TRANSPORTATION INFRASTRUCTURE AND ECONOMIC GROWTH: THE CASE OF ROMANIA

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Abstract: *This article analyzes the impact of transportation infrastructure which differs in terms of quality and administrative status in Romania on economic growth, using panel data on the county level for the period from 1995 to 2010. The model is built on the basis of Cobb-Douglass production function, adding infrastructure variables. The results obtained using models with different specifications show convincing evidence that Gross Regional Product is sensitive to the stock of roads available for transportation in Romania. Obtained results can serve as a proxy for policy makers in Republic of Moldova.*

Key words: *Transportation infrastructure, economic growth, econometric models, gross regional product, Romania.*

4. Introduction.

Romania performed a huge transition over the last 25 years: from the collapse of the communist regime in 1989 to integration in EU in 2007. Generally, this period of time can be characterized as a period of economic development and growth. However, the real GDP dynamic was not a stable up trend, it fluctuated during the last decade of the twentieth century, and decreased being affected by the world financial crisis. Thus, EU is often associated with trade liberalization, so transportation infrastructure plays a crucial role within this framework. Actually it is impossible to benefit from liberalization of trade and following economic growth without developed transportation network. The majority of transportation services are conducted by the roads and railways system in Romania. For example, 74% of goods were transported by roads and 14% by railways in 2010. The density of roads is presented on Figure 1.

Romania was divided into 8 development regions in order to simplify implementations of projects in EU integration framework, however these development have no administrative status or regional authorities. Simultaneously, the official administrative division includes 42 counties (including municipality of Bucharest).

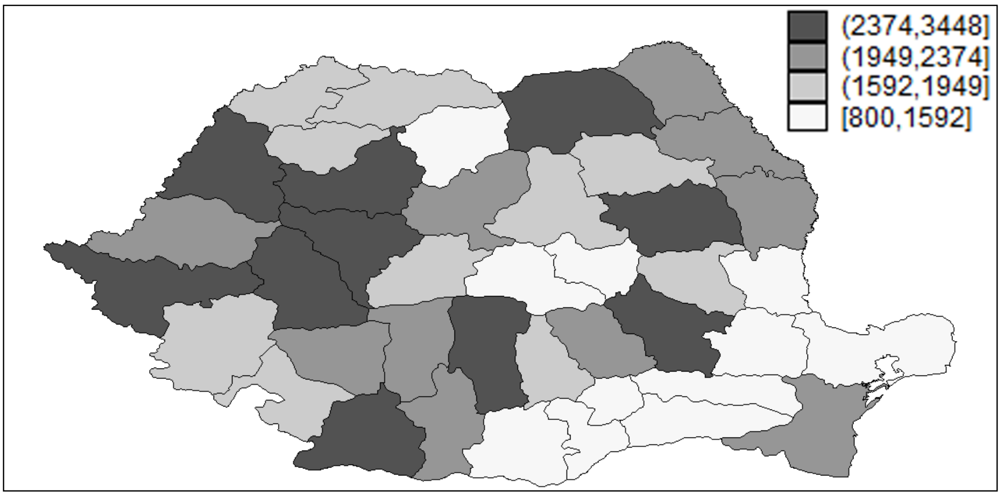

Figure1. The road density in 2010 (km).

5. The data and model.

The panel data include 41 Romanian counties and municipality of Bucharest (42 regions) during the period from 1995 till 2010 years (672 observations). The data are provided by the Romanian National Company of Motorways and National Roads (RNCMNR).

In order to estimate the impact of infrastructure on economic growth I'm going to follow the approach described by Canning (1999). Using the Cobb-Douglass production function:

$$Y_{it} = A_{it} K^{\alpha}_{it} X^{\beta}_{it} L_{it}^{1-\alpha-\beta} U_{it} \quad (1)$$

Where: Y is the Gross Regional Product (GRP) produced in the region i in year t; A is the aggregate factor of productivity; K is a real stock of assets accumulated in the region i; X is the stock of infrastructure assets; L is labor; U is the error term; i is the index of the country or municipality and t is the index of the time. Also it is important to introduce a set of assumptions for this model: the first one is constant return to scale, that is why, the second assumption is that log $A_{it} = a_i + b_t$, where a_i is regional or municipality fixed effect and b_t is the whole country's overall productivity in a given year t.

Deriving by L and then taking logs in (1) it is easy to derive:

$$y_{it} = a_i + b_t + \alpha k_{it} + \beta x_{it} + u_{it} \quad (2)$$

After that we split variable x in several groups in order to test the impact of the quality of covering and the administrative status. So the final model is

$$y_{it} = a_i + b_t + \alpha k_{it} + \gamma_1 nat\_road_{it} + \gamma_2 nat\_mod\_roads_{it} + +\gamma_3 nat\_light\_road_{it} + \gamma_4 cou\_road_{it} + \gamma_5 cou\_mod\_roads_{it} + \gamma_6 cou\_light\_road_{it} + \gamma_7 cou\_light\_road_{it} + \gamma_8 railways_{it} + u_{it} \quad (3)$$

Where: nat_road means the stock of the paved roads with national administrative status; nat_mod_roads means the stock of roads with national administrative status which experienced modernization in period t; nat_light_roas means the stock of national roads with light covering, cou_road means the length of county paved roads available in period t; cou_mod road means the length of county roads after modernization in period t; cou_light_road means the stock of county roads with light covering and railways means the stock of railways available in county I in year t.

The following data is used in order to fit the model, described above.

The dependent variable is GRP per capita in Romanian countries at constant prices 2000 in millions euro.

The independent variables are: stock of capital calculated by perpetual inventory method (k) at constant prices 2000 in millions euro; the length of all kinds of roads and railways used in (3) and is in km per capita.

