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# Assessing The Impact of Infrastructure on Economic Growth and Global Competitiveness

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**Abstract**

The aim of this research is to examine the degree of the influence of infrastructure on national competitiveness. Through an effectiveness of infrastructure management can improve industrial policy and gain national competitiveness. According to research of the World Bank there are several factors influencing the economy growth effectiveness and national competitiveness, including institutions, infrastructure, macroeconomic environment, health and primary education, technological readiness, market size, etc and also, there are various frameworks, models, and analytical tools that can be used in studying the causal relationships between some key infrastructure factors and national competitiveness. Based on existing models, this study aims to identify and discuss the key infrastructure factors that determine national competitiveness, which in turn influence positively on the total results of industrial policy. The results of study showed that national competitiveness is influenced basically by the level of institutional development and other seven factors, including infrastructure, in turn infrastructure factor is determined mainly by the quality of roads, railroad infrastructure, air transport and electricity supply. The key institutional traps were singled out that prevent the development of the national economy. These findings contribute to an understanding of the key factors that determine economic growth, help to explain what infrastructure factors allows to be more successful in raising income levels and offer policymakers and business leaders an important tool in the formulation of improved economic policies and institutional reforms.

*Keywords:* national competitiveness; infrastructure; the economy growth

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## 1. Introduction

The subject of this study is to evaluate the impact of infrastructure on global competitiveness. In general, infrastructure problems research is considering only a narrow part of the infrastructure capital that is in public ownership. Even if there is an opportunity evaluate private infrastructure capital, it is difficult to separate its impact on industrial growth from the effects of public infrastructure. Therefore, in our study, we will consider only the infrastructure assets in public ownership.

Fourie (2006) argues that the infrastructure consists of two elements - "capitalness" and "publicness". Accordingly, it consists of assets that have a major, but not necessarily social. We classified the degree of capital intensity of infrastructure and social significance (Table 1).

Table 1. Classification of the degree of capital intensity of infrastructure and public works

| Capital Publicity | High level | Low level |
|---|---|---|
| High level | roads, highways, railways, airports, ports, electricity, water and sewerage, telecommunications | schools, hospitals, parks, courts, museums, theatres, libraries, universities, hospitals |
| Low level | industrial infrastructure | Fountains and Statues |

Therefore, the infrastructure may include capital-intensive facilities that are not of public interest. But the public actively uses most of the infrastructure. Economists refer to such objects as physical infrastructure or infrastructure capital. In the scientific literature, the role of infrastructure is evaluated by the services provided by the physical infrastructure assets. Infrastructure services, such as energy, transport, telecommunications, provision of water, sanitation and safe disposal of waste are fundamental to all kinds of household activities and economic production. We agree with the Prud'homme (2004), Baldwin and Dixon (2008), that infrastructure is a long-term, spatially bound, capital-intensive asset with a long life cycle and the period of return on investment is often associated with a "market failure" (a situation in which the market system crashes, and economic efficiency is not achieved). For example, monopoly (if there is only one seller on the market, who can abuse their position and put a price on his product much higher than it costs), or a natural monopoly, it is a form of public goods with favourable externalities (including through external networks), which leads to reduce costs in the business, or provides significant social benefit (merit goods). Baldwin and Dixon (2008), in accordance with these features, divided infrastructure into three groups: machinery and equipment, buildings, engineering structures. The field of our study includes only the basic physical infrastructure, except the social, environmental and institutional infrastructure (schools, hospitals, prisons, etc.). In such a manner, under the infrastructure we mean the basic physical infrastructure consisting of: transport infrastructure, water infrastructure, telecommunication infrastructure and energy infrastructure. This infrastructure will be called the public infrastructure because it creates benefits for a large number of users.

## 2. Related Literature and Research Results

Last years the fact of the positive impact of infrastructure on productivity and economic growth is in increased attention. Fig. 1 depicts the most famous work on the subject in this area over the last 20 years.

