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THE CONTRIBUTION OF TRANSPORT INFRASTRUCTURES TO THE ECONOMIC AND REGIONAL DEVELOPMENT: A REVIEW OF THE CONCEPTUAL FRAMEWORK

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Abstract
Transport infrastructures are a major drive for achieving economic development at all geographical scales, and particularly at the regional and local level, at which the units of the spatial economic systems are usually configured. In the current literature, a great number of studies have dealt with the relationship between transportation and economic development and a considerable amount of them have revealed different aspects of the transport infrastructures' contribution to the local and regional development, highlighting the complexity and the importance of this symbiotic relationship. Within this context, this paper discusses, in a theoretical context, this contribution and it develops an integrated framework for the conceptualization of how transport infrastructures contribute to the economic and regional development. This is achieved, first, by distinguishing the main categories of transport infrastructures and, secondly, by reviewing the established regional development and economics theories that build on the relationship between transport infrastructures and regional development. Further, the paper reviews the main factors affecting, either directly or indirectly, this contribution and the determinants of the size and direction of the effects transport infrastructures contribute to the economic and regional development. Overall, the paper highlights the importance of transport infrastructures policy as a tool of regional and economic policy.
Keywords: economic growth, transport economics, transport policy, regional policy.

1. INTRODUCTION

One among the main objectives of the public policies targeting at national and regional development is the development of conditions for improving productivity. A key tool for achieving this goal is to invest in transport infrastructures, since transportation is a major component of economic growth, promoting communication, trade, and development (Polyzos, 2005; Handy, 2008; Tsiotas and Polyzos, 2018). In general, the impact of infrastructures on a regional or a local economy is ruled by complexity associated

with the type of infrastructures and with the specific features of the economy. In the current literature (Sasaki et al, 1987; Vickerman et al, 1999; Rodrigue et al., 2013; Allroggen and Malina, 2014; Tsiotas and Polyzos, 2018; Polyzos, 2019), there is a general consensus on the positive impacts of the infrastructures on the regional development, but there are distinctive differences related to the volume or to the significance of this impact. In particular, such differences mainly concern the scale of the infrastructures that should be developed in each regional economy (Sasaki et al, 1987; Vickerman et al, 1999; Polyzos, 2019), the type of infrastructures (hard or soft infrastructures) in terms of their effectiveness in promoting regional development (Polyzos, 2019), and the framework of the economies in which infrastructures are installed (Rodrigue et al., 2013). Further, there are some key issues that are of particular interest in the regional and infrastructures planning, all of which concern the impact (or the interaction) that these infrastructures have on their regional areas (Fayman et al., 1995; Vickerman et al. 1999; Spiekermann and Wegener, 2006; Venables et al. 2014; Tsiotas and Polyzos, 2018). One aspect regards the spatial dimensions and the range of that impact (Tsiotas and Polyzos, 2018), another regards its economic features (e.g. in terms of productivity and competitiveness) (Rodrigue et al., 2013; Polyzos, 2019), another the differentiations in these impacts due to geographical scale (i.e. upgrading an urban road can improve the life-quality of citizens, while upgrading an interregional road can improve both the life-quality and the productivity of the local economy), and a final the degree of utilization by its users (depending on the size, the scale, and the demand for the services provided by the infrastructure).

As evident from the literature (Vickerman et al. 1999; Banister and Berechman, 2001; Spiekermann and Wegener, 2006; Venables et al, 2014; Tsiotas and Polyzos, 2015a,b; Polyzos, 2019), transport infrastructures are a type of infrastructures of major importance because, for the most of the developed and developing countries, they account for the largest proportion of the budget of any public-works program. Investments in transport infrastructures have a significant impact on the economic activity of each region associated with these infrastructures. In the long-run, improvements in the accessibility and mobility can cause broad effects on the economies and the societies of the associated regions and they can also affect the geography of these economic activities, the urban configuration of land-uses, the efficiency of the economic activities, and the regions' competitiveness (Banister and Berechman, 2001; Venables et al, 2014). The relation of transport infrastructures with space is symbiotic, since such infrastructures influence distance and thus they affect interdependence or the interaction of the regional activities conducted in space (Spiekermann and Wegener, 2006). For each country, the safe, timely, low-cost, and environmental-friendly transportation of goods and people requires the development of transport infrastructures, which affect the regional economic configuration and the territorial cohesion of

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the country. This relation is multivariable and rather complex and it is particularly difficult to predict the outcome of the changes that an investment in transport infrastructures will have, which may be rather diverse, ranging from a polarizing or decentralizing to a centralizing process (Fayman et al. 1995; Vickerman et al. 1999; Polyzos et al., 2008; Polyzos, 2009; Venables et al, 2014), even under the same initial conditions.

