THE EVOLUTION OF ROAD TRANSPORT INFRASTRUCTURE IN ROMANIA AFTER 1990. ECONOMIC IMPLICATIONS

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Abstract: *The scope of this paper is to present the evolution of Romanian roads infrastructure, its economic impact based on data extracted from the European Statistical Database (EUROSTAT) and the opportunities for strategic investments with potential highly positive impacts on the nation's economy. The data used for this research spans over a period of 29 years, from 1990 right after the fall of the communist regime, to 2019 when Romania is already a Member of the European Union. The Romanian roads infrastructure is analysed according to its classification and compared with infrastructure from other European countries. The development of the Romanian transportation infrastructure in the selected timeframe was done in a complicated political environment with constant threat from corruption in all Public Authorities. The paper also aimed to establish the influence of road infrastructure over the economic development and international trade of goods and services of Romania. The econometric analysis was performed using Ordinary Least Squares method and studied the correlation between road length, as independent variable and GDP per capita, export and import of goods and services of Romania, as dependent variables. Based on empirical analysis, we found that Romanian road infrastructure is a significant determining factor for the development of the country's economy, as well as for international trade, thus, its importance is undeniable and efforts should be made in order for it to flourish. Policy implications are also included, as well as suggestions for strategic investments in a national motorway network that would connect the Black Sea to the European Markets. Effects of such investments would ripple through the entire Romanian economy.*

Keywords: *Romania; transport infrastructure; economic development; transport policies, investments.*

JEL classification: *F63; F68; L92*

1. Introduction

The larger context of this research is a broad analysis of the transportation infrastructure in Romania and the ways in which it can influence economic growth and economic competitiveness. The motivation for the topic comes from the desire to analyse a country that has emerged from a communist administration, transitioned to democracy, and became a member of the European Union (EU). Thus, we notice

a closed economy opening to the global market while receiving financial support from the EU. To enable such broader analysis, we had to study the availability of data on the subject and its evolution in time.

The impact of transportation infrastructure development on economic growth has been analysed and debated extensively (Fedderke et. al., 2006; Farhadi, 2015; Meersman & Nazemzadeh, 2017; Wang et al., 2021). Numerous empirical studies have shown that increased mobility improves the wellbeing of the population through enhanced access to higher-quality education, medical care, workplaces, social services or even leisure activities (Medeiros et. al., 2020; Churchill et. al., 2021).

This paper intends to investigate the impact of Romanian road infrastructure on the economic development of the country. Using the Least Squares method, it was established that there is a positive significant association of the road infrastructure with economic development and international trade over the period of 2002 to 2019. The intent is to show the gap between the current situation and potential benefits after implementation of a functioning and operational investment plan. Other Romanian researchers have shown before that Romanian authorities have drawn rather big and promising plans before 2007. These plans have been aiming at road, freight and inland waterways infrastructure and it is shown how they failed in the years to come, especially through a very low absorption rate of the cohesion funds allocated for Romania by the EU (Popescu and Fistung, 2014).

The paper is structured as follows. After the introduction, the paper presents the classification of roads in Romania and the evolution of communal, provincial and state roads over time. The next segment is focused on the evolution of the motorway network over the observed time frame, also in comparison to some other European countries. The forth section presents the data and methodology used to obtain the empirical results presented in the fifth section of the paper. The final part of this paper is dedicated to conclusions of our research.

2. The Classification of Roads in Romania

The first observation was that data regarding the transport infrastructure in Romania largely became available only after the revolution in 1989. The economic development of the following years was under an agitated political class that was struggling to find its place in the new order of things. A political class that had to resist the temptation of corruption facilitated by the instability Romania was dealing with. We underline this aspect since we know corruption can hinder the economic development of a country (Cieslik & Goczek, 2017), and to somewhat try to explain the trend we discovered in the development of transport infrastructure as we shall further show in this paper.

