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OPPORTUNITIES FOR INFRASTRUCTURE PROJECTS IN BOSNIA AND HERZEGOVINA

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Abstract

The paper analyses the infrastructure stock of Bosnia and Herzegovina (BiH) with the purpose of addressing the measuring and evaluating of the infrastructural gap.

The paper starts out with a simple benchmarking of infrastructure stock by countries of the region of Central and Southeastern Europe. Then a cross-sectional regression analysis is used to isolate the impact of individual factors on infrastructure stocks in a multivariate framework. Finally, the country-level benchmarking for BiH's infrastructure stock is carried out, comparing its stock with those of a regional peer group of countries to find out the relative position of BiH in infrastructure endowment.

Starting from the recent and most relevant literature on infrastructure's impact on a country's development and making use of regression analysis to control for a comprehensive set of economic, demographic and geographic conditioning factors, the paper shows that BiH lags behind all countries in the region of Central and Southeastern Europe in infrastructure endowment.

Key words

Bosnia and Herzegovina; Central and Southeastern Europe; infrastructure bottlenecks; infrastructure stock

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1 INTRODUCTION

It appears that BiH's development is constrained by its infrastructure bottlenecks. Nevertheless, policy makers at all levels measure neither allocation of public/private resources between various infrastructure sectors nor infrastructure performance (telecommunications, energy, transportation, water etc.) and impact in a growth model.

Tab. 1: BiH and comparators, 2011 (Source: World Bank's World Development Indicators)

	Transportation[1)]	Electricity[2)]	Servers[3)]	Phones[4)]
Austria	3.092	2.375	50.3	1.810
Bulgaria	0.460	1.251	7.2	1.617
Switzerland	3.997	2.261	107.9	1.727
Czech Republic	3.865	1.232	19.7	1.348
Greece	1.975	1.327	7.9	1.495
Croatia	1.223	0.870	11.7	1.479
Hungary	4.915	0.853	11.110	1.361
Macedonia, FYR	1.240	0.635	1.417	1.165
Romania	1.133	1.249	2.878	1.199
Slovak Republic	2.082	1.145	8.338	1.204
Slovenia	4.258	0.972	21.877	1.372
Average	**2.567**	**1.288**	**22.744**	**1.434**
BiH	1.00	1.00	1.000	1.000

[1)] the length of the road network coupled with the length of rail network; in km per 10,000 square km of land area; [2)] total electricity installed capacity (in kWh per 100 persons); [3)] secure Internet servers (per 1 million persons); [4)] main telephone lines augmented by mobile cellular subscriptions per 100 persons.

This paper is aimed at benchmarking BiH's infrastructure stocks by comparison with peer countries with the purpose of identifying a new potential for infrastructure projects [1]. Even a simple comparative inter-regional analysis of the infrastructure stock relating to BiH and the Central and Southeastern European countries shows a significant infrastructural gap. It seems that the lack of internet servers poorly affects the country's economic development (see Table1).

2 LITERATURE REVIEW

The debate about the role of infrastructure in the development of countries, started in the middle of 1980s due to fiscal stress in many countries and initiated two important worldwide developments.

The first was calling for public sector retrenchment and its decreasing role in infrastructure development. The overwhelming view of scientific and political community was that the private sector would take over building infrastructure assets and provide infrastructure services, leaving a residual role for governments (deregulation, the regulation of remaining residual monopolies etc.). It was believed that the time has come for the private sector to successfully replace an underperforming public sector [2].

The second was the opening of infrastructure sectors to private sector participation. The process gained momentum in higher income countries (the UK and Chile primarily) and extended to a growing number of low and middle income countries over the last two decades [3; 4].

However, fiscal consolidation conducted in many countries led to a compression of public infrastructure spending without having that offseted by the increase in the private sector participation in infrastructure spending. Consequently, it appeared an insufficient provision of infrastructure assets and services with major adverse effects on growth and development [4; 5].

It is clear that the vision did not play out as expected. Now almost 30 years after privatization began to be considered as the solution for infrastructure bottlenecks, the role of private sector participation in building and operating infrastructure assets is far from being as widespread as hoped for, at least in low and middle income countries. Consequently, many countries currently struggle to plug investment gaps in infrastructure development. The public sector is once again seen as the major player in financing infrastructure projects in many low and middle income countries. The emerging new vision is that the public sector should retain the important financing role while the private sector can only assist in meeting very significant needs associated with infrastructure development. This evolution is currently observed at the global level in high income countries as well as in low and middle income countries [2].