Within this context, the purpose of this paper is to develop a framework for examining changes in regional economy induced by the construction of transportation infrastructures and to provide a theoretical basis for a quantitative ex-ante assessment of such changes. Provided that an efficient future planning of a transportation infrastructures depends on a profound conceptualization of the current dynamics on transportation, communication, and socioeconomic systems (Handy, 2008; Tsiotas and Polyzos, 2018), this paper provides a context contributing to this conceptualization and understanding. Taking into account that transport infrastructures promote regional and local development, this theoretical context may support quantitative approaches studying the relationship of transport infrastructures and regional development.

The remained of this paper is organized as follows: section 2 provides a brief description of the basic categories of transport infrastructure, section 3 provides a classification of the effects of transport infrastructures in terms of immediacy and redistribution, section 4 describes the key factors affecting the volume and direction of the changes due to transport infrastructures, and in section 5 conclusions are given.

2. TYPES OF TRANSPORT INFRASTRUCTURES

With reference to the space of transportation but without referring to the transportation modes, transport infrastructures can be distinguished in the existing literature (Allroggen and Malina, 2014; Button et al., 2010; Mukkala and Tervo, 2013; Polyzos and Niavis, 2013; Rodrigue et al., 2013; Tsiotas and Polyzos, 2015a,b; Tsiotas et al., 2019) into four categories, namely air-transport, port, rail, and road transportation infrastructures, as it is shown in Figure 1. First, air-transport infrastructures (including the terminals, such as small or large airports) are a major factor for the regional development and particularly due to the increasing globalization affecting economies their role has become increasingly important. The main advantages of air-transport infrastructures regards their transportation speed, whereas their main drawbacks concern their high transportation cost, their restricted ability in bulk-cargo transportation, and their low flexibility due to scheduled routes (Button et al., 2010; Mukkala and Tervo, 2013; Tsiotas et al., 2019). Next, port infrastructures (including the terminals, such as small or large ports) are developed on sea, coastal, and river environments and they excel for their low-cost over long

distances and for their ability to transport large quantities or bulky goods. On the other hand, their disadvantages concern their low speed and flexibility on rerouting, as well as the inability to serve land-areas (Polyzos and Niavis, 2013; Tsiotas and Polyzos, 2015a,b). Next, rail-transport infrastructures (including the terminals, such as rail networks and local train stations) benefit due to low transport cost, to their safety and transport comfort, as well as to their potential of mass transportation. On the other hand they fall short for their low flexibility, as a transport system, due to their rail-dependent movements and to scheduled routes (Rodrigue et al., 2013; Tsiotas, 2017a). Although rail transport is considerably much more environmentally friendly and safer than road transport, it is not competent to the latter, in both the passenger and freight markets, because of its low flexibility due to mass transportation and scheduled routes (Kasraian et al. 2016). Finally, road-transport infrastructures, which comprise all the road networks of a region or a country, are the largest and most used transport infrastructures among all the others. Their advantages over the other types regard flexibility, door-to-door services (e.g. freight forwarding and delivery without the need for transshipment), high itinerary frequency, ease of use, low transportation cost, and speed and transportability over short distances. Their main disadvantages concern high transport-costs over long distances and high maintenance-costs (Rodrigue et al., 2013; Tsiotas, 2017b). In general, rail and road transportation belong to land transport. In the European Union (EU), road transport accounts for about 75% of the total land transport, whereas maritime transport is of great importance for European trade, as around 90% of the external and 40% of the European Union's inland freight transport is conducted by sea (Eurostat, 2018).

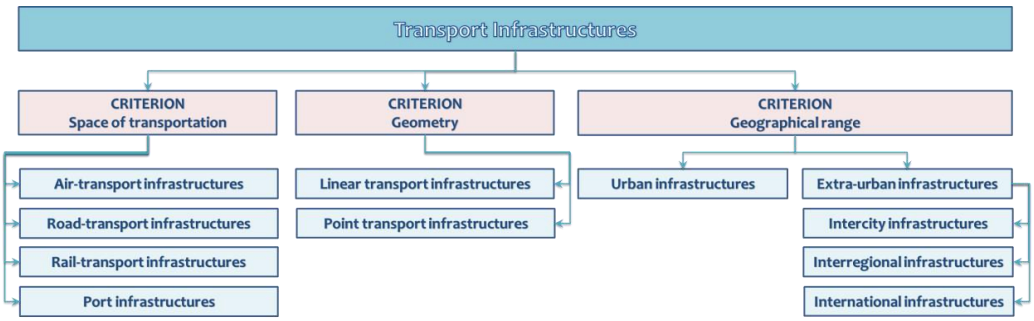

FIGURE 1 - TYPES OF TRANSPORT INFRASTRUCTURES.

