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CAUSAL RELATIONSHIP BETWEEN ECONOMIC GROWTH, TRANSPORT INFRASTRUCTURE AND INVESTMENT IN TRANSPORT INFRASTRUCTURE IN TRANSITION COUNTRIES

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Abstract

Provision and maintenance of adequate infrastructure facilities are necessary if there is need to achieve and sustain rapid economic growth. The availability of infrastructure like transport is vital for accelerated development and modernization of a country. Transport infrastructure in particular, is vital to the prosperity of regions. The contribution of our study refers to the investigation the relationship and causality between economic growth, transport infrastructure, investment in transport infrastructure, as in transition countries. To achieve this aim, we proposed the growth model.We use annual data of 25 transition countries (see Appendix 1) for the time period 1990-2013.The findings from GMM reveal that there is bidirectional causal relationship between repressors we have studied.

Keywords: *transportation, economic growth, investment, institutions*

JEL Classification: *F43, L9*

1 Introduction

Provision and maintenance of adequate infrastructure facilities are necessary if there is need to achieve and sustain rapid economic growth. The availability of infrastructure like transport is vital for accelerated development and modernization of a country. Availability of adequate infrastructure facilities is an important

pre-condition for sustainable economic and social development **(Hirschman, 1985)**. Improvements in infrastructural services such as transportation are essential for enhancing efficacy of the productive process and for raising productivity of any economic entity **(Patra and Acharya, 2011)**.

Transport infrastructure in particular, is vital to the prosperity of regions. First, it links residents with employment, public services, shopping or social networks, and businesses to labour, consumers, and suppliers **(Kirkpatrick, Parker and Zhang, 2004)**. Second transport infrastructure may increase productivity of existing inputs and/or decrease transport and production costs making the region more attractive for investors **(Pradhan and Baghi, 2013)**. Besides this, transport infrastructure affects economic growth through the aggregated demand.

Institutions can foster infrastructure investment and by this could have impact on economic output. Therefore, considering institutional indicators in our study is one of the crucial points. The degree of relationship between transport infrastructure and economic growth relation is vital for transport infrastructure strategy and policies in transition countries. Transition economies form an ideal set for study, as they have all been part of a natural experiment. Out of communism, they share a similar history. Moreover, they all faced the same shock as they abandoned communism and command economies; all inherited dysfunctional institutions. This shock and the following structural change cause a break between the levels of development (growth) and institutions **(Paakkonen, 2010)**.

The contribution of our study refers to the investigation the relationship and causality between economic growth, transport infrastructure, investment in transport infrastructure, as in transition countries. To achieve this aim, we proposed the growth model. We have used panel data approach. Generalized Method of Moments (GMM) estimation, and the instrument exogeneity tests are used to specify and estimate the model.

2 Literature Review

2.1 Transport Infrastructure in Transition Countries

Transport is the movement of people and goods from one location to another. Transport infrastructure facilitates that movement. It connects goods to markets, workers to industry, people to services and the poor in rural areas to urban growth centers. Transport infrastructure is developed to enhance the movement or to increase trade **(Bafoil and Ruiwen, 2010)**.

The responsibility of the development of transport infrastructure traditionally lies with the government of the country. However, often the development of

infrastructure is achieved in cooperation with the private sector. The role of the government is to supply the demand for infrastructure. Examples of the demand of infrastructure is "goods-to-market" and "raw materials-to-factories". The infrastructure should facilitate the movement of goods between the locations. If the location is outside the country, the infrastructure should be connected to transport models, which can facilitate such movement, such as seaports, airports, or dryports. In a global market where trade is determined by comparative advantages, it is in the country's interest to lower its transport cost, in order to increase its competitiveness. High transport costs will be an obstacle to trade and impede the realization of gains from trade liberalization **(ADB, 2008)**.

There exists a close relationship between infrastructure and transport costs. First it reduces direct transportation costs. Second, it lowers the time of transport, which indirectly reduces cost. Thirdly, it reduces risks. Finally, it provides access to new markets **(Nordas and Piermartini, 2004)**.

Various factors determine transport costs across countries: The geographical characteristics (such as the distance from major markets, access to oceans and the countries typography), the type of products that a country import/export, the degree of containerization of transport, the traffic on specific routes, the quality of the transport infrastructure, and the efficiency of related transport services **(UNESCAP, 2011)**.

Differences across countries in transport costs, including relative costs between different modes of transport, are a source of comparative advantage and affect the volume and composition of trade. For example a country with relatively lower air transport costs may have a comparative advantage in time-sensitive goods **(WTO, 2004)**.

Products with a high value-weigth ratio are mainly transported by air, whereas products with low value-weight ratio mainly are transported by water. In general agricultural and mining goods are more expensive shipping than manufacturing products **(Sønderskov, 2013)**.

When transition occurs, it traditionally indicates that the previous system did not work. This in turn means that the facilities most likely are outdated, including the transport infrastructure. Domestically it is important to connect the largest economic trade centers, and widen the infrastructure network to include as large a part of the country as possible. There is a need to maintain, repair and update already existing infrastructure routes, but also extend the existing network. At least it is necessary to engage in regional cooperation to develop infrastructure plans that can connect its infrastructure network to neighbouring countries. This can be achieved either by direct agreements between neighbouring countries or by multiparty cooperation between countries in a region to develop infrastructure

plans within a larger perspective. Infrastructure to facilitate trade between countries which markets have been neglected for decades, are expected to be in a poor state, either by poor quality or simply by missing links. It is important to recognize the most important links and complete those **(World Bank, 2010)**.

