousa	281,344	281,344	0
Edessa	294,732	294,614	0
Katerini (MD)	336,309	336,309	0
Kozani	206,620	210,147	1.71
Ptolemaida	196,056	196,811	0.39
Florina	119,877	120,997	0.93
Kastoria	95,375	103,838	8.87
Grevena	105,203	119,638	13.72
Ioannina (MD)	158,687	163,504	3.04
Arta	124,915	124,915	0
Preveza	91,175	91,175	0
Igoumenitsa	48,399	54,032	11.64
Tyrnavos	303,606	303,606	0
Larisa	346,367	346,367	0
Trikala	257,257	266,484	3.59
Karditsa	266,484	266,484	0
Volos (MD)	218,982	218,982	0
Gini coefficient	**0.449**	**0.438**	
Source of primary data: NSSG, 2001			

3.2.4. Accessibility

Accessibility refers to the size the population flows between urban centres may potentially acquire and expresses the aspect of connectivity inherent in polycentricity. The Gini coefficient expresses how much accessibility of urban centres differs from equal distribution. In theory, this coefficient would be zero if all cities had the same accessibility. Based on existing measurements of accessibility of urban centres (Tranos, 2005), it was observed that the operation of the system Egnatia Motorway – vertical axes results in a decrease of the Gini coefficient of accessibility of urban centres from 0.3 to 0.2, which means that the operation of the Egnatia Motorway and the vertical axes help in making the contrasts between urban centres in terms of their accessibility less intense.

Table 6. Accessibility of urban centres

Urban centres	Potential Accessibility "without" the Egnatia Motorway	Potential Accessibility "with" the Egnatia Motorway
Thessaloniki (WATh)	1,276,936	1,401,747
Alexandreia	1,052,857	1,179,049
Katerini (MD)	848,158	1,123,727
Giannitsa	1,032,366	1,113,695
Veroia	885,070	1,105,322
Naousa	819,378	1,016,826
Kilkis	853,152	984,562
Polygyros	816,301	896,745
Serres	658,017	889,115
Larisa	700,244	882,546
Kozani	522,747	859,673
Edessa	781,169	843,229
Grevena	406,543	782,456
Ptolemaida	574,919	782,278
Tyrnavos	607,080	760,493
Volos (MD)	587,803	725,625
Kavala	524,329	720,557
Drama	552,788	711,159
Karditsa	533,163	673,775
Trikala	519,276	667,455
Kastoria	348,461	636,692
Xanthi	389,648	590,531
Ioannina (MD)	202,978	538,416
Komotini	312,538	499,551
Florina	418,826	498,624
Alexandroupoli	208,267	408,306
Arta	154,913	402,160
Igoumenitsa	103,038	401,156
Preveza	120,828	297,035
Orestiada	110,958	235,214
Gini coefficient	**0.300**	**0.207**
Correlation coefficient (ρ) with the population	**0.4431**	**0.4419**

The following charts show the linear regression between accessibility of urban centres and their population "without" (Figure 6) and "with" (Figure 7) the operation of the Egnatia Motorway and its vertical axes. The operation of the Egnatia Motorway and its vertical axes results in a decrease of the inclination of the regression slope from 0.64 rad to 0.6 rad. Namely, the inclination of the regression slope in relation to the axis x between the population of urban centres and their accessibility is decreased, which means that the operation of the Egnatia Motorway and its vertical axes resulted in an accessibility of urban centres that is less dependant from their size of population. This is also evident from the decrease of the correlation coefficient (ρ) between accessibility and population size.

Figure 8. Regression slope between the accessibility of an urban centre before the operation of the Egnatia Motorway and its population (2001)