Roads in Romania and other European countries are classified as state, provincial, and communal roads, whilst main routes benefit from wider, better-quality roads classified as express roads and motorways. In Figure 1 we ranked the countries by the total length of the state, provincial, and communal roads. The countries included in the figures depended on data availability on EUROSTAT platform. For example,

Germany and Spain are not included due to lack of data in 2019 and not because it does not account for enough kilometres. Romania is situated 12th with a total of 85.525 km.

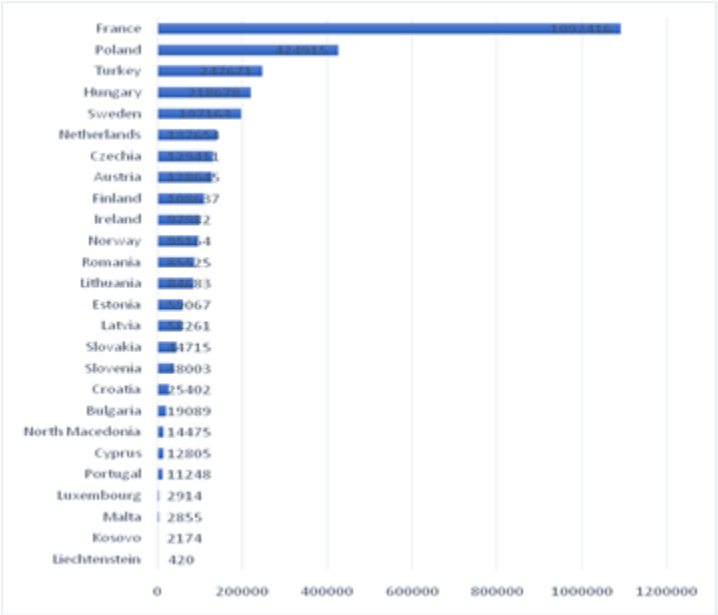

Figure 1. Length of State, Provincial and Communal roads in 2019 (km)
Source: Authors' computation based on Eurostat, ROAD_IF_ROADSC, accessed on 12.11.2021.

In Figure 2 it is shown that there is a big leap forward in the length of Romanian state roads from 1990 to 2007 with a total of 6.048km. The provincial roads have seen an even greater increase with an expansion of 8.468km. The communal roads on the other hand have lost a total of 1.826km which could represent part of the 8.468km increase in the provincial roads. This could have happened if investments were made in the provincial roads for reasons of economic or social importance as per decisions made by the local Authorities. The evolution of the total length of motorways was also included in Figure 2, to show the large mileage gap between the lengths of various types of roads in Romania (ROAD_IF_ROADSC; ROAD_IF_MOTORWA).

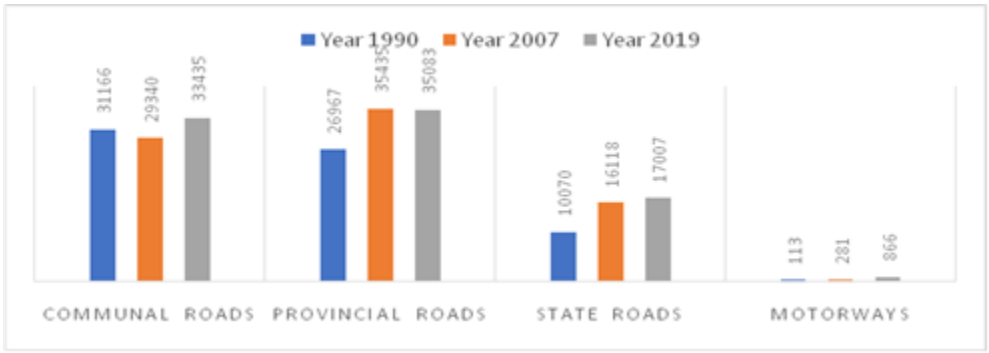

Figure 2. Evolution of Road Length in Romania by Category of Roads (km)
Source: Authors' computation based on Eurostat, ROAD_IF_ROADSC, accessed 12.11.2021; ROAD_IF_MOTORWA, accessed 12.11.2021.