Transport infrastructure i.e. road, railway, and pipelines typically means domestic trade, and foreign trade with neighbouring countries. However, a connection to a cross-border infrastructure network gains access to not only market but also markets connected to network. The connection gives an indirect access to global markets. For example the case of East-Central Europe, where Poland's road and railway connection to Germany, also meant access to France, Netherlands, Italy, etc. Transport infrastructure such as seaports and airports provides direct opportunities in world markets, depending on the geographic location, sea access etc. In the case of Vietnam the development of their ports, helped facilitate trade in a wide range of markets, such as America and Europe. As with the development of roads and railways, it is important to look at regional infrastructure when developing seaports and airports. Furthermore, the interdependence of the different kind of infrastructure is important. If large port is not connected to sufficient roads and/or railway facilities and their respective networks it will have a very limited purpose.

The quality of the transport networks reflects a number of factors, including their initial design. For example, in the Baltics the major trunk roads run east to west rather than north to south. The trunk roads in the former Soviet Union were also designed for lower vehicle weights than in the EU, although this is consistent with the traffic tasks which they had to perform in the past. With respect to railways, design standards are less exacting than those in the EU. However, most rail lines have adequate speeds and are of a sufficient standard for the majority of rail freight services currently provided **(GASPARD, 1996)**.

2.3 The Link between Transport Infrastructure and Economic Growth

Transport infrastructure is the basic infrastructure to national economy. The utilization of natural resources and the development of regional economy are heavily relying on it. Among specific ways that government contributes to total economic output and promote economic growth is The investment of public capital to transport infrastructure.

There have been numerous studies on the transport infrastructure and economic development related issues in the past decades. All the studies detect an effect of investments in infrastructure and economic growth. However, the views differ with respect to the size of this effect. The first studies dealing with this topic,

revealed that transport acts as a necessary condition for the growth to occur. **Aschauer (1989)** was one of the first estimating the macro effect of infrastructure investment on American economy. He found a strong impact of infrastructure capital on aggregate total factor productivity. Many researchers followed his work. The results of these first studies suggested high returns of infrastructure investment. However these studies were later on criticized by other authors for unrealistic results **(Gramlich 1994)**. Contrary to high estimates in these first studies, later results were predicting impacts that are more moderate. They explained that a first shock in infrastructure could cause great effect, but after the basic infrastructure was constructed, new investment would not cause much effect **(Huang and Harata, 2010)**. According to **Banister** and **Berechman (2001)**, it is widely agreed that the economic growth happens mainly due to capital, labor, etc. and only partly relying on the infrastructure improvement.

Canning and **Pedroni(1999)** used Granger causality test between investments in three types of economic infrastructure i.e., kilometers of paved road, kilowatts of electricity generating capacity, and number of telephones based on data from a panel of 67 countries for the period 1960-1990. They found strong evidence of causality running in both directions between each of the three infrastructure variables and GDP among a significant number of the countries investigated. **Demurger (2001)** used panel data from a sample of 24 Chinese provinces throughout the 1985 to 1998 period. She estimated a growth model and found out that transport facilities are a key differentiating factor in explaining the growth gaps.

Canning and **Pedroni (2004)** used panel cointegration technique and found that in general both short run and long run causality is bi-directional, with infrastructure responding to GDP per capita but GDP per capita also responding to infrastructure shocks. **Herranz-Loncan(2007)** analysed the impact of infrastructure investment on Spanish economic growth using VAR system. His paper showed that investment in local scope infrastructure exerted a clearly positive impact on Spanish economic growth between 1850 and 1935. **Pradhan** and **Bagchi (2013)** used Vector Error Correction Model to examine the effect of transport (road and rail) infrastructure on economic growth in India over the period 1970-2010. They found that transport infrastructure not only influences economic growth but also gross capital formation. **Kumo (2012)** conducted pairwise Granger causality tests between economic growth, economic infrastructure investment, and employment in South Africa for the period 1960-2009 using bivariate vector autoregression (VAR) model with and without a structural break. His results indicate a strong causality between economic infrastructure investment and GDP growth that runs in both directions.

3 Methodological Framework

According to objectives of our study, we have used growth model approach to explain the interrelationship between transport infrastructure, investment in transport infrastructure and economic growth (objective 1), where economic growth depends on transport infrastructure, investment in infrastructure and other inputs. The model framework helps us to explore the three-way linkage between the variables: transport infrastructure, investment in infrastructure and economic growth. These variables are in fact endogenous. It is therefore worth investigating the interrelationships between the three variables by considering them simultaneously in a modelling framework. Our proposed model, takes the following form:

$$GDP = \int (ITP, RRGT, RRPC, RRNL, GCF, L) \quad (1)$$

This essentially states that *GDP* is a function of investment in transport infrastructure with private participation (*ITPP*), gross capital formation (*GCF*), labour force (*L*), roads and rail goods transported in million ton per km (*RRGT*), roads and rail passengers carried in million passengers per km (*RRPC*), and roads and rail network length in km (*RRNL*).

We can rewrite Eq. (1) in growth form as follows:

$$Y'_{i,t} = \beta_0 + \beta_1 ITPP_{i,t} + \beta_2 RRGT_{i,t} + \beta_3 RRPC_{i,t} + \beta_4 RRNL_{i,t} + \beta_1 GCF_{i,t} + \beta_1 L_{i,t} + u_{it} \quad (2)$$

where the subscript $i=1,\ldots,N$ denotes the country and $t=1,\ldots,T$ denotes the time period. *Y'* represents growth rate of GDP; *GCF* represents the gross capital formation; *L* represents the total labour force; *ITPP* indicates investment in transport infrastructure with private participation; *RRGT* indicates roads and rail goods transported; *RRPC* indicates roads and rail passengers carried; *RRNL* indicates roads and rail network length.