Two other major distinctions that can be found in the literature (Rephanm, 1993; Rietveld, 1994; Spiekermann and Wegener, 2006; Polyzos, 2009; Rodrigue et al., 2013; Polyzos, 2019) are based on geometry and geographical range to which transport infrastructures are developed. According to the first criterion (geometry) can be further subdivided to another pair of subcategories, to the linear infrastructures (Rodrigue et al., 2013; Polyzos, 2019), which consists of road (Tsiotas, 2017b) and rail (Tsiotas, 2017a) infrastructures, where transportation is conducted within channels (constructed routes), and to the point infrastructures (Rodrigue et al., 2013; Tsiotas and Polyzos, 2018; Polyzos, 2019), which

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consists of port and airport infrastructures, where their constructed elements are only terminals and stations and not the routes. According to the second criterion (geographical range) is discriminated by the urban scale and it is divided into the subcategory of urban infrastructures (Polyzos, 2015, 2019), which includes all transport infrastructures developed within the urban scale, and the subcategory of extra-urban infrastructures, which includes intercity, interregional, and international transport infrastructures (Rodrigue et al., 2013), developed over the city scale. This distinction is of particular importance for the analysis of the contribution of transport infrastructures to regional development. For instance, point transport-infrastructures are exclusively related to the area where they are located (Polyzos, 2019), since they link this area to others with further infrastructures and they generally enhance this area in spatial competition. In contrast, interregional and international transport infrastructures link two or more regions and thus they affect the spatial interdependence of the associated regions and of their wider system. Changes in transport infrastructure this category induce consequent changes to inter-regional distances and to the current spatial equilibrium, making it difficult to predict effects.

3. CLASSIFICATION OF THE IMPACT OF TRANSPORT INFRASTRUCTURES

Current literature in the impact of transport infrastructures on economic development at all geographical levels of scale (national, interregional, regional, and local) (Polyzos, 2009; Rodrigue et al., 2013; Polyzos et al., 2015; Polyzos, 2015, 2019) highlights the complexity and the diversity in which this issue is examined. These diverse approaches are obviously due to the differences in the socioeconomic and other characteristics of each region, but also due to the differences in types of infrastructures. For instance, the effects of an airport in a region are different than these of a national road or port. The level of regional development, the regions overall socioeconomic, geographical, and other characteristics, the dependence of the regional economies on transportation-costs, the regions' competitiveness in the national and international markets, and other factors, such as the type and size of the infrastructure results, result to a different level of integration of the transport infrastructures to their regions (Polyzos, 2009; Polyzos et al., 2015).

According to relevant theoretical and empirical studies (Rietveld, 1994; Bronzini and Piselli, 2009; Polyzos, 2009; Venables et al, 2014; Tsiotas and Polyzos, 2018), the impacts (or the changes) caused by transport infrastructure on the regional and local economies can be studied based on different criteria, which are briefly described as follows.

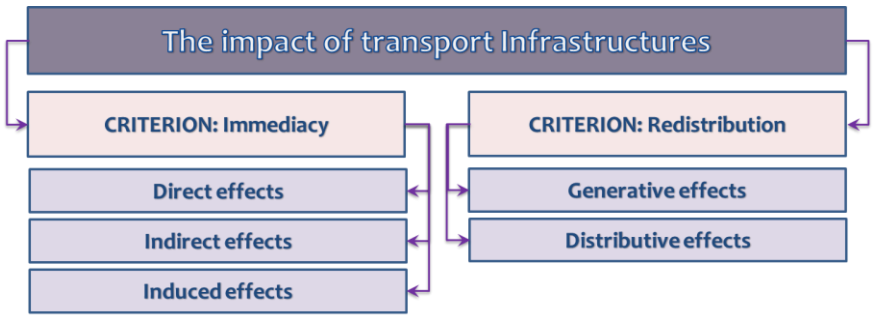

FIGURE 2 - CLASSIFICATION OF THE IMPACT OF TRANSPORT INFRASTRUCTURES.

(a) Classification based on directness.

Based on directness, the effects coming from the functionality of the transport infrastructures can be divided into direct, indirect, and induced effects. The first category (direct effects) concerns the impacts (or the changes) coming directly from the use of transport infrastructures and they mainly concern the so-called "user-benefits" (Venables et al, 2014; Polyzos, 2019). The user-benefits are described by both quantitative features (e.g. cost, time, and reliability) and qualitative features (e.g. comfort and security). On the other hand, the indirect effects are not caused by the use of transport infrastructures per se, but by the activities depending on the main change to infrastructures. Finally, the induced effects emerge as an effect of the main change caused to the transport infrastructures (Venables et al, 2014). The distinction between the indirect and induced changes is not an easy task, since many cases may have at the same time indirect and induced features. To highlight this difficulty, a number of cases are described below, such as (Rietveld, 1994; Venables et al, 2014) the improvement of the citizens' living standards due to greater mobility, the increase of the purchasing power due to lower transport-costs, the better access to markets, to education, to health, to entertainment, and to other social services, the changes in employment, wage levels, and in the consumption in the region, and the improvement (or deterioration) of environmental characteristics affecting (either positively or negatively) the quality of life.

(b) Discrimination on the basis of redistribution.