It has long been recognized in literature that an adequate supply of infrastructure is an essential ingredient for productivity and growth [6]. Rapidly growing literature, particularly over the last two decades, starting with the seminal work of Aschauer [7], has sought to quantify the contribution of infrastructure to income and development [5; 8]. Infrastructure is necessary for modern societies to function but it does not mean that more infrastructure necessarily causes more growth at all stages of development. Binding constraints may lie elsewhere – in poor incentives, missing markets, institutional setups, government regulations etc. [2]. It is therefore very important to correctly estimate the contribution of infrastructure to the development of a country.

3 METHODOLOGY

In the first step of the analysis, the aggregate index of infrastructure stock is constructed by using the principal component analysis (PCA), in contrast with applying a single indicator in empirical analysis of infrastructure's impact on a country's development.

The number of main telephone lines per capita used to be taken as the preferred single indicator of overall infrastructure availability [9; 10]. Currently used proxies include energy generation capacity (for example, total electricity installed capacity in MWh per 100 persons) and transportation (kilometres of total road network per capita or per km^2 or coupled with total road network per capita or per km^2).

However, these proxy measures of infrastructure are highly correlated with each other. For example, the correlation between measures of phone density and electricity generating capacity is about 0.80-0.94, between main phone lines and roads about 0.70, and roads and power generating capacity close to 0.6 [3; 10].

To solve the problem of high colinearity among the different types of infrastructure assets, this paper will follow a different strategy. It will establish an aggregate index of infrastructure stock that summarizes the different types of infrastructure assets in various infrastructure sectors. In building that index, it will follow [3; 4; 11 and 12].

The synthetic index of infrastructure stock is constructed using the PCA. This takes *n* specific indicators and yields new indices (principal components) that capture information on the different dimensions of the data and that are mutually uncorrelated.

The aggregate index of infrastructure is the first principal component of the vector of physical indicators of infrastructure stocks $\{K_1, K_2$ and $K_3\}$. Generally speaking, the first principal component is defined by the vector of weights $a = (a_1, a_2, \ldots, a_n)'$ on the (standardized) set of infrastructure quantity indicators $\{X_1, X_2, .., X_n\}$ such that the linear combination

$$IS_1 = a_1X_1 + a_2X_2 + \ldots + a_nX_n \quad (1)$$

has the maximum variance for any possible choice of weights subject to restriction that the sum of squares normalisation is equal to 1 (that is $a'a = 1$).

The second step is conducting multiple linear regression analysis by using cross-sectional, ordinary least squares (OLS) models and OLS panel models to control for country differences (fixed effects) in the operating environment faced by particular countries [1]. This is represented by equation (2), where IS_{it} is defined as the infrastructure stock for country i at time t, X_{it} is a matrix of economic and demographic explanatory variables, and η_i is a time-invariant country-specific fixed effect [1].

$$IS_{it} = \alpha + \beta' X_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

This approach follows [13] and [1] in including economic and demographic variables, such as population density, urbanization rate, the shares of manufacturing, agriculture, exports and public debt in GDP as explanatory variables.

The third step of the analysis is country-level benchmarking for a country's infrastructure stock, comparing it with infrastructure stocks of a regional peer group of countries to find the country's position in infrastructure endowment. Benchmarking is a technique widely used in the international comparison, for instance by the World Bank, World Economic Forum and European Bank for Reconstruction and Development to compare the performance of a country against a relevant peer group.

The benchmarking exercise compares each country's actual infrastructure stock to an expected or predicted value based on its economic and demographic structure. The predicted value is derived from a regression model that explains variation in infrastructure stock among comparable countries based on a set of explanatory variables. It should be borne in mind that the concept of an expected or predicted infrastructure stock is not being treated as an ideal. It simply expresses the average stock of a comparable country [1].

Each country's infrastructure stock is measured by the deviation between its actual stock and the stock predicted by the model (equation 3). A positive deviation indicates that the country outperforms the benchmark provided by the regression model (i.e. the average for the relevant peer group) and vice versa. The larger the size of the deviation, the greater the extent of the corresponding over- or underachievement [1].

$$\text{deviation} = (\text{actual} - \text{predicted}) / \text{predicted} \quad (3)$$

4 RESULTS

The analysis is based on a panel dataset of 12 Central and Southeastern European countries (namely, Austria, BiH, Bulgaria, Croatia, Czech Republic, Greece, Hungary, FYR Macedonia, Romania, Slovak Republic, Slovenia and Switzerland) for the most recent year of data available for infrastructure stocks i.e. for the years 2006 to 2011:

1. Road network (in km per 10,000 square km of land area)
2. Road network (in km per 100 persons)
3. Rail network (in km per 10,000 square km^2)
4. Rail network (km per 100 persons)
5. Transportation network (the length of the road network coupled with the length of rail network; in km per 10,000 square km of land area)
6. Transportation network (in km per 100 persons)
7. Total electricity installed capacity (in kWh per 100 persons)
8. Fixed telephone line (per 100 persons)
9. Mobile cellular subscriptions (per 100 persons)
10. Phone sector (number of main telephone lines per 100 persons augmented by mobile cellular subscriptions per 100 persons)
11. Secure internet servers (per 1 million persons)
12. GDP per capita (in constant 2005 US$)
13. Urban population (in % of total)
14. Urban population growth (annual %).
15. Population density (in persons per sq. km of land area)
16. Agriculture, value added (% of GDP)
17. Manufacturing, value added (% of GDP)
18. Gross savings (in % of GDP)
19. Central government debt, total (% of GDP)
20. ICT goods exports (% of total goods exports).