4 Time Series Analyses

4.1 Panel Unit Root Tests

Panel unit root tests are used to examine the degree of integration between the variables and to assess the stationarity properties of the variables. In this study we have used seven different panel unit root tests including LLC test proposed by **Levin, Lin** and **Chu (2002)** IPS test proposed by **Im,Pesaran** and **Shin (2003)**, Fisher-type tests using ADF and PP tests of **Maddala** and **Wu (1999)** and **Choi (2001)**, **Breitung (2000)** and **Hadri (2000)**.

4.2 Panel Cointegration Tests

Cointegration implies the existence of a long-run relationship between variables. The principle of testing for cointegration is to test whether two or more integrated variables deviate significantly from a certain relationship **(Abadir and Taylor, 1999)**.

In our empirical analysis, we used two sets of cointegration test methods. The first set of tests is **Pedroni (2004)**. The second set of tests is **Kao (1999)**, which is based on the Engle-Granger two-step procedure and imposes homogeneity on the members in the panel and is a generalization of the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests in the context of panel data.

4.3 Generalized Method of Moments (GMM) Estimation Technique

We later transform the growth model into regression equations in order to treat simultaneously our variables as endogenous. On this basis, we use the following simultaneous equations model to investigate the interrelationship between transport infrastructure indicators, investment in transport infrastructure with private participation, gross capital formation, labour force, and economic growth. The linkages between these variables are empirically examined by making use of the following equations:

$$Y'_{it} = a_0 + a_1\ ITPP_{it} + a_2\ RRGT_{it} + a_3\ RRPC_{it} + a_4\ RRNL_{it} + a_5\ GCF_{it} + a_6 L_{it} + a_7 FD_{it} + \varepsilon_{it} \quad (3a)$$

$$ITPP_{it} = \beta_0 + \beta_1\ Y'_{it} + \beta_2\ RRGT_{it} + \beta_3\ RRPC_{it} + a_4\ RRNL_{it} + \beta_5\ GCF_{it} + \beta_6 L_{it} + \beta_7 EBRD_{it} + \varepsilon_{it} \quad (3b)$$

$$RRGT_{it} = \varphi_0 + \varphi_1\ Y'_{it} + \varphi_2\ ITPP_{it} + \varphi_3\ RRPC_{it} + \varphi_4\ RRNL_{it} + \varphi_5\ GCF_{it} + \varphi_6 L_{it} + \varphi_7 EBRD_{it} + \varphi_8 FD_{it} + \varphi_9 TP_{it} + \varepsilon_{it} \quad (3c)$$

$$RRPC_{it} = \xi_0 + \xi_1\ Y'_{it} + \xi_2\ ITPP_{it} + \xi_3\ RRGT_{it} + \xi_4\ RRNL_{it} + \xi_5\ GCF_{it} + \xi_6 L_{it} + \xi_7 EBRD_{it} + \xi_8 FD_{it} + \xi_9 TP_{it} + \varepsilon_{it} \quad (3d)$$

$$RRNL_{it} = \gamma_0 + \gamma_1\ Y'_{it} + \gamma_2\ ITPP_{it} + \gamma_3\ RRGT_{it} + \gamma_4\ RRPC_{it} + \gamma_5\ GCF_{it} + \gamma_6 L_{it} + \gamma_7 EBRD_{it} + \gamma_8 FD_{it} + \gamma_9 TP_{it} + \varepsilon_{it} \quad (3e)$$

Equation (3a) states that investment in transport infrastructure with private participation (*ITPP*), transport infrastructure, and other variables, namely, gross capital formation (*GCF*), labour force (*L*), and financial development (*FD*) can potentially determine economic growth. Equation (3b) states that economic growth (*Y'*), transport infrastructure (*RRGT, RRPC, RRNL*) and other variables, namely, gross capital formation (*GCF*), labour force (*L*), institutions (*EBRD*), can potentially affect investment in transport infrastructure with private participation (*ITPP*). Equation (3c) suggests that economic growth (*Y'*), investment in transport infrastructure with private participation (*ITPP*), rail and road passenger carried and network length (*RRPC* and *RRNL*), gross capital formation (*GCF*),

labour force (*L*), and financial development (*FD*) and total population (*TP*) can potentially affect RRGT. Equation (3d) suggests that economic growth (*Y*), investment in transport infrastructure with private participation (*ITPP*), rail, and road goods transported and network length (*RRGT* and *RRNL*), gross capital formation (*GCF*), labour force (*L*), and financial development (*FD*) and total population (*TP*) can potentially affect RRPC. And similarly, equation (3e) suggests that economic growth (*Y'*), investment in transport infrastructure with private participation (*ITPP*), rail and road goods transported and passenger carried (*RRGT* and *RRPC*), gross capital formation (*GCF*), labour force (*L*), and financial development (*FD*) and total population (*TP*) can potentially affect RRNL.