Based on redistribution, we can distinguish the impacts (or economic effects) of transport infrastructures into generative and distributive (Bronzini and Piselli, 2009; Polyzos, 2009; Venables et al, 2014; Polyzos, 2019). The first category regards cases causing positive change to the economic indicators (contributing to economic growth) and it is exclusively related to those regions that are directly linked to the infrastructures. In this category, the main effects are first the direct savings of the transport-costs in the regions utilizing the infrastructures. Transport-costs can be easily expressed in monetary terms (e.g. fuel-costs, tire-costs, capital-costs, time-costs, etc.) or they may require some assumptions and

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calculations (e.g. accident-costs, shipping reliability, travel safety, travel comfort, pollution, fatigue, stress, etc.). The requirement for a unique expression of the transport cost by using a single expression has led to the emergence of the so-called "generalized transport cost" (Venables et al, 2014). Another effect is the increase of regional productivity, which is achieved by the diffusion of technology and of knowledge from the big cities (which usually are technology or production centers) to the periphery. At the same time, productivity improvements derive from the direct savings of transport-costs, since the cost savings of transportation are shifted to the businesses production-costs (Bronzini and Piselli, 2009; Polyzos, 2009; Venables et al, 2014). By default, savings in transport-costs are applicable by the infrastructure's startup, whereas changes in productivity appear afterwards (Venables et al., 2014). Measuring the user benefits is a major approach for evaluating the investments in transport infrastructures but also the indirect effects are, by considering their contribution to the national development. However, this approach ignores the regional dimension of the effects and the so-called regional problem (Venables et al., 2014). Relevant literature (Bronzini and Piselli, 2009; Polyzos, 2009; Venables et al, 2014; Polyzos, 2019) suggests that the economic impacts of transport infrastructures can be significantly greater than those estimated to be by project-appraisal methods. It should be noted that in the evaluation process particular attention is given to the user benefits and to easily measurable impacts. Therefore, a broader view of those impacts should also include the secondary impacts that are of particular importance to the economy of a region.

The second category includes the indirect and induced changes that are redistributive, namely those changes that do not generate but they redistribute the development throughout the space. Generally, redistribution is a conservative process, implying that the sum redistributive changes for all regions will be zero, since any positive effect to one region induces equal a negative effect to the others. Therefore, any regulatory reinforcement of these changes will lead to a consequent balance to the total of regions, so that all redistributive changes will eventually become zero. By grouping the type of redistributive changes, we can distinguish (Leung, 2006) the exploiting of endogenous advantages (physical, social, economic), the transfer from other productive regions (capital, labor, technology), the change in the direction of tourist flows (which follows the construction of new transport infrastructures, the reduction of transport-costs, and the change of the accessibility of tourist areas), and the change in the origin and destination of the trade flows or services. The overall change in the development of each region results by the sum of the individual, positive and negative, and derivative and redistributive effects that will occur after the transport infrastructure is set operational. Figure 1 illustrates those economic changes and their interdependencies in a conceptual diagram.

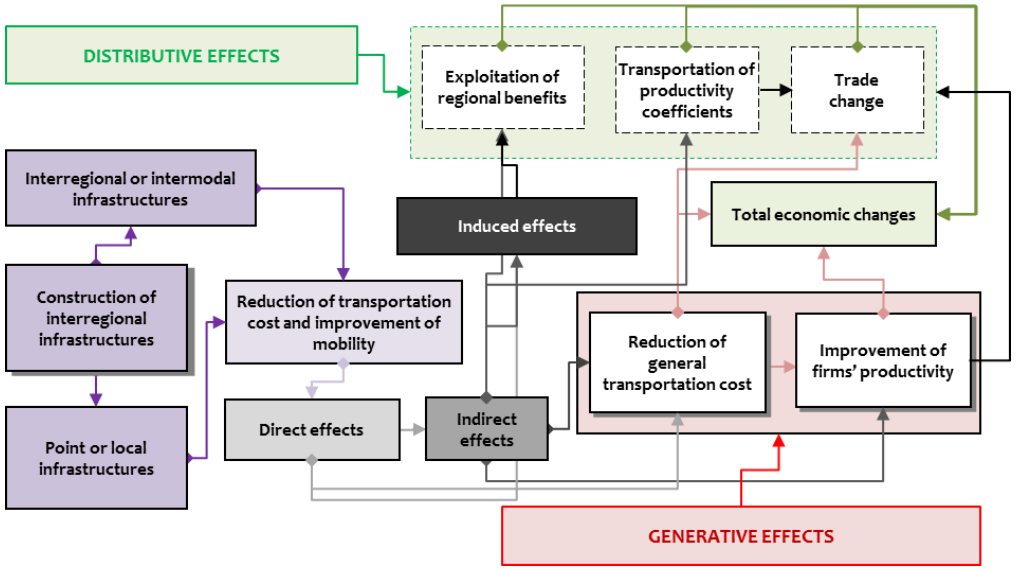

FIGURE 3 - CONCEPTUAL DIAGRAM WITH THE CLASSIFICATION AND INTERACTION OF ECONOMIC CHANGES.