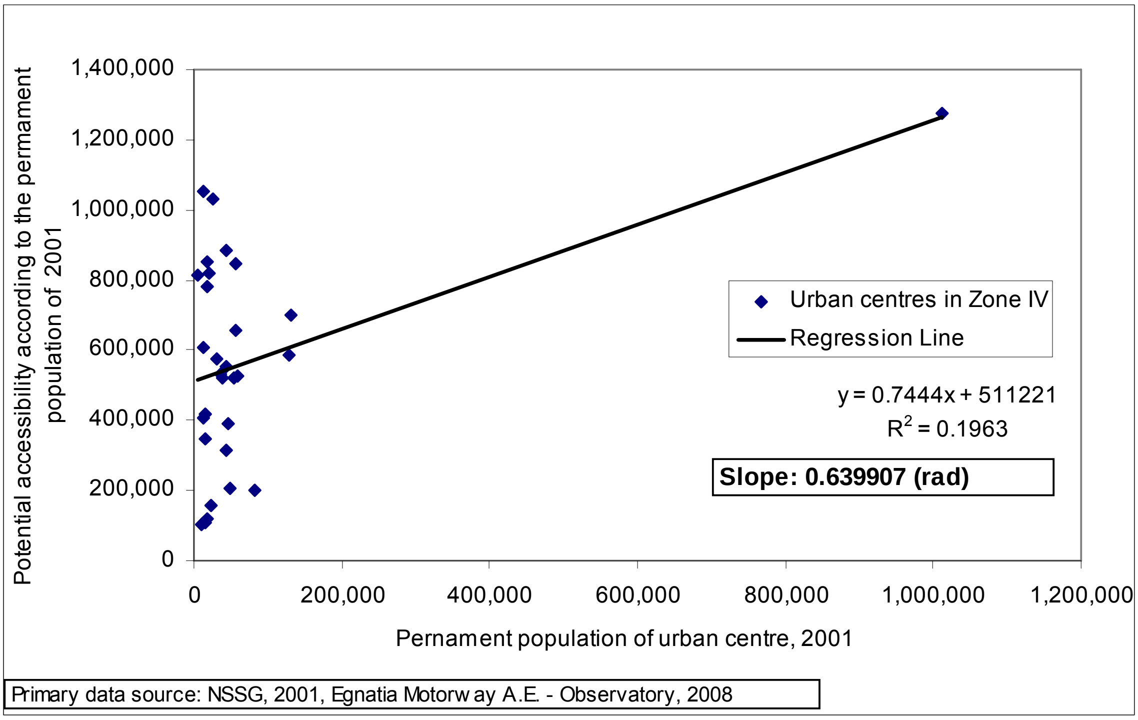
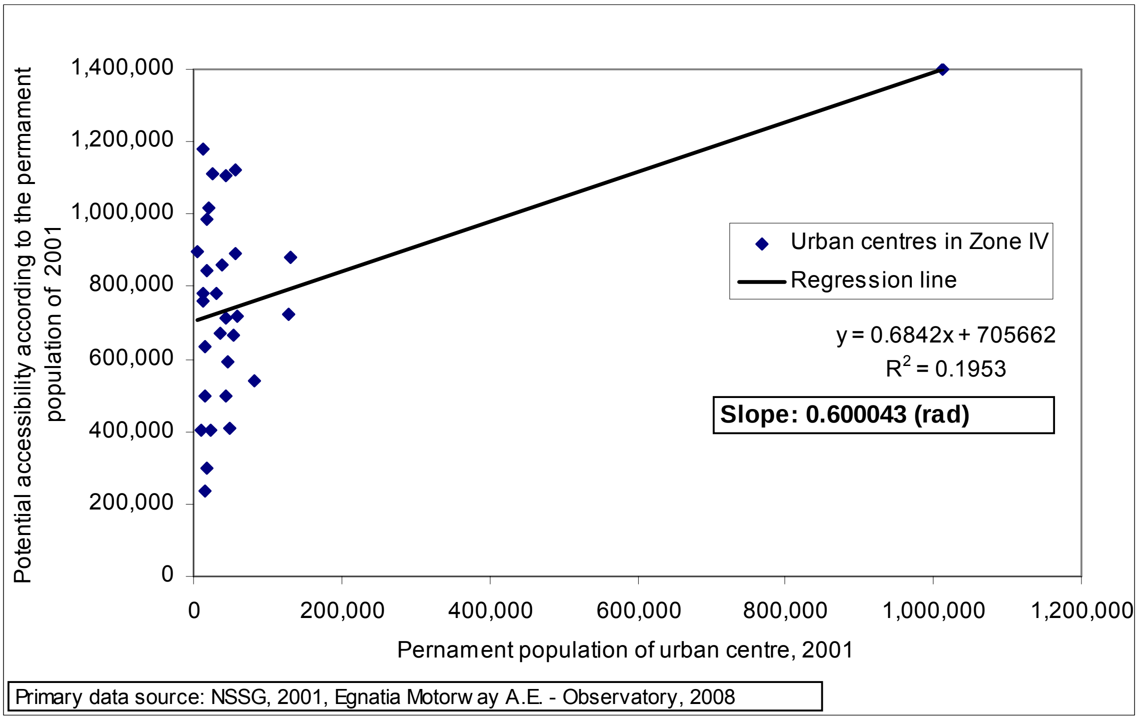