As it is mentioned above for growth model we have employed a dynamic panel data approach in a simultaneous-equations with lagged levels of economic growth, ITPP, and infrastructure variables by using the **Arellano** and **Bond (1991)** GMM estimator. For the growth model, our proposed modelling is as follows:

$$Y'_{it} = a_0\ Y_{i,t-1} + \varphi ITPP_{i,t} + \varphi RRGT_{it} + \varphi RRPC_{it} + \varphi RRNL_{it} + \beta X_{i,t} + \mu_{i,t} + \varepsilon_{it} \quad (4a)$$

$$ITPP_{it} = \varphi_0\ ITPP_{i,t-1} + \psi Y'_{it} + \psi\ RRGT_{it} + \psi\ RRPC_{i,t} + \psi\ RRNL_{i,t} + \beta X_{i,t} + \mu_{i,t} + \varepsilon_{it} \quad (4b)$$

$$RRGT_{it} = \xi_0 RRGT_{i,t-1} + \sigma ITPP_{i,t} + \sigma Y'_{i,t} + \sigma\ RRPC_{i,t} + \sigma RRNL_{i.t} + \beta X_{i,t} + \mu_{i,t} + \varepsilon_{it} \quad (4c)$$

$$RRPC_{it} = \rho_0 RRPC_{i,t-1} + \gamma ITPP_{i,t} + \gamma Y'_{i,t} + \gamma RRGT_{i,t} + \gamma RRNL_{i,t} + \beta X_{i,t} + \mu_{i,t} + \varepsilon_{it} \quad (4d)$$

$$RRNL_{it} = \xi_0 RRNL_{i,t-1} + \nu ITPP_{i,t} + \nu Y'_{it} + \nu RRGT_{i,t} + \nu RRPC_{i,t} + \beta X_{i,t} + \mu_{i,t} + \varepsilon_{it} \quad (4e)$$

$$i=1,\ldots,N;\ \ t=1,\ldots,T$$

Where Y'_{it}, $ITPP_{it}$, $RRGT_{it}$, $RRPC_{it}$ and $RRNL_{it}$ represent the GDP, investment in transport infrastructure with private participation and transport infrastructure of country *i* at time *t*, respectively. a_0 is the parameter to be estimated. *X* is a vector of core explanatory variables used to model economic growth (GCF, labour force and financial development), to model investment in transport infrastructure with private participation (GCF, labour force, institutional indicator) and to model transport infrastructure (GCF, labour force, institutional indicator total population, and financial development). φ captures the effect of ITPP and transport infrastructure on economic growth; ψ captures the effects of economic growth and transport infrastructure on ITPP and so on. μ is country-specific effect and ε is the error term. Then the lagged dependent variables ($Y'_{i,t-1}$, $ITPP_{i,t-1}$, $RRGT_{i,t-1}$, $RRPC_{i,t-1}$, $RRNL_{i,t-1}$) are correlated with the error term, the use of panel Ordinary least squares (OLS) estimator (with fixed and random effects) is problematic. The **Arellano** and **Bond (1991)** approach solves this problem by first differentiating the above equations.

5 Data

We use annual data of 25 transition countries (see Appendix 1) for the time period 1990-2013. All the data are obtained from the World Bank, World Development Indicators, WDI, 2014. Our panel data set is unbalanced since we do not have complete information for all countries over the sample period.

The annual data on gross domestic product (GDP) in constant 2005 US dollars are used as a proxy for economic growth (Y'), road, and railway transport, which are: RRGT is roads and rail goods transported (million ton-km), RRPC is roads and rail passengers carried (million passenger per km), and RRNL is roads and rail network length (km). These variables are used as a proxy for transport infrastructure. Investment in transport infrastructure with private participation (ITPP) (current US dollars) and gross capital formation (GCF) in constant 2005 US dollars are used. L represents total labour force (percentage of total population). Financial development (FD) (total credit to private sector as a ratio of GDP) and total population (TP) in thousands are used. The institutional quality variable is represented through the European Bank for Reconstruction and Development indicator (Appendix 2). All variables are transformed into natural logarithms and have been processed using EViews 8 statistical program.

6 Empirical Results

6.1 Panel Unit Root Tests Results

Before the own analysis we had to check the nature of time series used. To test the stationarity of our time series we have applied different unit root tests. In Table 1 the results of the LLC, IPS, Fisher-ADF, and Fisher-PP, Breitung and Hadri panel unit root tests for each of the variables are presented. We have performed each test for the level and first difference.

Table 1 **Panel Unit Root Test Results**

Null: unit root							Null: No unit root	
Methods		**LLC**	**Breitung t-stat**	**IPS**	**Fisher-ADF**	**Fisher-PP**	**Hadri Z-stat**	**Heteroscedastic consistent Z-stat**
Variables								
Level	**Y'**	-1.809	1.580	2.810	54.018	76.997	8.189***	5.873***
	ITPP	-4.085	0.081	-1.471	16.213	15.791	9.643***	11.003***
	RRGT	0.404	0.337	3.257	38.518	34.187	8.410***	7.732***
	RRPC	1.185	0.142	2.988	21.105	29.138	7.635***	4.448***
	RRNL	-3.165	0.511	1.874	31.025	33.741	6.026***	5.753**
	GCF	-0.108	0.831	0.120	68.731	82.221	11.286***	12.619***
	L	-2.421	3.292	-0.063	75.923	48.792	11.387***	10.769***
	EBRD	-3.476	0.987	-1.627	58.011	35.203	12.524***	12.006***
	FD	0.597	3.703	2.323	30.480	33.481	7.856***	7.463***
	TP	9.598	-1.293	-1.478	56.861	65.344	11.259***	9.570***
First difference	**ΔY'**	-16.511***	-4.499***	-15.042***	290.865***	271.865***	0.511	0.345
	ΔITPP	-6.472***	-0.304*	-7.504***	26.081***	263.412***	0.49	0.949
	ΔRRGT	-15.846***	-7.763***	-9.732***	226.045***	271.562***	0.825	0.131
	ΔRRPC	-15.267***	-5.395***	-18.264***	445.349***	567.915***	0.095	-0.264
	ΔRRNL	-13.295***	-4.427***	-20.296***	226.872***	208.521***	-0.218	1.571
	ΔGCF	-13.082***	-6.189***	-12.729***	276.347***	294.926***	1.541	-0.915
	ΔL	-8.501***	-5.524***	-5.596***	200.646***	225.921***	0.307	-0.941
	ΔEBRD	-11.528***	-3.762***	-11.302***	249.577***	340.060***	-1.367	0.230
	ΔFD	-6.374***	-1.775**	-2.401***	66.730***	129.220***	2.232	1.578
	ΔTP	-4.294***	-3.062**	6.939***	173.378***	132.409***	-1.281	0.491