Another distinction that can be made for the economic impact of transport infrastructures, without considering the immediacy, the redistributive nature, and the evaluation process of a transport project is into microeconomic impact, concerning changes captured at micro (business or household) level and macroeconomic impact, concerning changes captured at macro (e.g. contributions to GDP, investment or employment and spatial patterns of economic activity) level (Leung, 2006). Any quantitative assessment about the impact of transport infrastructures on the economic development of regions requires a clear distinction of the economic changes, in terms of their direction or their redistributive character. This requires precision in the measurement of the redistributive changes in order to estimate the positive and negative effects that will emerge in each region. In some cases, the difference between derivative and redistributive changes is difficult to be distinguished, such as in the case of technological diffusion, which is an induced but at the same time and redistributive effect (it affects the interregional trade), while the exploitation of endogenous advantages can cause redistributive effects (e.g. spatial redistribution of tourist flows) but can also generate development (e.g. exploitation of mineral wealth) (Rietveld, 1994; Polyzos, 2005).

Another point of particular interest for the regional science is the inter-regionality and the intra-regionality of transport infrastructures (Polyzos, 2009, 2019). In particular, the first case concerns the reduction of distance between two or more regions which induces consequent changes to the regional economies, to their functional cooperation, as well as to their spatial competitiveness. An indicative example of such changes is shown in Figure 2, where nodes in the graph-based model represent regions and links represent interregional relations.

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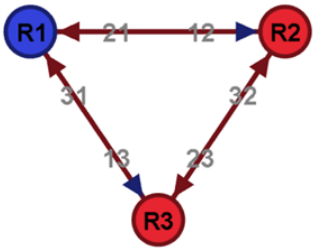
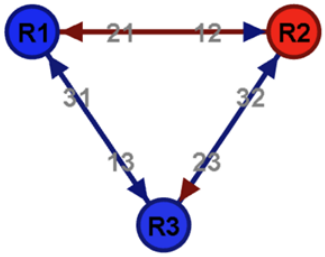


(i) Distance reduction between R_2 and R_3 and increase of competitiveness of R_2 and R_3



(ii) Decrease of intraregional distance of R_2 and increase of R_2 competitiveness.

FIGURE 4 - EFFECTS INDUCED TO REGIONS DUE TO THE DECREASE OF (I) INTERREGIONAL AND (II) INTRA-REGIONAL DISTANCE.

According to Figure 2, the decrease of the interregional distance between regions R2 and R3 favors these regions (participating to the distance d(R2,R3)), which consequently reduce their transport-costs, their productivity-costs, and their competitiveness against the region R2. At the same time, these regions reinforce their functional cooperation and competition. On the other hand, case (ii) only favors the R2 region, which consequently reduces its intra-regional and productivity-costs along with its competitiveness against the other regions. This example illustrates that distance change (either between two or more regions or within one region) induces consequent changes to the regional economy. Although it is obvious to identify such changes based on intuition, under the perspective of regional science, these changes should be measured and well defined in quantitative terms (Rodrigue et al., 2013; Tsiotas and Polyzos, 2018, Polyzos, 2019; Tsiotas, 2019). In order to calculate the total volume of changes, for each region, the overall sensitivity of each regional activity along with the change in transport-costs should be taken into account.

In each regional economy, there are certain characteristics determining the contribution of transport infrastructures to the regional development. Such characteristics are related to the technological and other characteristics of production, to the products type in terms of marketability, and to the geographical features and the structure of the market. Different types of regions and productivity sectors are not affected at the same level by the construction of transport infrastructures. However, the ex-ante computation of the direction of the changes that are related to the construction of transport infrastructures is a difficulty task. For example, the link between an (economically) small region and a strong region is likely to induce short-term negative effects on the regional economy of the small region due to the competition increase and to the dominance of the strong region's economy. The comparative and the competitive advantages of the strong region will be those determining the volume of the (either positive or negative) effects to the small region on the competition balance between them. However, in

the long run, this transportation link may favor the diffusion of technology from the strong region (center) to the small region (periphery) and consequently to contribute to the increase of the productivity of the small region (Polyzos, 2006). Therefore, both positive and negative effects on the economy of the less powerful region can occur, the intensity of which will configure the final profile to the overall effects.

Based on the previous remarks, the direction where the changes between regions occur will be further discussed. First, the generalized and the induced changes (emerging as a direct result of the reduction of transportation-costs) attain by default positive sign and thus no further discussion about their direction is necessary. However, this is not the case for the redistributive changes, which show a rather complex behavior in their direction. In particular, regions exploiting their endogenous advantages will enjoy positive changes in their economies due to the construction of transport infrastructures. Less developed activities, such as tourism, and exploitation of natural resources, will have a chance to develop and they will induce a consequent development of the positively affected regions (Polyzos et al., 2014, Tsiotas and Polyzos, 2018). As far as the productive activities are concerned, changes in infrastructure-related regions will be positive. All the location theories focus on the transportation cost for selecting the optimum location of the productive activities (Tsiotas and Polyzos, 2013; Polyzos et al., 2013, 2014, 2015a,b; Tsiotas and Polyzos, 2018). The regions that improve their accessibility will benefit from the location process due to the reasonable preference of businessmen for installing their firms in areas with high population potential (Polyzos et al., 2013, 2014,) or with an increased demand, provided that other factors do not change. Therefore, benefits (or losses) will emerge for the regions with relative increase (or decrease) in their market accessibility (Rodrigue et al., 2013; Polyzos et al., 2015).