**The contribution of infrastructure to the industrial growth, the result of an increase in production:** (Aschauer (1989), Holtz-Eakin (1994); Kashin (1995); Baltagi и Pinnoi (1995),Canning(1999), Demetriades и Mamuneas (2000), Roller и Waverman (2001), Fernald (1999), Calderon и Servén (2003)

**The contribution of infrastructure to long-term economic growth:** Easterly and Rebelo (1993), Sanchez-Robles (1998) Devarajan соавт. (1996)

**Evaluating the effectiveness of the use of infrastructure and its institutional values:**
Lopes (2003), Hulten (1996), Esfahani и Ramires (2002), Easterly and Levin(1996)

**Effect of infrastructure on income inequality (smoothing):** Lopes (2003), Ferreira (1995), Estache (2003), Gannon and Liu (1997), Jacoby (2000), Leipziger, Fay and Yepes (2003), Brenneman and Kerf (2002), Behrman and Wolfe (1987); Lavy et al. (1996); Lee et al. (1997); Jalan and Ravallion (2002), Galiani et al. (2002)
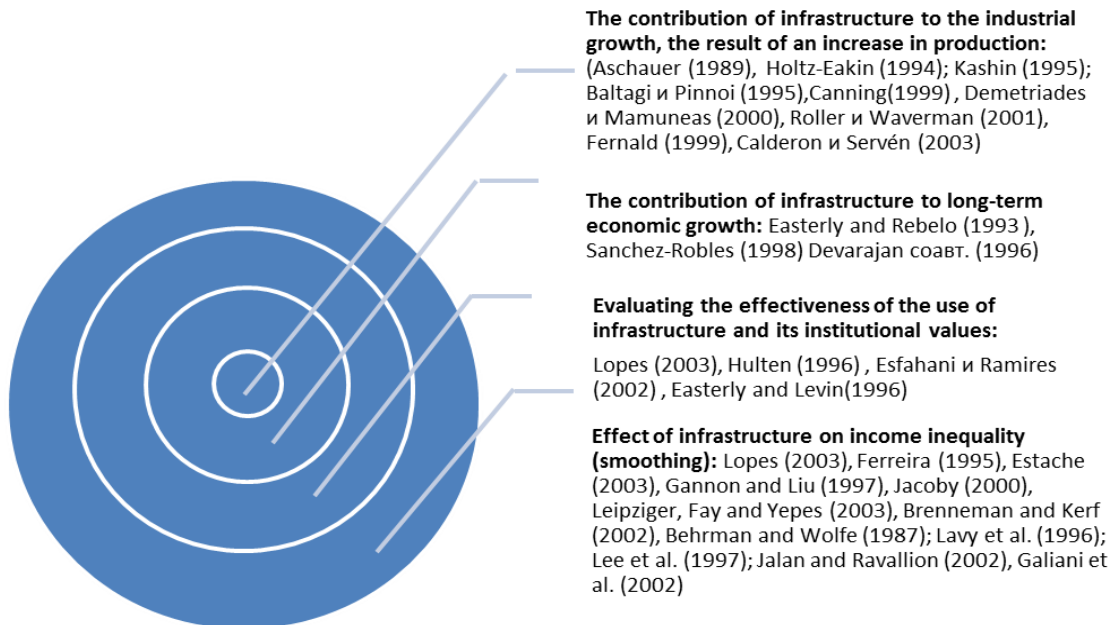
Fig. 1. The evolution of the subject of research of the infrastructure factors impact on industrial growth