Source: Own elaboration.

Notes: Δ denotes the first difference. The optimal lag length is selected automatically using the Schwarz information criteria
*** Indicate that the parameters are significant at the 1% level
** Indicate that the parameters are significant at the 5% level.
* Indicate that the parameters are significant at the 10 % level

Y' - Economic Growth, ITPP - Investment in Transport Infrastructure with Private Participation, RRGT Roads and Rail Goods Transported, RRPC Roads and Rail Passengers Carried, RRNL Roads and Rail Network Length, GCF Gross Capital Formation, L Labour Force, EBRD European Bank for Reconstruction and Development Indices, FD Financial Development, TP Total Population

For the variables in level form, the null hypothesis is not rejected for the IPS LLC, Breitung tests, Fisher-ADF, and Fisher-PP tests, while the Hadri test rejects the null hypothesis at the 1% significance level for almost all variables. After taking the first difference, the first five tests reject the null hypothesis almost at the 1% significance level. So, we can conclude that all variables (in first differences) are stationary and integrated of order one or I(1).

The null hypothesis is that the variable follows a unit root process, except for the Hadri Z-stat and the Heteroscedastic Consistent Z-stat. Probabilities for the Fisher-type tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

6.2 Panel Cointegration Tests Results

For the robustness check, this study used two kinds of panel cointegration tests, i.e. Pedroni's (2004) and Kao's (1999) tests. Table 2 reports the within and between dimension results of the panel cointegration tests. As shown in Table 2, the results of Pedroni's (2004) heterogeneous panel tests indicate that the null hypothesis of no cointegration can be rejected at the 1% and 5% significance levels except for the panel pp-statistic and the group pp-statistic. Most of the tests reject the null hypothesis and it means the variables are cointegrated.

Table 2 **Pedroni Residual Cointegration Test Results (Y' as dependent variable)**

	Statistics	Probability
Within dimension		
Panel v-Statistic	1.655***	0.001
Panel rho-Statistic	1.126***	0.004
Panel PP-Statistic	-1.155	0.123
Panel ADF-Statistic	-1.183**	0.051
Between dimension		
Group rho-Statistic	1.765***	0.004
Group PP-Statistic	0.482	0.685
Group ADF-Statistic	-1.614**	0.054

Source: Own elaboration.

Notes: The null hypothesisis that the variables are not cointegrated.Under the null tests,all the statistics are distributed as normal(0,1).
*** Indicate that the parameters are significant at the 1% level.
** Indicate that the parameters are significant at the 5 % level

Beside the Pedroni cointegration tests we applied the test proposed by Kao (1999) to check the robustness of our results. Table 3 reports the results of Kao's (1999) residual panel cointegration tests, which reject the null hypothesis of no cointegration at the 1% significance level.

Table 3 **Kao's Residual Cointegration Test Results (Y' as dependent variable)**

	t-statistic	Probability
ADF	-2.911***	0.00

Source: Own elaboration.

Note: The ADF is the residual-based ADF statistic (Kao, 1999).
*** Indicates that the parameters are significant at the 1% level

Thus, we conclude that there is a panel long-run equilibrium relationship among variables, meaning that variables of economic growth, investment in transport infrastructure with private participation and transport infrastructure move together in the long run.

6.4 Dynamic GMM Results

The results of the GMM estimation are reported in Table 4. In model 1, we have found that investment in transport infrastructure and transport infrastructure have positive and statistically significant effects on economic growth. The magnitude of 0.441 and 0.227, 0.361, 0.251 implies that 1% increase in the investment in transport infrastructure and transport infrastructure increases the economic growth of transition countries by 0.44% and 0.23%, 0.36%, 0.25% respectively. Capital stock (GCF) is also statistically significant determinant of economic growth, while labour is statistically insignificant and financial development has negative effect on economic growth.