Finally, as far as trade changes are concerned, there is difficulty in determining the direction of the most important regional impact, in terms of size. According to the neoclassical theory of international trade (or to its variant expressed by the well-known Heckscher-Ohlin theorem) (Polyzos, 2009, 2019), the free movement of capital and labor between regions will cause equilibrium between the prices of productivity coefficients (Polyzos, 2009). However, the experience has shown that the market forces do not lead to a regional equilibrium and that the industry neither does automatically shift towards the position where the production-costs are minimized nor do the workers shift where their payments are maximized (Polyzos et al, 2015). Therefore, it can be concluded that the major criterion in the direction of trade flows is the overall competitiveness of the regional economy. In particular, high competitiveness leads to lower production prices and to an advantage in interregional trade of the region. Therefore, for any region, the combination of sufficiently low transport-costs with high productivity will increase the region's trade status and will benefit the regional economy.

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4. FACTORS DETERMINING THE CONTRIBUTION OF TRANSPORTATION INFRASTRUCTURES TO REGIONAL DEVELOPMENT

Transportation is an important factor in realizing the economic potential of a region, but it does not a priori lead to economic development. According to many scholars (Button, 1998; Button et al, 2010; Rodrigue et al., 2013; Tsiotas and Polyzos, 2018; Polyzos, 2019), a good transportation system is a necessary but not a sufficient condition for the development of a region. Reversely, the economic development may motivate regions to develop better transportation systems. Thus, there is typically a strong relation between transportation and economic growth but transportation modeling, in quantitative terms, is rather complicated (Button, 1998; Button et al, 2010).

The type, the size, and the direction of the changes associated with the construction of transport infrastructures are a function of the overall improvement in the time-distance or in the generalized transport-costs. In addition, there are a variety of other factors contributing to such changes, which are summarized in Figure 5 and they are briefly described at the following paragraphs.

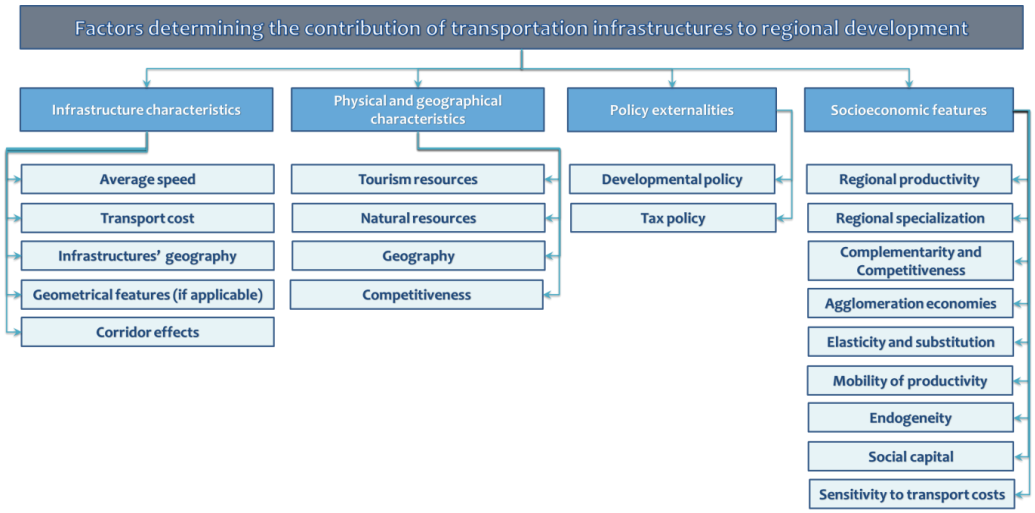

FIGURE 5 - FACTORS DETERMINING THE CONTRIBUTION OF TRANSPORTATION INFRASTRUCTURES TO REGIONAL DEVELOPMENT.

(i) The infrastructure characteristics

Traffic speed and transportation-costs depend on the characteristics of the linear transport infrastructures. Another critical feature is the geographical direction of the infrastructures affecting connectivity with urban centers of high demand, of innovation and technology, and of commercial transactions. As far as road infrastructures are concerned, the attributes of highways (e.g. motorway category, geometrical data, etc.) usually determine traffic congestion and thus they affect land-use and similar business activities (Polyzos et al., 2008). Finally, a common phenomenon for the intra-regional

land transportation networks is the so-called corridor effects, which allow developing functional cooperation between the region and the infrastructure and thus it contributes to regional development (Vickerman et al., 1999). In urban areas, the urban and interurban transport infrastructures influence the choice of residence, the living conditions, the quality of life, the land use and the cities attractiveness (Kasraian et al. 2016).