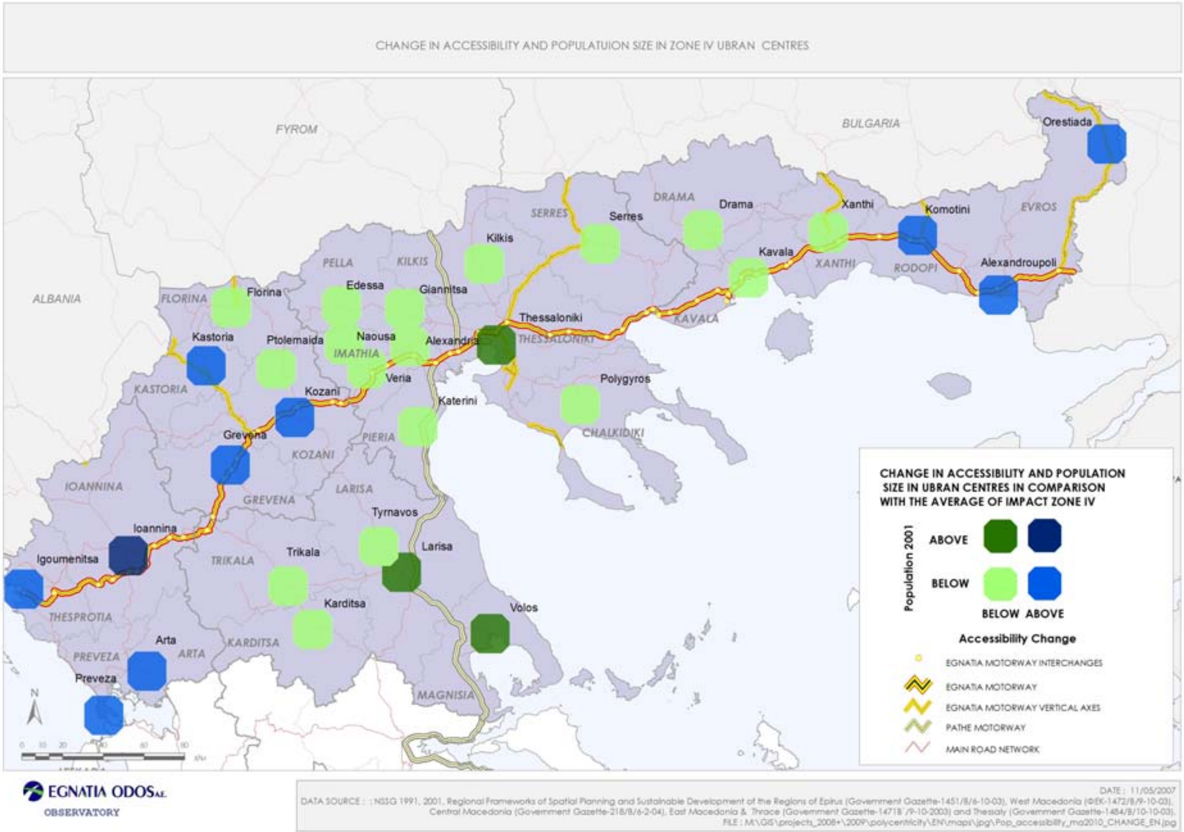
Figure 9. Regression slope between the accessibility of an urban centre after the operation of the Egnatia Motorway and its population (2001)



There follows a map indicating all changes in the relation between accessibility and population, since, besides studying the relation between accessibility and population, as expressed by the ESPON linear regression indicator, it is very important how this relation is formulated in space.

The largest urban centres in Zone IV are located along PATHE, the country's traditional development axis. These centres are large in population size, but benefit less from the operation of the Egnatia Motorway than the rest. These are the urban centres of Thessaloniki, Larisa and Volos, which are marked on the map in dark green. They are located in the top quartile as far as their population is concerned, but at the bottom in terms of any shifts in their accessibility. The operation of the Egnatia Motorway benefits more the centres which are geographically away from the traditional development axis and located in the top quartile in terms of any shift in their accessibility (light blue), but at the bottom one as far as their population is concerned, with the exception of Ioannina (dark blue).

Map 2. Changes in accessibility and population size in the urban centres of Zone IV



3.2.5. Trips – Special Functional Polycentricity

The total number of the average annual daily trips for 2006 between the counties crossed by the Egnatia Motorway that have urban centres within their territory was 49,113. For the same counties, the number of trips according to the national Origin-Destination study conducted in 1993 was 22,381. On the basis of the origin-destination matrices for the years 1993 and 2006, the parameters that are used to assess special functional polycentricity are calculated for the examined urban network for the years 1993 and 2006.