Table 4 **Dynamic GMM Results**

Independent Variables	Model 1 Y'	Model 2 ITPP	Model 3 RRGT	Model 4 RRPC	Model 6 RRNL
Y'	-	0.197** (0.02)	0.277**(0.03)	0.249***(0.00)	0.167***(0.00)
ITPP	0.441***(0.00)	-	0.446***(0.00)	0.204**(0.03)	0.267**(0.03)
RRGT	0.227***(0.00)	0.112(0.23)	-	0.152(0.21)	0.318**(0.03)
RRPC	0.361***(0.00)	0.125(0.35)	0.064(0.56)	-	0.430***(0.00)
RRNL	0.251***(0.00)	0.092**(0.02)	0.201**(0.02)	0.210**(0.04)	-
GCF	0.161*(0.03)	0.207*(0.06)	0.194**(0.04)	0.567**(0.04)	0.194*(0.04)
L	0.113 (0.146)	0.034(0.62)	0.115(0.34)	0.164(0.11)	0.099(0.12)
FD	-0.187*(0.07)	-	0.186**(0.04)	0.199*(0.07)	0.342**(0.02)

Inde-pendent Variables	Model 1 Y'	Model 2 ITPP	Model 3 RRGT	Model 4 RRPC	Model 6 RRNL
EBRD	-	-0.195*(0.06)	0.349***(0.00)	0.199*(0.07)	0.189*(0.09)
TP	-	-	0.164*(0.06)	0.419**(0.03)	0.189*(0.09)
Number of Oservation	600	520	600	600	600
Tests					
Hausen	21.66	22.19	26.19	19.39	24.82
AR(2)	0.205	0.098	0.118	0.675	0.199

Source: Own elaboration.

Note: Values in parentheses are the estimated p-values
Hansen J-test – over identification test of restrictions in GMM estimation
AR2 test – Arellano-Bond's test to analyze the existence of 2nd order autocorrelation in first differences.
*, ** and *** indicate significance at 10%, 5% and 1%

Y' - Economic Growth, ITPP - Investment in Transport Infrastructure with Private Participation, RRGT Roads and Rail Goods Transported, RRPC Roads and Rail Passengers Carried, RRNL Roads and Rail Network Length, GCF Gross Capital Formation, L Labour Force, EBRD European Bank for Reconstruction and Development Indices, FD Financial Development, TP Total Population

In model 2, we have found that the effect of economic growth and one variables of transport infrastructure (RRNL) are positive and statistically significant at the 5% level. The magnitude of 0.197 and 0.092 implies that a 1% increase in economic growth and RRNL increases the investment in transport infrastructure by around 0.10%. GCF is also statistically significant determinant of investment in transport infrastructure, while labour remains statistically insignificant and EBRD indicator has negative effect. In model 3, we have found that the effects of economic growth, investment in transport infrastructure and RRNL are positive and statistically significant at the 5%, 1%, and 5% levels, respectively. The magnitude of 0.277, 0.446, and 0.201 implies that a 1% increase in economic growth, investment in transport infrastructure and RRNL increases the RRGT by 0.27%, 0.45% and 0.20%, respectively. This means that an increase in economic growth, investment in transport infrastructure and RRNL tends to more goods transported by rail and roads. In model 4, we have approximately the same picture like in model 3. The effects of economic growth, investment in transport infrastructure

and RRNL are positive and statistically significant. Financial development, GCF, EBRD indicator, and population are also positive significant, while labour force is positive insignificant. Finally, in model 5, we have found that economic growth, investment in transport infrastructure, RRGT, RRPC are positive and statistically significant at the 1%, 5% ,5% and 1% levels, respectively. GCF, FD, EBRD indicator, and population are also statistically significant determinants of RRNL, but labour force is statistically insignificant.

In addition, the findings reveal that there is bidirectional causal relationship between economic growth and investment in transport infrastructure, and between economic growth and transport infrastructure. There is also uni-directional causal relationship from investment in transport infrastructure to transport infrastructure. Based on these findings we may conclude that the first, second and third hypotheses were confirmed.

7 Conclusion

The aim of our study was to find the relationship among economic growth, transport infrastructure and investment in transport infrastructure with private participation; economic output, infrastructure index and institution quality in transition countries.

Economic growth is important for all countries in addition, for transition countries, it bears a crucial importance. The transition from a planned-economy to an open market economy is considered to be one of the factors of transition countries. Twenty-five transition countries have been studied.

While empirically evaluating growth model we have used unit root tests and found that all variables (in first differences) are stationary and integrated of order one. For robustness check, we have performed the panel cointegration test and we have found that there is a panel long-run equilibrium relationship among variables, meaning that variables move together in the long run. The findings from GMM reveal that there is bidirectional causal relationship between economic growth and investment in transport infrastructure, and between economic growth and transport infrastructure. Therefore, investment in transport infrastructure and increase in quantity and quality of transport infrastructure induce the economic growth and this relationship is mutual. There is also unidirectional causal relationship from investment in transport infrastructure with private participation to transport infrastructure.

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Appendixes

Appendix 1 List of Transition Countries

Table 1 **List of Transition Countries**

	Country		Country
1	Albania	19	Romania
2	Armenia	20	Russia
3	Azerbaijan	21	Serbia
4	Belarus	22	Tajikistan
5	Bosnia and Herz.	23	Turkmenistan
6	Bulgaria	24	Ukraine
7	Croatia	25	Uzbekistan
8	Estonia		
9	Georgia		
10	Kazakhstan		
11	Kosovo		
12	Kyrgizstan		
13	Latvia		
14	Luthiania		
15	Macedonia		
16	Moldova		
17	Mongolia		
18	Montenegro		

Appendix 2 Transition Indicators Methodology (EBRD)

The transition indicator scores reflect the judgment of the EBRD's Office of the Chief Economist about country-specific progress in transition. The scores are based on the following classification system, which was originally developed in the 1994 Transition Report, but has been refined and amended in subsequent reports.

"+" and "-" ratings are treated by adding 0.33 and subtracting 0.33 from the full value. Averages are obtained by rounding down, for example. a score of 2.6 is treated as 2+, but a score of 2.8 is treated as 3-.