(ii) Physical and geographical characteristics

The physical and geographical characteristics significantly determine the comparative advantages of each region, the most important of which are:

Tourism resources

The degree of using tourism resources (which vary by region both quantitatively and qualitatively) largely depends on the transportation connectivity. The improvement of transportation connectivity increases the accessibility of areas with unexploited tourism resources along with their proximity to large population centers, which are generally the main feeders of tourist flows. Consequently, the increase in tourist flows has a positive impact on the establishment of tourism entrepreneurship and or related services.

Natural resources

The development of transportation infrastructures (which contributes at lowering the transportation-costs) creates opportunities for the better use of natural resources, such as mineral resources, agricultural and forestry resources, etc., in the region, it enhances the regional economies and it strengthens the competitiveness of regions. The reduction of transport-costs creates the conditions for the products to be sold at a competitive price and it therefore increases the range of the regional markets. A consequent result is the establishment of new firms related to the exploitation of natural resources of each area (Polyzos et al., 2015).

Geography

The geographical characteristics of a region (e.g. morphology, climate conditions, coastline, port existence, etc.) may affect the overall changes that will occur due to the development of transportation infrastructures. For instance, a coastal morphology favoring the development of a port can increase the benefits related to the development of a transport infrastructure (when inland), to the climatic conditions and to sea-tourism or urban concentration, etc. Moreover, the geographical location of a region is crucial in shaping the volume of economic change because it affects the overall accessibility and thus

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the position of the region in the spatio-economic competition. The effects may be negative in cases of developing connectivity with more developed regions and positive (and thus favorable for the development of comparative advantage) in cases of connecting regions with the same productivity structure (Rodrigue et al., 2013; Polyzos, 2019).

Competitiveness

There are infrastructures that can operate either complementary or competitively with the regions and thus they can contribute either positively or negatively to the regional development. These infrastructures may be either transportation (e.g. the complementary operation between land transportation infrastructure with a port or an airport and vice versa) or not (e.g. an industrial area enhances the efficiency of a transportation axis or of a port).

(iii) Policy externalities

There are government policies that can highlight the benefits of the region and can affect the contribution of transport infrastructures to the regional development and vice versa. Such policies are mainly the developmental policy and tax policy and they are briefly described as follows:

Developmental policy

The developmental and regional policy may affect the relative position of each region in the spatial competition and to create comparative advantages in certain areas. Developmental incentives such as subsidies, tax exemptions, etc., can affect in regional basis the benefits of transportation infrastructures' development, as they influence the final preferences of entrepreneurs in choosing their businesses location, they reduce the effects of transport-costs in the location process, and they affect the optima location criteria (Polyzos et al, 2015).

Tax policy

Imposing tolls or charges on users increases the cost of using transportation infrastructures and it reduces the infrastructures' contribution to economic development. This policy affects the real rather than the perceived costs, since it increases the money-costs without creating time delays (Botham, 1980; Rodrigue et al., 2013; Polyzos, 2019).

(iv) Socioeconomic features

These are mainly related to quality factors identifying competitive advantages.

Regional productivity

A key measure of the intensity of the spatial interdependence between regions is the volume of their trade-flows, while the flow direction largely depends on the productivity structure of each regional economy, on its productivity, and on its competitiveness. Each region with production advantages and with a productive structure ensuring efficiency, standardized product quality, and relatively increased productivity of its economy, will benefit more from improved transport infrastructures because its commercialization and specialization will be strengthened (Button, 1998; Polyzos, 2009; Bronzini and Piselli, 2009; Beyzatla et al, 2014). In contrast, a region with a (structurally) weak productivity basis, with low productivity, and relative low competitiveness, will either have fewer benefits or will even experience losses from other stronger in productivity regions.

Regional specialization

Reducing transportation-costs contributes to the expansion of the business market (due to lower production-costs) and it leads to more specialized productivity. The lower the initial level of specialization, the greater the expected output in the regional productivity and economy. Therefore, the transportation development effects will be favorable for the productive and competitive, in the interregional economic competition, regions (Beyzatla et al, 2014; Polyzos, 2019).

Complementarity and competitiveness

When regional economies that are specialized in complementary or in different productive sectors are being connected, then the change in trade due to transportation development will have a positive effect on their overall productivity. On the contrary, when regions with competing economies are being connected then the more productive (or more competitive) region will increase its comparative advantage (expressed as productivity or competitiveness), whereas the region with higher production-costs will reduce its productivity and it will consequently reduce its commercial transactions (Button, 1998; Beyzatla et al., 2014).

Agglomeration Economies

Agglomeration of economic activities (or of population) generally affects the use of transport infrastructures proportionally to the size of agglomeration and it increases the volume of total benefits comparatively to the gain of transportation-costs. Therefore, the emergence of agglomeration economies in the regions leads to greater economic benefits related to the high degree of transportation infrastructure use.