We did not put much emphasis on express roads due to the lack of constant data across the selected timeframe and also the length of express roads in the observed countries did not change much due to the fact that during the observed time frame they have been mainly modernizing the national roads and building motorways, so the focus was on a different category.

3. Evolution of the Romanian Motorway Network

In 1990 Romania had a total of 113km of motorway and in 2007 when Romania became a member of the European Union (EU), it had a total of 281 km. In 2019, Romania had 866 km of highway which means 168 km were built in the 17 years following the fall of the communist regime and another 585 km in the 12 years after entering the EU. This ranks Romania 15th, as shown in Table 1, amongst European Countries in 2019, being surpassed by much smaller countries, area wise, like Austria, Hungary, or Ireland (ROAD_IF_MOTORWA).

Table 1: Length of Motorways in European Countries in 2019

No.	Countries	Length of Motorways (km) in 2019
1	Germany	13.183
2	France	11.671
3	Portugal	3.065
4	Turkey	3.060
5	Netherlands	2.790
6	Sweden	2.133
7	Austria	1.743
8	Hungary	1.723
9	Poland	1.676
10	Croatia	1.310
11	Czechia	1.276
12	Norway	1.008
13	Ireland	995

14	Finland	926
15	Romania	866
16	Bulgaria	790
17	Slovenia	623
18	Slovakia	495
19	Lithuania	403
20	North Macedonia	335
21	Cyprus	257
22	Luxembourg	165
23	Estonia	161
24	Kosovo	137

Source: Authors' computation based on Eurostat (ROAD_IF_MOTORW accessed on 01.11.2021)

Table 2 shows the evolution of motorway networks in European countries throughout our selected timeframe. Germany and France have not been included in the table since they dispose of a very extensive motorway network. The timeframe focuses on the year 1990, first year of available data for Romania, 2007 the year when Romania became a member of the EU and 2019 the beginning of the Covid-19 Pandemic. We shall try to keep this timeframe throughout the paper as much as availability of data allows, since we believe these years represent turning points in Romania's economy and policy.

Table 2. Evolution of Motorway Networks (km) in European Countries

Countries / Years	1990	2007	2019
Portugal	316	2613(d)	3065(d)
Turkey	281	1908	3060
Netherlands	2092	2582	2790
Sweden	939	1836	2133
Austria	1445	1696	1743
Hungary	267	858	1723.2(d)
Poland	257	663	1676
Croatia	291	1156(d)	1310
Czechia	357	657	1276
Norway	73	239	1008
Ireland	26	269	995
Finland	225	700	926
Romania	113	281	866
Bulgaria	273	418	790
Slovenia	228	578	623
Slovakia	192	364.5	495
Lithuania	370	309	403
North Macedonia	83	221	335
Cyprus	154	257	257

Luxembourg	78	147	165
Estonia	41	96	161

Source: Authors' computation based on Eurostat, ROAD_IF_MOTORWA, accessed on 08.11.2021.

Table 2 shows a clear positive trend in motorway development in all countries selected but also shows how Romania has one of the shortest motorway networks if we take into consideration the size of the country as well and not only the number of kilometres independently. This leaves much room for future investments in this sector, to increase the mobility of goods and work force but also to stimulate the process of urbanisation which has been shown to have a positive impact on economic growth (Pradham et al., 2021).

Investment in the development of the motorway infrastructure could also be encouraged by the geographical location of Romania. Linking the Black Sea with Continental Europe is an opportunity for international transit of goods and merchandise. This has been shown to be a potential generator of workplaces and economic growth in the case of Belgium, who serves as a similar gateway to Europe but in the West. While Belgium is an attractive market due to the proximity to Europe's largest purchasing powers, Romania could be an attractive market due to cheaper labour force and easier access to cheaper goods supplied in the ports at the Black Sea (Meersman & Nazemzadeh, 2017).