Overall transition indicators

Large-scale privatisation

1 Little private ownership.

2 Comprehensive scheme almost ready for implementation; some sales completed.

3 More than 25 per cent of large-scale enterprise assets in private hands or in the process of being privatised (with the process having reached a stage at which the state has effectively ceded its ownership rights), but possibly with major unresolved issues regarding corporate governance.

4 More than 50 per cent of state-owned enterprise and farm assets in private ownership and significant progress with corporate governance of these enterprises.

4+ Standards and performance typical of advanced industrial economies: more than 75 per cent of enterprise assets in private ownership with effective corporate governance.

Small-scale privatisation

1 Little progress.

2 Substantial share privatised.

3 Comprehensive programme almost ready for implementation.

4 Complete privatisation of small companies with tradable ownership rights.

4+ Standards and performance typical of advanced industrial economies: no state ownership of small enterprises; effective tradability of land.

Governance and enterprise restructuring

1 Soft budget constraints (lax credit and subsidy policies weakening financial discipline at the enterprise level); few other reforms to promote corporate governance.

2 Moderately tight credit and subsidy policy, but weak enforcement of bankruptcy legislation and little action taken to strengthen competition and corporate governance.

3 Significant and sustained actions to harden budget constraints and to promote corporate governance effectively (for example, privatisation combined with tight credit and subsidy policies and/or enforcement of bankruptcy legislation).

4 Substantial improvement in corporate governance and significant new investment at the enterprise level, including minority holdings by financial investors.

4+ Standards and performance typical of advanced industrial economies: effective corporate control exercised through domestic financial institutions and markets, fostering market-driven restructuring.

Price liberalisation

1 Most prices formally controlled by the government.

2 Some lifting of price administration; state procurement at non-market prices for the majority of product categories.

3 Significant progress on price liberalisation, but state procurement at non-market prices remains substantial.

4 Comprehensive price liberalisation; state procurement at non-market prices largely phased out; only a small number of administered prices remain.

4+ Standards and performance typical of advanced industrial economies: complete price liberalisation with no price control outside housing, transport and natural monopolies.

Trade and foreign exchange system

1 Widespread import and/or export controls or very limited legitimate access to foreign exchange.

2 Some liberalisation of import and/or export controls; almost full current account convertibility in principle, but with a foreign exchange regime that is not fully transparent (possibly with multiple exchange rates).

3 Removal of almost all quantitative and administrative import and export restrictions; almost full current account convertibility.

4 Removal of all quantitative and administrative import and export restrictions (apart from agriculture) and all significant export tariffs; insignificant direct involvement in exports and imports by ministries and state-owned trading companies; no major non-uniformity of customs duties for non-agricultural goods and services; full and current account convertibility.

4+ Standards and performance norms of advanced industrial economies: removal of most tariff barriers; membership in WTO.

Competition policy

1 No competition legislation and institutions.

2 Competition policy legislation and institutions set up; some reduction of entry restrictions or enforcement action on dominant firms.

3 Some enforcement actions to reduce abuse of market power and to promote a competitive environment, including break-ups of dominant conglomerates; substantial reduction of entry restrictions.

4 Significant enforcement actions to reduce abuse of market power and to promote a competitive environment.

4+ Standards and performance typical of advanced industrial economies: effective enforcement of competition policy; unrestricted entry to most markets.

Banking reform and interest rate liberalisation

1 Little progress beyond establishment of a two-tier system.

2 Significant liberalisation of interest rates and credit allocation; limited use of directed credit or interest rate ceilings.

3 Substantial progress in establishment of bank solvency and of a framework for prudential supervision and regulation; full interest rate liberalisation with little preferential access to cheap refinancing; significant lending to private enterprises and significant presence of private banks.

4 Significant movement of banking laws and regulations towards BIS standards; well-functioning banking competition and effective prudential supervision; significant term lending to private enterprises; substantial financial deepening.

4+ Standards and performance norms of advanced industrial economies: full convergence of banking laws and regulations with BIS standards; provision of full set of competitive banking services.

Securities markets and non-bank financial institutions

1 Little progress.

2 Formation of securities exchanges, market-makers and brokers; some trading in government paper and/or securities; rudimentary legal and regulatory framework for the issuance and trading of securities.

3 Substantial issuance of securities by private enterprises; establishment of independent share registries, secure clearance and settlement procedures, and some protection of minority shareholders; emergence of non-bank financial institutions (for example, investment funds, private insurance and pension funds, leasing companies) and associated regulatory framework.

4 Securities laws and regulations approaching IOSCO standards; substantial market liquidity and capitalisation; well-functioning non-bank financial institutions and effective regulation.

4+ Standards and performance norms of advanced industrial economies: full convergence of securities laws and regulations with IOSCO standards; fully developed non-bank intermediation.

Infrastructure reform

The ratings are calculated as the average of five infrastructure reform indicators covering electric power, railways, roads, telecommunications, water and waste water. The classification system used for these five indicators is detailed below.

Electric power

1 Power sector operates as government department with few commercial freedoms or pressures. Average prices well below costs, with extensive cross-subsidies. Monolithic structure, with no separation of different parts of the business.

2 Power company distanced from government, but there is still political interference. Some attempt to harden budget constraints, but effective tariffs are low. Weak management incentives for efficient performance. Little institutional reform and minimal, if any, private sector involvement.

3 Law passed providing for full-scale restructuring of industry, including vertical unbundling through account separation and set-up of regulator. Some tariff reform and improvements in revenue collection. Some private sector involvement.