Aschauer (1989) found out that almost simultaneously with a reduction of public investment almost everywhere the productivity growth fell sharply. He was the first who proposed that the reduction of productive public services in the United States may be crucial in explaining the overall reduction in the rate of productivity growth in the country. Mamatzakis' (2008) calculations suggest that the infrastructure is an important component of economic activity in Greece. His estimates show that the public infrastructure reduces costs in the most manufacturing industries, as it strengthens the growth of productivity of resources. The efficient infrastructure supports economic growth, improves quality of life, and it is important for national security (Baldwin, Dixon, 2008). The researchers analyze the impact of infrastructure in various aspects: regional competitiveness, economic growth, income inequality, output, labour productivity, the impact on the environment and well-being (in time and cost savings, increased safety, the development of information networks) (Bristow and Nellthorp (2000)). Some authors argue that investment in infrastructure can stimulate organizational and management changes: the construction of the railway system will lead to the standardization of the schedule, which leads to increased revenue in addition to having railway service (Mattoon, 2004). Public infrastructure provides the geographic concentration of economic resources and wider and deeper markets for output and employment (Gu, Macdonald, 2009). It affects the markets and resources of the finished product, helps to determine the spatial patterns of development and provides an extensive network of individual users at low prices. Public infrastructure is generally seen as a foundation on which to build the economy (Macdonald, 2008). Grundey (2008), Burinskiene and Rudzkiene (2009) have conducted an analysis of the implementation of sustainable development policies, they note the development of infrastructure as one of the most important aspects in the field of strategic planning for sustainable spatial and socio-economic development of the country. Aschauer (1998) confirms that the public infrastructure is the basis of the quality of life: good roads reduce the number of accidents and increase public safety, water supply system reduces the level of disease, waste management improves the health and aesthetics of the environment. Agenor and Moreno-Dodson (2006) examined the association between the presence of infrastructure and health and education in the community, and proved that infrastructure services are essential to ensure the quality and availability of health and education, which provide a wealth effect to a large extent. Damaskopoulos, Gatautis, Vitkauskaite (2008) attributed to the sources of infrastructure performance. Demetriades and Mamuneas (2000) suggest that social capital infrastructure has a significant positive impact on earnings, the demand for private means of production and delivery of products in 12 OECD countries. The results of the assessments that were made by Mentolio, Sole-Olle (2009) confirmed the idea that productive public investment in

roads positively influenced by the relative increase in labour productivity in the Spanish regions. Macdonald (2008) analyzed the impact of public infrastructure on the level of private production and found that private infrastructure is vital for the private manufacturing sector. Companies are looking at social capital as an unpaid factor of production while maximizing profits.

Nijkamp (1986) confirms that the infrastructure is one of the tools for the region development. It can affect, directly or indirectly, on the social-economic activities and other regional capacity, as well as factors of production. The author emphasizes that infrastructure policy is a condition of the regional development policy: it does not guarantee regional competitiveness, but creates the necessary conditions for achieving regional development objectives. Snieska and Draksaite (2007) say that the competitiveness of the economy is determined by many different factors, and indicator of infrastructure is one of them. Snieska and Bruneckiene (2009) identified infrastructure as one of the indicators of the competitiveness of regions within the country. It refers to the physical infrastructure (consisting of road transport infrastructure, telecommunications, newly built property, external accessibility of the region by land, air and water) as an indicator of the factors of production, competitive conditions in the region. Martinkus and Lukasevicius (2008) consolidate that the infrastructure services and physical infrastructure are factors that affect the investment climate at the local level and increase the attractiveness of the region. Further, we examine the extent of the infrastructure influence for global competitiveness and sources.

## 3. Methodology

There is no agreement among researchers on a set of variables that characterize the infrastructure: some authors explore the infrastructure as a set, the others study one particular type of infrastructure such as transport, and ignore any relationship between different types of infrastructure. In most scientific works researchers use physical indicators of public infrastructure, but not the cost parameters to avoid the difficulty of estimating the infrastructure, but there is no agreed methodology for assessing the infrastructure variables. Agénor and Moreno-Dodson (2006) define infrastructure generally, it includes transportation, water and sanitation, information and communication technology (ICT) and energy. Seethepalli, Bramati, Veredas (2008), Seethepalli and others (2007) and Straub (2008) examine the physical attributes of the communication infrastructure (number of telephone lines, mobile subscribers), power (energy consumption), roads (kilometres of paved roads, the percentage of paved roads), sanitation (percent of population with access to improved sanitation conditions), water supply (the percentage of the population with access to improved sources of water). Grubesic (2009), Straub, Vellutini, Warlters (2008), Yeaple, Golub (2007), Canning and Pedroni (2008) also analyze the physical characteristics of infrastructure, they assess the performance of three different sectors - telecommunications, energy and transport: main telephone lines or phone number, electricity production capacity, the length of railway lines or the length of paved roads. The use of physical indicators (on their opinion) better reflects the investment in infrastructure than in monetary terms.