Table 7. Assessment of the special functional polycentricity, 1993 and 2006

Μέγεθος	Περιγραφή	1993	2006
σ_{∂}	Standar deviation of trips	1,224	2,187
L	Total number of average annual daily trips	22,381	49,113
Max	Maximum average annual daily trips	7,637	13,540
$\sigma_{\partial max}$	Standar deviation between Max and 0	5,400	9,574
$1 - \sigma_{\partial l} / \sigma_{\partial max}$	Quantity that expresses the trips' dispersion	0.77328	0.77153
L_{max}	Population of the Prefectures crossed by the Egnatia Motorway in thousands*	2,224.62	2,374.40
$\Delta = L / L_{max}$	Quantity that expresses the trips' density	10.06×10^{-3}	20.68×10^{-3}
$P_{sp}(N) = (1 - \sigma_{\partial l} / \sigma_{\partial max})\, \Delta$	Special Funcional Polycentricity	7.78×10^{-3}	15.96×10^{-3}

* Primary data sources: Eurostat, 2/2009. Eurostat data concern Prefectures' population after 1995. To estimate the population in 1993 the population of 1995 was reducted, using the annual average rate of the period 1995-2006.

In 2006, the sample of trips shows a slightly smaller dispersion compared to 1993, i.e. there are larger contrasts in the values of trips in various origin-destination zones. In 2006, trips are more concentrated between certain origin-destination zones than in 1993. The examination of the origin-destination matrices shows that this change is due to the high rises of absolute values of trips to and from Thessaloniki. However, this does not mean that mobility has been "transferred" towards the "core" of the area crossed by the Egnatia Motorway, i.e. towards Thessaloniki and Central Macedonia. The highest percentages of increase are recorded in inter-regional trips and, in particular, in trips between Thessaloniki and the cities of Thrace and Epirus[14]. As far as the density of trips is concerned, it was greatly increased in the period 1993-2006, its product with the dispersion of trips (i.e. the special functional polycentricity indicator) hence being increased despite the reduction recorded in dispersion.

The data on trips lead to significant conclusions pertaining to the networking of urban centres in the periphery. The aspects of networking that stand out are the following:

- The networking of the cities in Thrace. Trips between the cities of Xanthi-Komotini-Alexandroupoli were greatly increased both in absolute and in percentage values. So, there is an increase in the annual average trips by 370% (i.e. by 310 trips) between Alexandroupoli and Xanthi, by 270% (i.e. by 980 trips) between Alexandroupoli and Komotini, and by 81% (i.e. by 798 trips) between Komotini and Xanthi.

[14] see the results of the transport indicator TRA14 Characteristics of Vehicle Movements on the axis http://observatory.egnatia.gr/factsheets/fs_2009/en/TRA14_factsheet_2009_en.pdf

- The inter-regional networking of Thessaloniki. Trips between Thessaloniki and the urban centres of Igoumenitsa, Ioannina, Grevena, Kozani, Kavala, Xanthi and Alexandroupoli more than doubled in the examined period.
- The networking of the city of Veroia, both to the west with Kozani (an increase by 229% in percentage and 495 trips in absolute numbers) and Grevena (by 258% in percentage and 59 in absolute numbers), and to the east with Kavala (by 195% in percentage and 21 in absolute numbers).

4. Conclusions

Modern European and national policies aim at a polycentric structure in spatial development and one of the tools they employ towards this direction is transport infrastructures. In Greece, the role of transport and, mainly, road infrastructures in spatial development was and still is considered very important, a fact that is clearly stated in all official spatial plans. Taking into account methodological approaches adopted in studies regarding polycentricity and using as a basis the methodology applied by ESPON, this report formulates a method for the assessment of polycentricity adequately adapted to the main question set by the research, i.e. the assessment of polycentricity in Zone IV as an impact of the Egnatia Motorway-Vertical Axes system. Two dimensions, which according to the relevant theory express the concept of polycentricity, were selected: morphological polycentricity (size and location of centres) and functional polycentricity (connectivity between centres).

The changes resulting from the Egnatia Motorway – Vertical Axes system in terms of morphological polycentricity, which is expressed by the size and location of the centres and is, in general, rather difficult to change, are minor and cannot be easily characterized as positive or negative. On the contrary, very significant appear to be the impacts of the Egnatia Motorway – Vertical Axes system on the functional polycentricity of the urban centres' network in Zone IV.