The data are drawn from the World Bank's World Development Indicators except for the total electricity installed capacity that is drawn from the U.S. Energy Information Administration (EIA).

The index IS_1 is the first principal component that comprises information on secure internet servers, electricity-generating capacity, length of total road network and phones. All four variables are expressed in logs, and the coefficients can accordingly be interpreted as elasticities [14].

Tab. 2: Aggregating infrastructure variables: PCA

Nos	Variables	Stock (IS_1) (1+2+3+4)
1	Total electricity installed capacity (in kWh per 100 persons)	0.4926 (0.7419)
2	Secure Internet servers (per 1 million persons)	0.5776 (0.9775)
3	Transportation network (the length of the road network coupled with the length of rail network; in km per 10,000 square km of land area)	0.4340 (0.8030)
4	Phone sector (number of main telephone lines per 100 persons augmented by mobile cellular subscriptions per 100 persons)	0.4852 (0.7476)
5	Eigenvalue	2.78
6	Variance Proportion	69.51

Note: the numbers in parentheses (below the different eigenvectors) represent the correlation of the first principal component with the corresponding infrastructure variable.

Table 2 presents the results of the PCA [4]. The indicator IS_1 accounts for 69.5% of overall variance of the different types of infrastructure assets in different infrastructure sectors. All four measures of infrastructure stocks enter the first principal component with slightly different weights:

$$IS_1=0.4926*\ln(electr.) + 0.5776*\ln(servers) + 0.4340*\ln(transport) + 0.4852*\ln(phone) \quad (4)$$

The second step of the analysis is to estimate cross-sectional, ordinary least squares (OLS) models and panel data models. Six econometric models (as shown in Table 3) are estimated for four different infrastructure variables: urban population, population density, gross savings (used as a proxy for financial system's ability to collect and allocate financial resources) and central government debt (used as a proxy for government policy).

Tab. 3: Effect of country variables on infrastructure stocks (data in logs)

	(1)	(2)	(3)	(4)	(5)	(6)
	FE & time dummy	Fe	Re & time dummy	OLS	OLS & time dummy	OLS& time and country dummies
Urban Popul.	-3.634	26.04***	2.929*	1.679**	1.635**	-3.634
	(2.528)	(5.791)	(1.649)	(0.767)	(0.734)	(2.528)
Popul. density	-5.685***	6.250	1.744*	2.358***	2.380***	-5.685***
	(1.757)	(4.511)	(0.947)	(0.508)	(0.494)	(1.757)
Gross savings	0.173*	0.306	0.365***	1.474***	1.509***	0.173*
	(0.0971)	(0.255)	(0.104)	(0.330)	(0.325)	(0.0971)
Gover. debt	-0.172	0.817***	0.0742	1.217***	1.164***	-0.172
	(0.107)	(0.218)	(0.111)	(0.206)	(0.207)	(0.107)
Constant	56.28***	-123.7***	-6.214	-10.69***	-11.19***	58.84***
	(15.99)	(36.07)	(7.385)	(2.794)	(2.675)	(16.28)
Observations	72	72	72	72	72	72
R-squared	0.939	0.448		0.756	0.793	0.996
	Hausman test 0.0019	Hausman test 0.0073			Breush-Pagan/Cook-Weisberg test 0.1313	
	testparm i.year 0.0000				Ramsey RESET test 0.2684	
	Modified Wald test 0.0000				Mean VIF 1.71	
					swilk IS-predicted 0.65205	
					Shapiro-Wilk W test for normal data of independent variables 0.0000	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Several models on a full dataset of 20 variables are run and then on selected to allow obtaining consistent parameter estimates for infrastructure stock variations. It is found that urban population, urban population density, gross savings and central government debt have the largest explanantory power with an R^2 of 79.3%. and that more variables are not needed.

The main objective of the regression models is to predict expected levels of infrastructure stock for the purposes of a country-level benchmarking exercise for infrastructure stock in BiH. As described in the third section of the paper, the benchmarking is done by comparing the infrastructure stock of each country with the value predicted by the regression model and then by calculating the deviation.