It is difficult to estimate the stock of social capital reliably. Researchers commonly use the sum of past investment flows, adjusted for depreciation. In the application of the so-called perpetual inventory method, it is necessary to make certain assumptions about the duration of the life cycle and wear. You also need to know the initial amount of capital. All these assumptions are far from trivial to infrastructure. There is a huge difference in the duration of the life cycle of various types of infrastructure: for example, a railway bridge and power lines. Europe still uses roads and sewers that were built by the Roman Empire. This characteristic has serious implications in terms of funding and maintenance. Further infrastructure is divided into sub-sector, that are defined by a set of physical quantities.

The literature can be divided into four approaches to measure the effect of social capital on competitiveness. 1. In the so-called behavioural approach, estimated the cost function or profit, which includes social capital. This allows the use of flexible functional forms and some better account of the different characteristics of public and private capital. 2. The introduction of various economic restrictions with VAR-model (Vector auto regression) solved the problem of causality (cause) and endogenous. 3. The final alternative way to model the effect of public spending on social capital includes the slice (cross-section) regression analysis. Each approach has its advantages and its own set of problems. Nevertheless, the general conclusions drawn using different approaches are remarkably similar. Or, at least, the differences in the identified effects do not depend on what kind of approach

was used.

We used regression analysis as a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables with the focus on the relationship between a national competitiveness and ten independent variables, the same as the Global Competitiveness Index pillars from the World Economic Forum's annual Global Competitiveness Report at the first stage, followed by determination of  relationship between quality of overall infrastructure and its eight components at the second stage. So regression analysis helps us to understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is on a Quintile, or other location parameter of the conditional distribution of the dependent variable given the independent variables. In all cases, the estimation target is a function of the independent variables called the regression function. Regression analysis is also helps to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships.

## 4.  Result

To estimate the conditional expectation of the dependent variable given the independent variables and to explore the forms of these relationships we used the data from the Global competitiveness Report-2012 covering 124 economies. So dependent variable is global competitiveness (y) and global competitiveness (y) independent variables are institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labor market efficiency, financial market development, technological readiness, market size. When testing the statistical significance of the regression coefficients null hypothesis was rejected by two factors - higher education and training, goods market efficiency, the rest were statistically significant and were included in the regression equation.

As a result regression function of the impact of economic factors on the global competitiveness (y) has the form (1) with certainty $R_2$=98%:

$$Y = 0{,}2x_1 + 0{,}05x_2 + 0{,}1x_3 + 0{,}1x_4 + 0{,}1x_7 + 0{,}06x_8 + 0{,}07x_9 + 0{,}13x_{10} + 0{,}175 \qquad (1),$$

where $x_1$ – Institutions, $x_2$ – Infrastructure, $x_3$ – Macroeconomic environment, $x_4$ – Health and primary education, $x_7$ – Labor market efficiency, $x_8$ – Financial market development, $x_9$ – Technological  readiness, $x_{10}$ – Market  size

According to the model, the main problems that hinder the development of national competitiveness are questions of an institutional nature. The low level of institutional development makes investment highly risky and, therefore, ineffective. We single out the key institutional traps that prevent the development of the national economy:

1)    The trap selection of catch-up development model, involving the combination of leadership in some segments, which are (or can be quickly set up) a competitive advantage, but with the implementation of the catch-up strategy in most sectors of the economy and industry. If the specific guidelines for industrial policy are not delivered, the manufacturer is expected to acquire of the cheapest and, as a consequence, the non-competitive equipment that may be advanced by national standards technologies. As a result, the problem of scientific and technological backwardness of many branches will appear in a few years due to technological change. Deep gap in the scientific and technological development can lead to the abandonment of the production of their own products and their replacement by an assembly of non-competitive imported counterparts.