The regional stock of capital is calculated according to the perpetual inventories method: the law of motion for capital is set up as the following:

$$K_{t+1} = (1-\sigma)*K_t + I_t \quad (4)$$

Where: I – formation of fixed capital \$ in real terms; K – stock of capital in period t \$ in real terms; σ – depreciation.

Depreciation σ is calculated as the following:

$$\sigma = \frac{1}{t_2 - t_1 + 1} * \sum_{t=t_1}^{t_2} \frac{CF_t}{GDP_t} \quad (5)$$

Where: CF – consumption of fixed capital in \$ in real terms.

The first value of K is taken as three times GDP of the initial period (1991). The source of data for calculating of capital stocks is World Bank.

Both GRP and capital follow up-trend in almost all counties in Romania during the period of interest, with the largest growth during the first three years after entering EU. All paved road variables also follow up-trend. Overall, Romania increased the stock of road capital by 15% during the period of interest.

6. Empirical results and conclusions

We present the estimations of coefficients of interesting in the Table 1. Here fixed effect regression is preferable to random effect regression according to the Hausman test. Significant coefficients on the stock of roads are positive, however, the magnitude seems to be very large in comparison to estimations from others papers which deal with infrastructure variables in other countries. Another interesting observation here is the fact that roads with poorer quality of covering are more important drivers of GRP having county administrative status. The coefficient on the overall stock of capital is expectedly positive and statistically significant.

Nevertheless, this model suffers of reverse causality, which is a quite common econometric problem for the majority of such models. However, there are several approaches which help to get estimations robust to reverse causality. For instance, Canning (1999) uses the cointegration method in order to get results, which are robust to reverse causality. An alternative issue is to use lags and/or instrumental variables.

Table 1. Model with different quality and administrative status of roads

	Fixed effect	Random effect
Log capital	1.180*** (0.03)	1.482*** (0.02)
Log railways	-0.673*** (0.12)	-0.187*** (0.05)
Log national roads	1.225*** (0.36)	0.267 (0.29)
Log national modernized roads	1.471*** (0.37)	0.033 (0.28)
Log national light covering roads	-0.046 (0.03)	0.002 (0.02)
Log county roads	0.502* (0.21)	0.038 (0.09)
Log county modernized roads	0.197*** (0.03)	0.046* (0.02)
Log county light covering roads	0.300*** (0.06)	0.070 (0.05)
Constant	-20.582*** (0.45)	-23.129*** (0.42)
R^2	0.911	

*Note: The numbers in parentheses are standard errors, *,**,***indicates significance at the 10%, 5% and 1% levels respectively.*

So the next issue is to run per capita GRP on the lagged variables of infrastructure stocks. This exercise can show the lag between the construction or modernization of road stocks and its impact on economic development, also it can help to get the results, which are robust to reverse causality. We run one regression with lags from 1 to 4. Only significant coefficients are reported in Table 2.

Table 2. The model with lags

	Fixed effect
Log capital	1.529*** (0.02)
Lag 1 log national roads	0.881* (0.39)
Lag 4 log national repaired roads	0.992** (0.33)
Lag 4 log county roads	0.859*** (0.20)
Constant	-26.093*** (0.48)
R^2	0,907

*Note: The numbers in parentheses are standard errors, *,**,***indicates significance at the 10%, 5% and 1% levels respectively.*

The majority of significant coefficients are on variables with 1 and 4 lags. This result corresponds to those obtained by Queiroz and Gautam (1992), who show that roads are an important driver of economic growth, but there is 4 year delay between the period of building of the road and eventual impact on economic development.

Taking into account the fact that we use panel data with 16 periods, raise the issue of the stationarity of time series, so we run special unit root test, which showed the evidence that it is good idea to run the regression with first difference.

Table 3 shows only significant coefficients from model with first-differences. According to the Hausman test we use random effect regression in order to estimate coefficients of interest. There is a positive and statistically significant impact of the overall capital, moreover the intercept is also positive and significant. The impact of railways stock is positive, but small and insignificant even on a 1% level. The only significant coefficient on road-infrastructure variables is the coefficient on overall stock of roads with national administrative status. So 1% increase in length of the national roads per 1000 workers is associated with 0.36% increase of GRP. These results are economically significant as well.

Table 3. The model with first difference

Variable	Fixed effect	Random effect
ΔLog capital	0.629***	0.630***
	(0.02)	(0.02)
ΔLog national roads	0.384**	0.360**
	(0.14)	(0.13)
ΔLog national modernized roads	-0,057	-0,051
	(0.13)	(0.12)
ΔLog county roads	-0,005	-0,005
	(0.01)	(0.01)
ΔLog county modernized roads	-0.031*	-0,027
	(0.02)	(0.01)
ΔLog county light covering roads	-0,016	-0,013
	(0.03)	(0.03)
ΔLog railways	0,005	0,002
	(0.07)	(0.07)
Constant	0.162***	0.162***
	(0.01)	(0.01)
R^2	0,644	

*Note: The numbers in parentheses are standard errors, *,**,***indicates significance at the 10%, 5% and 1% levels respectively.*

Let us to sum up the main ideas. So we had begun with simple fixed effect regression model which showed that almost all types of roads have statistically significant impact on GRP, however railways and intercept had negative sign, which was an unexpected result, moreover that model suffer of reverse causality. The next step was the model with lags, which allows us to get robust to endogeneity results. The last model with first differences allows us to deal with unstationarity of time series in panel data.

Further research may be concentrated on estimation of the impact of others infrastructure variables such as water supply, electricity lines and others for longer periods of time. Moreover, the network effect of Romanian transportation infrastructure can be investigated.

Bibliografie

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