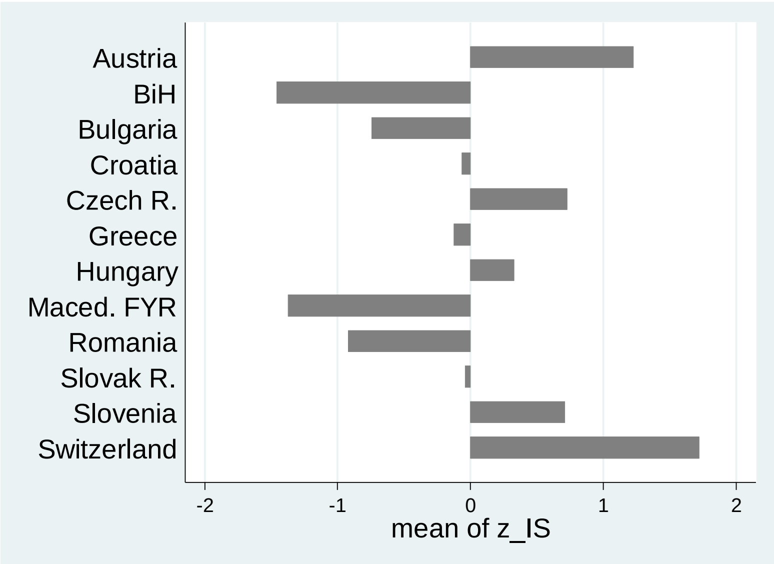

Fig. 1: Benchmarking IS; Central and Southeastern European Countries, 2006-2011

A severe negative deviation for BiH indicates that it performs below the benchmark i.e. below mean of the average IS. Actually, BiH has the largest deviation in infrastructure stock when compared with a regional peer group of countries (see Figure 1).

5 DISCUSION

As no aggregate index of infrastructure stock has previously been available for BiH, this paper has created it. To our knowledge this is the first paper dealing with this issue for the countries of the respective region, and it could accordingly serve as a reference point for future research activities in this field.

When compared with the results for the aggregate index in those few papers available on the subject, this paper's results are to a certain degree different as the paper deliberately puts a stronger emphasis on the IC sector, including servers, into the aggregate infrastructure stock. BiH should start carrying out infrastructure investment in the service of digital economy.

Therefore the choice of infrastructure indicators underlying this paper's aggregate index is not fully consistent with the literature as the latter is focused on power, transportation, and phone sectors. This paper puts a strong emphasis on servers (there are better proxies but we were not able to collect data on them). When servers excluded, paper's results are not inconsistent with [4].

However, the analysis applied in this paper reflects only the quantity of infrastructure, saying nothing about the quality or infrastructure utilisation. For example, road densities for BiH, Croatia, Serbia and Romania are approximately the same, but their respective networks arguably maintained and used at different levels. Unfortunately, there are no datasets available which provide information about the quality of infrastructure stock. Nevertheless, some research indicates a close correspondence between quality and quantity of infrastructure [1; 3].

The regression analysis applied in this paper to show the relationship between the aggregate index as the dependent variable and urban population (% of total), population density (people per sq. km of land area), gross savings (% of GPD) and general government gross debt (% of GPD) as regressors serves well.

It should be borne in mind that the concept of an expected or predicted infrastructure level does not refer to any concept of demand, since actual levels of infrastructure may also be driven by supply factors. Moreover, the expected value should not be treated as an ideal; it simply expresses the average endowment of countries with comparable characteristics [1].

6 CONCLUSION

In order to appraise the sufficiency of the BiH's infrastructure stock, the paper examines the issue in the context of Central and Souteastern European countries i.e. in the context of various relationships between infrastructure stocks and groups of the same socio-economic and demographic variables.

According to this paper's analysis, BiH's development is severely constrained by infrastructure bottlenecks. Over the last 20 years, i.e. in the post-war period, infrastructure investments in BiH were designed just to enable the functioning of an economic model that strongly prioritized consumption over investments.

BiH desperately needs to grow and support the tradable sector i.e. knowledge-based manufacturing and high-end services. The IC sector or rather investment into that sector is a prerequisite for building up such a tradable sector. It is necessary to promote infrastructure-led growth since the lack of infrastructure assets affects the country's development. BiH will not improve currently uncompetitive economy without making smart infrastructure choices.

A great many of the infrastructure projects in BiH could be financed using the project finance model or one of its numerous variants. As the practice of project finance models has evolved in transition European countries as elsewhere in the world during the 1990s and 2000s, a firm ground for the BiH governments has been established. They can take a strategic and structured approach to the introduction of project finance models as a new and significant policy initiative for delivering infrastructure and related services across a range of sectors. However, analyses of failed projects in developing and transition countries suggest that those projects were unsuccessful because of poor legal and regulatory framework. Improving that is the first priority for BiH.

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