An interesting observation is to be made regarding data in Figure 3 referring to Lithuania, which is the only country to show a decrease in the total length of motorways between years 1990 and 2007. Since the focus in this paper is on Romanian roads infrastructure, we shall not investigate this topic in more depth, but it leaves room for further explorations to see the reasons for such data evidence.

In Table 3, we calculated the percentage by which the length of motorways increased in each country. This shows that from 1990 to 2007 Romania was ranked 11th and that from 2007 to 2019 it was ranked 4th. This ranking is based on percentage of increase in the length of motorway, but because Romania only had 113 km of motorway built in 1990, to avoid confusion we ranked the countries again based on the increase in the number of kilometres. Now Romania is ranked 16th from 1990 to 2007 and 9th from 2007 to 2019. This shows a positive impact on the development of transport infrastructure, after Romania became a member of the EU and shows how cohesion funds helped speed up the construction of the motorway network.

Table 3: Increase in Motorway Networks in European Countries (%)

No.	Countries	Length of motorway built from 1990 to 2007 (km)	Increase in motorway length from 1990 to 2007 (%)	Length of motorway built from 2007 to 2019 (km)	Increase in motorway length from 2007 to 2019 (%)
1	Germany	1.740	16.03%	589	4.67%
2	France	4.134	60.58%	713	6.5%
3	Portugal	2.297	726.89%	452	17.29%

4	Turkey	1.627	579%	1.152	60.37%
5	Netherlands	490	23.42%	208	8.05%
6	Sweden	897	95.52%	297	16.17%
7	Austria	251	17.37%	47	2.77%
8	Hungary	591	221.34%	865,2	100.83%
9	Poland	406	157.97%	1.013	152.79%
10	Croatia	865	297.25%	154	13.32%
11	Czechia	300	84.03%	619	94.21%
12	Norway	166	227.39%	769	321.75%
13	Ireland	243	934.61%	726	269.88%
14	Finland	475	211.11%	226	32.28%
15	Romania	168	148.67%	585	208.18%
16	Bulgaria	145	53.11%	372	88.99%
17	Slovenia	350	153.5%	45	7.78%
18	Slovakia	172	89.84%	130,5	35.80%
19	Lithuania	-61	-16.48%	94	30.42%
20	North Macedonia	138	166.26%	114	51.58$
21	Cyprus	103	66.88%	0	0%
22	Luxembourg	69	88.46%	18	12.24%
23	Estonia	55	134.14%	65	67.7%
24	Kosovo	No data	No data	No data	No data

Source: Authors' computation based on Eurostat, ROAD_IF_MOTORWA, accessed on 08.11.2021.

4. Data and Methodology

The paper starts with the research hypothesis that Romanian road infrastructure has a direct and positive influence over the economic development and international trade of goods and services of Romania. For this purpose, a database was built regarding Romanian road infrastructure, economic development and trade using data published by Eurostat. Since all the data was available for the period 2002-2019, the database includes the following variables for this time period:

- road length (LENGTH) to express the developments of Romanian road infrastructure;
- GDP per capita (GDPCAPITA) to show the economic development of Romania;
- export (EXP) and import (IMP) of goods and services of Romania.

In order to estimate the impact of road infrastructure on economic development and international trade we will use the following regression equation:

$$Y_t = \alpha + \beta_1 \cdot X_t + \beta_2 \cdot z_t + \varepsilon_t \quad (1)$$

where: Y_t is the dependent variable, t-denotes time, X_t is the explanatory variable, z_t is a dummy variable, α is a constant, β_1 β_2 are regression parameters, and ε_t is the error.

A dummy variable was included, in order to capture the effect of market liberalization after the inclusion of Romania in European Union (EU).
We will estimate there separate equations, one for each dependent variable (GDPCAPITA, EXPORT and IMPORT), as follows:

$$GDPCAPITA_t = A_1 + A_2 \cdot LENGTH_t + A_3 \cdot EU_t + \varepsilon_t \quad (2a)$$

$$IMP_t = B_1 + B_2 \cdot LENGTH_t + B_3 \cdot EU_t + \varepsilon_t \quad (2b)$$

$$EXP_t = C_1 + C_2 \cdot LENGTH_t + C_3 \cdot EU_t + \varepsilon_t \quad (2c)$$

Where: GDPCAPITA denotes Gross domestic product per capita, LENGTH express the Romanian road length, IMP signifies Romanian import of goods and services, EXP represents Romanian export of goods and services, and EU specifies the inclusion in European Union (the value is 0 for 2002 to 2007 and 1 for 2007-2019).
The models are estimated with the E-Views software using the Least Squares method.