2)    The trap of non-system of strategic thinking. Process contingency of already established production causes the synchronization of complementary and mutually supportive of each other innovations. This kind of feedback with a strong positive effect forms the growth trajectory of the new technological order. Therefore it is necessary to adopt a common strategy of innovative development of the national economy, taking into account the complementarity and interdependence of industries.

3)    The state governmental orders placement corruption. Creation of a common information field does not exclude the possibility of corruption. Various indicators of corruption on the stability of the various levels of government say that the corruption is a major factor in the level of authority of customers contracting system.

4) The trap of limiting the mechanism of refinancing. The need of raising funds for the modernization of most enterprises highlights the issue of the cost of credit. If the average of credit rate on loans in the country higher than similar rates in other countries because of the imperfection of the mechanism of refinancing, manufacturers of imported products having sufficient credit, have an advantage in the cost of investment of resources, which leads to further intensification of competition between foreign and domestic businesses and the latest crisis

5) The trap of short horizon of strategic planning.  The development of public-private partnership (PPP) requires changes in the strategic planning of the State: A long-term financial planning, the development of the system of guaranteeing private sector investment, state property investing, development of monitoring of PPP projects, the economic efficiency of projects. In this case, the uncertainty for the investor is reducing.

6) The trap of inefficient owner and inefficient management. The liberalization of the economy through the large-scale privatization of state property can lead to the elimination of the administrative institutions of government rule, the loss of control of economic processes. As a consequence, the new owners of the enterprises are not able to organize an effective enterprise management, and management of enterprises, in turn, choose an effective strategy.

Further, we examine the contribution of various types of infrastructure in the level of overall quality. Of the eight factors four were significant. The model with the reliability $R^2 = 0,93$ becomes:

$$Y = 0,33x_1 + 0,089x_2 + 0,27x_4 + 0,18x_6 \tag{2}$$

where Y - Quality of overall infrastructure,  $x_1$ - Quality of roads, $x_2$ - Quality of railroad infrastructure, $x_4$ - Quality of air transport infrastructure, $x_6$ - Quality of electricity supply.
Quality of port infrastructure, Available airline seat kms/week, billions, Mobile telephone subscriptions/1000 pop., Fixed telephone lines/1000 pop are not included in the list of important factors.

It is assumed that the services of social capital are clean, non-competitive public goods and are proportional to the capital stock. Thus they can, however, be deficient: number of vehicles can not exceed the performance of the road. More roads will reduce congestion and improve performance. However, the increase above a certain threshold will no longer affect the gross domestic product and competitiveness, as it will not "embroider bottlenecks» (Sanchez-Robles, 1998).

A theoretical analysis of the impact of infrastructure on economic growth and the competitiveness of domestic producers can be concluded that the impact of infrastructure is expressed as follows:
- Infrastructure enables businesses to generate additional production capacity, reduce the cost of inputs in the production and transaction costs. This is called a direct impact performance;
- Infrastructure increases the productivity of workers, and this effect is known as an indirect effect;
- The impact of infrastructure on economic growth achieves in the initial period of construction work: creating jobs in construction and related industries. Investments in infrastructure require maintenance; it further increases the number of created jobs;
- The infrastructure also has a positive impact on education and health: good health and a high level of education of labour causes economic growth;
- Infrastructure contributes to the accession of the poor and undeveloped areas to the core business activities, public communications, which can raise the value of their assets, and increase human capital.

## 5. Conclusion

The empirical studies on the relationship between social capital and national competitiveness should provide answers to two important questions. First is whether increase in public capital causes the increase of the national competitiveness? Second is the "politically relevant" question of investment in infrastructure is not, "what is the effect of additional infrastructure, assuming everything else is constant?" But "what is the net effect of more infrastructure, despite the fact that the construction of infrastructure diverts resources from other uses? "In other words, is the existing stock of social capital is optimal?

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