4 Separation of generation, transmission and distribution. Independent regulator set up. Rules for cost-reflective tariff-setting formulated and implemented. Substantial private sector involvement in distribution and/or generation. Some degree of liberalisation.

4+ Tariffs cost-reflective and provide adequate incentives for efficiency improvements. Large-scale private sector involvement in the unbundled and well-regulated sector. Fully liberalised sector with well-functioning arrangements for network access and full competition in generation.

Railways

1 Monolithic structure operated as government department, with few commercial freedoms. No private sector involvement and extensive cross-subsidisation.

2 Rail operations distanced from state, but weak commercial objectives. Some business planning, but targets are general and tentative. No budgetary funding of public service obligations. Ancillary businesses separated, but little divestment. Minimal private sector involvement.

3 Commercial orientation in rail operations. Freight and passenger services separated and some ancillary businesses divested. Some budgetary compensation available for passenger services. Improved business planning with clear investment and rehabilitation targets, but funding unsecured. Some private sector involvement in rehabilitation and/or maintenance.

4 Railways fully commercialised, with separate internal profit centres for freight and passenger services. Extensive market freedoms to set tariffs and investments. Implementation of medium-term business plans. Ancillary industries divested. Private sector participation in freight operation, ancillary services and track maintenance.

4+ Separation of infrastructure freight and passenger operations. Full divestment and transfer of asset ownership implemented or planned, including infrastructure and rolling stock. Rail regulator established and access pricing implemented.

Roads

1 Minimal degree of decentralisation and no commercialisation. All regulatory, road management and resource allocation functions centralised at ministerial level. New investments and road maintenance financing dependent on central budget allocations. Road user charges not based on the cost of road use. Road construction and maintenance undertaken by public construction units. No public consultation in the preparation of road projects.

2 Moderate degree of decentralisation and initial steps in commercialisation. Road/highway agency created. Improvements in resource allocation and public procurement. Road user charges based on vehicle and fuel taxes, but not linked to road use. Road fund established, but dependent on central budget. Road construction and maintenance undertaken primarily by corporatised public entities, with some private sector participation. Minimal public consultation/participation on road projects.

3 Fair degree of decentralisation and commercialisation. Regulation and resource allocation functions separated from road maintenance and operations. Level of vehicle and fuel taxes related to road use. Private companies able to provide and operate roads under negotiated commercial contracts. Private sector participation in road maintenance and/or through concessions to finance, operate and maintain parts of highway network. Limited public consultation/participation and accountability on road projects.

4 Large degree of decentralisation. Transparent methodology used to allocate road expenditures. Track record in competitive procurement of road design, construction, maintenance and operations. Large-scale private sector participation in construction, operations and maintenance directly and through public-private partnerships. Substantial public consultation/participation and accountability on road projects.

4+ Fully decentralised road administration. Commercialised road maintenance operations competitively awarded to private companies. Road user charges

reflect the full costs of road use and associated factors, such as congestion, accidents and pollution. Widespread private sector participation in all aspects of road provision. Full public consultation on new road projects.

Telecommunications

1 Little progress in commercialisation and regulation. Minimal private sector involvement and strong political interference in management decisions. Low tariffs, with extensive cross-subsidisation. Liberalisation not envisaged, even for mobile telephony and value-added services.

2 Modest progress in commercialisation. Corporatisation of dominant operator and some separation from public sector governance, but tariffs are still politically set.

3 Substantial progress in commercialisation and regulation. Telecommunications and postal services fully separated; cross-subsidies reduced. Considerable liberalisation in the mobile segment and in value-added services.

4 Complete commercialisation, including privatisation of the dominant operator; comprehensive regulatory and institutional reforms. Extensive liberalisation of entry.

4+ Effective regulation through an independent entity. Coherent regulatory and institutional framework to deal with tariffs, interconnection rules, licensing, concession fees and spectrum allocation. Consumer ombudsman function.

Water and waste water

1 Minimal degree of decentralisation; no commercialisation. Services operated as vertically integrated natural monopolies by government ministry or municipal departments. No financial autonomy and/or management capacity at municipal level. Low tariffs, low cash collection rates and high cross-subsidies.

2 Moderate degree of decentralisation; initial steps towards commercialisation. Services provided by municipally owned companies. Partial cost recovery through tariffs; initial steps to reduce cross-subsidies. General public guidelines exist regarding tariff-setting and service quality, but both under ministerial control. Some private sector participation through service or management contacts, or competition to provide ancillary services.

3 Fair degree of decentralisation and commercialisation. Water utilities operate with managerial and accounting independence from municipalities, using international accounting standards and management information systems. Operating costs recovered through tariffs, with a minimum level of cross-subsidies. More detailed rules drawn up in contract documents, specifying tariff review formulae and performance standards. Private sector participation through the full concession of a major service in at least one city.

4 Large degree of decentralisation and commercialisation. Water utilities managerially independent, with cash flows – net of municipal budget transfers – that ensure financial viability. No cross-subsidies. Semi-autonomous regulatory agency able to advise and enforce tariffs and service quality. Substantial private sector participation through build-operator-transfer concessions, management contacts or asset sales in several cities.

4+ Water utilities fully decentralised and commercialised. Fully autonomous regulator exists with complete authority to review and enforce tariff levels and quality standards. Widespread private sector participation via service/ management/lease contracts. High-powered incentives, full concessions and/or divestiture of water and waste-water services in major urban areas.

http://www.ebrd.com/cs/