5. Empirical results

Figure 5 exposes the distribution and descriptive statistics of the variables. The abnormal distribution, according to Jarque-Bera test (p > 5%), and a platykurtic kurtosis (Kurtosis < 3) can be noted for all variables. There is a negative skewness of GDP per capita and road length (Skewness < 0), but a positive skewness of import and export (Skewness > 0).

Table 4: Descriptive statistics of variables

	LENGTH	IMP	GDP	EXP
Mean	81541.56	53491.19	131452.9	46489.83
Median	82703.50	56722.35	132276.4	44742.40
Maximum	85525.00	99317.50	223162.5	90120.20
Minimum	73215.00	14461.30	48695.70	11693.30
Std. Dev.	4237.904	24730.05	49897.11	25385.79
Skewness	-1.010172	0.097576	-0.094468	0.206127
Kurtosis	2.738741	2.274079	2.363839	1.842234
Jarque-Bera	3.112537	0.423784	0.330298	1.132781
Probability	0.210922	0.809052	0.847767	0.567570
Sum	1467748.	962841.4	2366152.	836816.9
Sum Sq. Dev.	3.05E+08	1.04E+10	4.23E+10	1.10E+10
Observations	18	18	18	18

Source:Authors' computation based on Eurostat NAMA_10_GDP,ROAD_IF_ROADSC accessed 12.11.2021

The results of the first regression equation regarding the influence of road length over GDP per capita in Romania are presented in Table 5 and show that the Romanian road length has a positive impact on GDP per capita (A2 = 0.438415), being a significant determining factor (p < 5%). However, it seems that the integration in European Union has a positive influence on GDP per capita (A3 = 1196.290), even if it is not a significant factor (p > 5%).

Table 5. Empirical results of regression equation 2a

Dependent variable GDPCAPITA
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample: 2002 2019
Included observations: 18

	Coefficient	Std. Error	t-Statistic	Prob.
A(1)	-30080.79	11432.63	-2.631134	0.0189
A(2)	0.438415	0.150630	2.910549	0.0108
A(3)	1196.290	1385.050	0.863716	0.4013

R-squared	0.782162	Mean dependent var	6532.222
Adjusted R-squared	0.753117	S.D. dependent var	2658.515
S.E. of regression	1320.944	Akaike info criterion	17.36109
Sum squared resid	26173382	Schwarz criterion	17.50949
Log likelihood	-153.2498	Hannan-Quinn criter.	17.38155
F-statistic	26.92932	Durbin-Watson stat	0.832475
Prob(F-statistic)	0.000011		

Source:Authors' computation based on Eurostat, NAMA_10_GDP,ROAD_IF_ROADSC accessed 12.11.2021

The results of the second regression equation regarding the influence of road length over the imports of Romania are presented in Table 6. It is noted that Romanian import of goods and services is positively (B2 = 4.430989) and significantly influenced by the developments of road infrastructure, with a p value less than 1%. Also, the integration in European Union implies a positive influence on the import (B3 = 6883.067), but it was not a significant explanatory factor of Romanian import of goods and services (p > 5%).