In particular, with regard to the size of the centres, as expressed by the GDP and the population, all cities, except for Thessaloniki, present changes that slightly improve the polycentricity level in the urban network that comprises all other cities except for Thessaloniki. With regard to Thessaloniki, there is a trend towards the city's enlargement and an increase of its dominance is recorded compared to the rest of the cities in Zone IV both in terms of its population and its market size. If we exclude Thessaloniki, polycentricity in the rest of the system is improved with a significant increase recorded in relatively small –in terms of population- Prefectures (e.g. Xanthi, Chalkidiki, Pieria), but not in the smallest 5 ones. In these Prefectures (Grevena, Thesprotia, Kastoria, Florina and Preveza) the increase observed in their GDP is significantly higher than the increase in their population, an indication of their improvement as "economic centres" despite their low population.

It should be noted, though, that the population and GDP data concern the period 1997-2006, i.e. a period when the Egnatia Motorway – vertical axes system was not fully constructed yet and, therefore, the GDP and population indicators do not fully reflect the system's possible impact on them. With regard to morphological polycentricity, more clear are the results that concern the impact of the Egnatia Motorway – vertical axes system on the benefited population that was selected as a "location indicator". The operation of the system results in a more equal distribution of the benefited populations between the urban centres in Zone IV, while the smaller urban centres are now far more able to service the neighboring areas and become larger by providing more functions to them.

The most crucial conclusion drawn from this study results from the potential contribution of the examined transport system to the observed functional polycentricity. As analysed in the literature review, modern theories of spatial planning argue that polycentricity is, to a great extent, a function of connectivity, i.e. the frequency and form of the flows between "centres". The assessment of these parameters indicates that the Egnatia Motorway (and its vertical axes) improves accessibility and increases mobility between urban centres thus directly contributing to the functional polycentricity in its Impact Zone.

This is proved in two ways: First, a higher connectivity potential provided by the system significantly increases accessibility for all cities in Zone IV and presents high corresponding percentage increase in smaller cities. As a result, differences between urban centres in terms of accessibility become smaller. Second, the flows between urban centres become larger (which is reflected by an increase in the average annual daily traffic). Although the equal distribution of flows in space is not improved, what is positively affected is special functional polycentricity, in particular as a function of the size of the trips that have significantly increased.

This study mainly constitutes an attempt to develop a methodological framework for the assessment of the impacts of new transport infrastructures on crucial spatial phenomena, such as polycentiricity, which are focal points in modern spatial policies both on a European and a national level. Since the data studied for the application of this methodological tool concern a period when the examined transport system was under construction and not in full operation, the exact results have, obviously, a relative importance. Nevertheless, they underline the need to connect transport planning with spatial planning. This study clearly shows that these infrastructures improve connectivity between centres, both inter- and intra-regionally, changing polycentricity, a concept very crucial in spatial development, since it expresses the potential of urban centres.

This identification of a system of centres that have a potential for connectivity and development of functional relations, and cover the whole zone of Northern Greece, some times between neighboring centres (e.g. Ioannina–Igoumenitsa, Kozani-Veroia, Xenthi-Komotini-Alexandroupoli) and other times between the main urban centre of Northern Greece and the more remote dynamic urban centres (in the Regions of Epirus and Eastern Macedonia-Thrace), shows that new infrastructures can contribute to the emergence of adequate prerequisites for new forms of spatial organization. The degree of this contribution, though, depends not only on transport infrastructures but also on the spatial policies and how these are applied throughout Greece.

The changes that can result from an improved connectivity may also affect the polycentricity model that applies between the major and minor centres in a Region, causing new connections to emerge leading to a new organization and positioning of activites and services. An increase in functional polycentricity due to the operation of the Egnatia Motorway and vertical axes system may lead to an upgrading of the relative position of smaller and more regional cities and settlements.

Apart from the above, it is very important to further investigate in the future the contribution of the Egnatia Motorway and vertical axes system to polycentricity in the borderline area of Northern-Eastern Europe, a parameter that can significantly help in a balanced development of the region and an improvement of its competitiveness and cohesion with the rest of the European space.

Finally, crucial data that would help this study on polycentricity on all the aforementioned spatial levels to continue have to be derived from an Origin-Destination survey, which will record the frequency and the characteristics of trips – flows; these data will then be related to spatial organization issues, in order to accurately have the basic trends. Such a study would also be useful in the regional spatial planning that may be modified through a reviewing of the Regional Frameworks of Spatial Planning and Development.