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Elasticity and substitution

Decrease of transportation-costs will result in lower production-costs, while it will not initially alter the revenue. The level of change in production depends on the elasticity of the supply factors. If the supply factors are elastic, then an increase in productivity, greater than the reduction of transportation-costs, will be observed. Also, the reduction of transportation-costs affects product or input values. The level of inputs substitution affects production-costs, since economic resources are saved in the production process which they consequently affect the magnitude of benefits (Button, 1998; Banister and Berechman, 2001). Equivalent savings due to substitution of non-transported from transported products will be observed in the field of consumption (Polyzos, 2019).

Mobility of productivity

High sensitivity of the mobility of the productivity, capital, and labor-costs in terms of the transportation-costs will result to significant regional economic changes. The most important interregional capital movements are those associated with the establishment of firms or companies. A change to the optimum location of the economic activities will induce a rearrangement of them in the geographical space, which will be implemented by the transfer of companies to the regions supported by new infrastructures, as well as by facilitating of the workers' mobility from region to region (Tsiotas and Polyzos, 2013; Polyzos, 2019). However, both the academic experience and practice have shown that the capital is a more inactive productivity coefficient than the labor, although it is a necessary condition for generating demand.

Endogeneity

The businesses trend for productivity expansion is a serious indication of the robustness and the market competitiveness of the functional companies. This trend will be strengthened in the regions favored by the development of transport infrastructures so that the effects of the business expansion will be multiplicative (Tsiotas and Polyzos, 2013; Polyzos, 2019).

Social capital

The social capital of the region is an important and determinative factor for the regional development and the overall spatial integration. The social structure of each region, which consists of a set of components, such as the level of education, the labor education and profession, demographic characteristics, etc., affects regional development, because it relates to the implementation of new technology, to the ability to improve productivity or to reduce production-costs within the framework of

spatial competition, to the development of new or to the expansion of existing businesses, etc. (Polyzos, 2019).

Sensitivity to transportation costs

According to the previous review, it is clear that the reduction in transport costs induces a reduction in the prices of products whose production is affected by transportation infrastructures. A condition for this price reduction to apply is the cost savings due to transportation not to be absorbed by third activities in the transport sector but to be transferred to the prices of the transported products or raw materials. The amount of transportation-cost involved in the configuration of the final product-prices will also affect the reduction of the final price. As a consequent result, many substitute products may emerge in the regional market, whereas an increase in the consumer surplus or a relative increase in the income will emerge, affecting the overall demand in the regions favored by the transportation infrastructures. In general, in regions with already developed transportation networks, many objections have been raised about the impact of the further development of transportation infrastructure on the regional economic development (Sasaki et al., 1987; Banister and Berechman, 2001; Beyzatla et al., 2014).

5. CONCLUSIONS

The relationship between transportation infrastructures and economic development goes beyond the specific purpose defined for the construction of these infrastructures and serves the broader social need related to the transportation of people and goods between places. By definition, transportation infrastructures involve facilitating the movement of people and goods within or between areas. Within this context, each region or country requires quality and efficient transportation infrastructures network to serve intra-regional and inter-regional mobility and to boost its economic and regional development. Transportation networks formulate the basis of the national supply chains and the national economies, they serve the efficient distribution of goods and the movement of people by providing access to various destinations, and they contribute to the improvement of the standard of living. The intra-regional transportation infrastructures contribute to the increase of mobility, to the reduction of intra-regional transportation-costs and they contribute to regional development of the regions they are built. Interregional or national transportation infrastructures contribute to the reduction of interregional transportation-costs, to the increase of the overall accessibility of regions, to the improvement of business access to raw materials and to markets, to the widening of the regional markets' range, and to the increase of business productivity.

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Calculating the changes in the economy of region that are directly or indirectly affected by the construction and functionality of transportation infrastructure is a very complex task. The difficulty in calculating the final contribution of transport infrastructures to regional development is related to the redistributive results, since the reduction of interregional distances affects the intensity of the spatial interdependence, the economic cooperation, and the regional spatial competition. Therefore, many economic activities are redistributed between the regions, where some regions are benefited from this distribution and some others are not. Moreover, broader issues than the direct changes due to transportation exist, which must be taken into account when designing transportation infrastructures that are relate to indirect and to the induced changes. In the long-run, these changes can affect business location, urban sprawl, land-use change, tourism flows, the environment, and other aspects of the intra-regional and interregional economies.

Within this context, this paper reviewed all the factors contributing to the economic development of each region and they are affecting the volume of productivity and the direction of the redistributive changes. The overall review frames the necessary theoretical background and gives the opportunity for a broader and more detailed analysis about the relationship between transportation infrastructure and (local and regional) economic development. Through this approach, the paper provides insights for the quantitative assessment of the spatial changes and therefore for the decision-making for the implementation of transportation infrastructures serving regional development, for the evaluation of the planning and use of transportation infrastructures, as an effective tool for promoting economic growth, and for the convergence of the economic inequalities between regions or, generally, for the reduction of spatial inequalities.

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