Table 6. Empirical results of equation 2b

Dependent Variable: IMP
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample: 2002 2019
Included observations: 18

	Coefficient	Std. Error	t-Statistic	Prob.
B(1)	-312789.7	111272.2	-2.811031	0.0132
B(2)	4.430989	1.466056	3.022387	0.0086
B(3)	6883.067	13480.49	0.510595	0.6171

R-squared	0.761526	Mean dependent var	53491.19
Adjusted R-squared	0.729729	S.D. dependent var	24730.05
S.E. of regression	12856.56	Akaike info criterion	21.91211
Sum squared resid	2.48E+09	Schwarz criterion	22.06050

Log likelihood	-194.2090	Hannan-Quinn criter.	21.93257
F-statistic	23.94991	Durbin-Watson stat	0.945487
Prob(F-statistic)	0.000021		

Source: Authors' computation based on Eurostat, NAMA_10_GDP,ROAD_IF_ROADSC accessed 12.11.2021

The results of the last regression equation regarding the influence of road length over the exports of Romania are presented in Table 7. As it can be seen, the coefficient of the Romanian road infrastructure reflects a positive influence on the export of goods and services (C2 = 5.299010), being a significant explanatory factor of it with a p value less than 1%. However, the integration of Romania in European Union has a negative influence over the exports (C3 = -796.0006), but it was not a significant explanatory factor based on a p value much higher than 5%.

Table 7. Empirical results of equation 2c

Dependent Variable: EXP
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample: 2002 2019
Included observations: 18
EXP01=C(1)+C(2)*LENGTH+C(3)*EU

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-385024.8	114434.5	-3.364588	0.0043
C(2)	5.299010	1.507720	3.514584	0.0031
C(3)	-796.0006	13863.60	-0.057417	0.9550

R-squared	0.760641	Mean dependent var	46489.83
Adjusted R-squared	0.728726	S.D. dependent var	25385.79
S.E. of regression	13221.93	Akaike info criterion	21.96815
Sum squared resid	2.62E+09	Schwarz criterion	22.11655
Log likelihood	-194.7134	Hannan-Quinn criter.	21.98861
F-statistic	23.83362	Durbin-Watson stat	1.099970
Prob(F-statistic)	0.000022		

Source:Authors' computation based on Eurostat NAMA_10_GDP,ROAD_IF_ROADSC, accessed 12.11.2021

The obtained results confirmed the research hypothesis and are in line with other studies such as that of Chen et al. (2020), who showed the investments made under the Belt and Road initiative positively influenced the economic growth in regions impacted by the development project. Trade costs are reduced while volumes are stimulated to grow thus the economic productivity is following an increasing curve. Our results are also in line with Herranz-Loncan (2007) who analyzed the implications of infrastructure investments over more than eighty years of Spanish

economic development proving that even with significant inefficient investments the returns were still larger than zero.

6. Conclusions

The transport infrastructure has been shown to be a contributor to economic development and population wellbeing. Considering the market liberalization, the transport infrastructure plays an important role in stimulating international trade and therefore increasing the competitiveness of a country. This paper proposed to enhance the role of Romanian road infrastructure in economic development and international trade. The empirical results established the direct correlation between road length and GDP per capita, import and export of goods and services, being a significant explanatory factor. Also, it can be seen that the accession to the EU had a positive influence on the GDP per capita and imports, but manifested a negative correlation regarding export. However, it is not a significant explanatory factor and the export volumes of Romania are influenced by many other factors such as the huge deindustrialisation of the country caused by the collapse of most of the large Romanian producers in areas such as mining, agriculture, rolling stock, etc. These results can be a start point for policy makers, which must understand the "whole picture" regarding the importance of the investments in transport infrastructure. The geographical positioning of Romania must be seen as an advantage for governmental initiatives that support economic development through efficient transport infrastructure. As highlighted by other authors (e.g., Fistung et al., 2014) a policy option could be to refocus financial budgetary allocations to modernize and increase of the European national roads.

One of the most impacting strategic investments in this sector would be also linking the Black Sea to Central European and Western European markets through a network of motorways in order to stimulate the movement of goods on Romania's territory. This strategic investment would positively impact the economy trough increased income from road taxes, creation of workplaces in the logistics sector and road maintenance, facilitating the development of logistics hubs, construction companies and business in general since the spill over effect would be felt in all sectors of the economy.

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