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APPENDIX

THEMATIC ESPON REPORTS CONCERNING POLYCENTRICITY – PROJECT PARTNERS

ESPON Project 1.1.1: Potentials for polycentric development in Europe, Luxembourg: ESPON Monitoring Committee, 2005

Project Partners

Nordregio (Stockholm, Sweden) (Lead partner)
Danish Centre for Forest, Landscape and Planning (Copenhagen, Denmark)
OTB - Research Institute for Housing, Urban and Mobility Studies, Delft University of Technology (Delft, the Netherlands)
CNRS-UMR Géographie-cités (Paris, France)
Centre for Urban Development and Environmental Management CUDEM, Leeds Metropolitan University (Leeds, UK)
Austrian Institute for Regional Studies and Spatial Planning (ÖIR) (Vienna, Austria)
Spiekermann & Wegener, S&W (Dortmund, Germany)
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Norwegian Institute for Urban and Regional Research (NIBR) (Oslo, Norway),
Institute for Territorial Development and Landscape (IRL) Swiss Federal Institute of Technology (Zurich, Switzerland)
Hungarian Institute for Regional and Urban Development and Planning, VÁTI (Budapest, Hungary)
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ESPON Project 2.1.1: Territorial impact of EU transport and TEN policies, Luxembourg: ESPON Monitoring Committee, 2004

Project Partners

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Vrije Universiteit (Amsterdam, Netherlands)
Department of Infrastructure, Kungl Techniska Högskolan (Stockholm, Sweden)
Centre for European, Regional and Transport Economics (Kent, UK)
Bundesamt für Bauwesen und Raumordnung (Bonn, Germany)
Furthermore the Institute of Transport Economics, Oslo, Norway and the Federal Office for Spatial Development, Bern, Switzerland, have contributed to the research.

ESPON Project 1.2.1: Transport services and networks: territorial trends and supply, Luxembourg: ESPON Monitoring Committee, 2004

Project Partners

University of Tours (Tours, France) (Lead partner):
Institut National de Recherche sur les Transports et leur Sécurité (INRETS) (Lille, France)
MCRIT (Barcelona, Spain)
Nouveaux Espaces de Transport en Europe (NESTEAR) (Gentilly, France)
Politecnico di Milano (Milano, Italy)
Spiekermann & Wegener (S&W) (Dortmund, Germany)

ESPON Project 1.1.3: Enlargement of the EU and its polycentric spatial structure, Luxembourg: ESPON Monitoring Committee, 2006

Project Partners

KTH, The Royal Institute of Technology (SWEDEN) (Lead Partner):
Faculty of Civil and Geodetic Engineering, Chair of Spatial Planning, Ljubljana (FGG) (SLOVENIA)
Institute of Geography and Spatial Organization (IGSO), Polish Academy of Sciences (POLAND)
Centre for Advanced Spatial Analysis (UCL) (UNITED KINGDOM)
National Technical Univ. of Athens (NTUA) (GREECE)
Spiekermann & Wegener, Urban and Regional Research (S&W) (GERMANY)
Austrian Institute for Regional Studies and Spatial Planning (ÖIR) (AUSTRIA)
Global Urban Development (formerly the Prague Institute for
Global Urban Development) (CZECH REPUBLIC)
Centre for Urban and Regional Development Studies, Ltd. (CEDRU) (PORTUGAL)
IRER, University of Neuchâtel (SWITZERLAND)
Karelian Institute, University of Joensuu (FINLAND)
TNO Inro (THE NETHERLANDS)
Hungarian Public Nonprofit Company for Regional Development and Town Planning (VÁTI) (HUNGARY)
Nordregio (SWEDEN)
Swedish Institute for Growth Policy Studies (ITPS) (SWEDEN)

ESPON Project 1.4.3: Study on Urban Functions, Luxembourg: ESPON Monitoring Committee, 2007

Project Partners

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Institute of Geography and Spatial Organization (IGSO) – Polish Academy of Sciences (Poland)
Laboratoire Techniques, Territoires, Sociétés (LATTS) Ecole Nationale des Ponts et Chaussées (France)
Experts:
Department of Geography, Tourism and Territorial Planning (TSA), Oradea University (Romania)

ESPON Project 1.4.4: Study on Feasibility on Flows Analysis, Luxembourg: ESPON Monitoring Committee, 2007

Project Partners

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