Research on Relationship Between Road Freight Transport and Infrastructure in European Countries

Pavol Varjan¹, Jozef Gnap¹, Pavol Ďurana², Mariusz Kostrzewski³

¹Department of Road and Urban Transport, Faculty of Operation and Economics of Transport and Communications, University of Zilina, Univerzitná 1, Zilina 010 26, Slovak Republic
²Department of Economics, Faculty of Operation and Economics of Transport and Communications, University of Zilina, Univerzitná 1, Zilina 010 26, Slovak Republic
³Faculty of Transport, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland

Abstract The article deals with research of relationship between the performance of road and freight transport and transport infrastructure (motorways) in EU countries. The main goal is to find out how transport infrastructure has a relationship and influence on the development of transport performance. The relationship between transport performance and transport infrastructure has been examined by correlation and regression analysis. Research has shown that the strength of these relationships is different for states. There is a strong direct and indirect dependence between transport infrastructure and transport performance.

Keywords road freight transport performance, motorway, road infrastructure,

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1. Introduction

Transport is an indispensable basis for the support of almost all economy’s sectors. It is necessary to support and safeguard social and economic processes connected to transport [1]. Transport services are important for economic growth and society development [2]. Transport has a wider impact on microeconomic factors of productivity such as the labor market, domestic and international trade, investment and innovation. Transport infrastructure is an integral part of a transport system of any city or state. In connection to the development of societies and intensification of international relations due to the globalization processes, the importance of transport as a factor for economic and social development has enhanced [3]. Infrastructure development is one of the visible signs of technological progress. Many studies state that transport infrastructure is one of the most important factors of the regions’ development, which enables the creation of new businesses or supports contacts with other regions. Many different factors affect the economic growth, but they are all directly or indirectly related to infrastructure development [4, 5]. As example it may be given that the construction of motorways increases regional accessibility and enhances human activities along the transportation routes. Well-developed transport infrastructure can be seen as a precondition for regional economic integration. For instance, transport of agricultural products can develop faster and faster in farming areas. Transport accessibility is determined by the way the area is developed making it possible to move in various conditions [6]. What is the correlation between the development of the transport infrastructure and the growth of the freight transport performance in road and rail transport? Growth in transport performance is related to the growth of gross domestic product [7, 8].

2. Transport Infrastructure and Its Importance

One of the most important presumption and factors of the social and economic development of the states and their regions is road infrastructure. This is also true in the Slovak Republic as road transport is the most widespread transport sector [9].

The development of transport infrastructure has been regarded long as the main instrument for promotion of economic development. Several studies point to a close link between investment in infrastructure and the economic development of a region [10, 11, 12].

Tuhin Subhra Maparu and Tarak Nath Mazumder showed existence of long-run relationship between transport infrastructure and economic development and that the direction of causality is from economic development to transport infrastructure in most of the cases thus drawing support in favour of Wagner’s law [13].

It was not possible to obtain complete data on all EU countries. In their next review, only those states that had the data...
for the given period for transport performance and infrastructure at the same time were selected. For road transport 25 countries of Europe could be analysed (Tab. 1).

**Table 1.** Length of motorway infrastructure in European countries (km)

| Country          | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  |
|------------------|-------|-------|-------|-------|-------|-------|-------|
| Bulgaria         | 437   | 458   | 541   | 605   | 610   | 734   | 740   |
| Czech Republic   | 734   | 745   | 751   | 776   | 776   | 1 223 |       |
| Germany          | 12 819| 12 845| 12 879| 12 917| 12 949| 12 993| 12 996|
| Estonia          | 115   | 115   | 124   | 140   | 141   | 147   | 145   |
| Ireland          | 900   | 900   | 900   | 897   | 897   | 916   | 916   |
| Spain            | 14 262| 14 531| 14 701| 14 981| 15 049| 15 336| 15 444|
| France           | 11 392| 11 413| 11 413| 11 552| 11 560| 11 599| 11 612|
| Croatia          | 1 244 | 1 254 | 1 254 | 1 289 | 1 290 | 1 310 | 1 310 |
| Italy            | 6 668 | 6 668 | 6 726 | 6 751 | 6 844 | 6 943 | 6 943 |
| Cyprus           | 257   | 257   | 257   | 257   | 257   | 272   | 272   |
| Lithuania        | 309   | 309   | 309   | 309   | 309   | 309   | 314   |
| Luxembourg       | 152   | 152   | 152   | 152   | 152   | 161   | 161   |
| Hungary          | 1 477 | 1 516 | 1 515 | 1 767 | 1 782 | 1 884 | 1 924 |
| Netherlands      | 2 646 | 2 651 | 2 658 | 2 666 | 2 678 | 2 730 | 2 756 |
| Austria          | 1 719 | 1 719 | 1 719 | 1 719 | 1 719 | 1 719 | 1 719 |
| Poland           | 857   | 1 070 | 1 365 | 1 482 | 1 556 | 1 559 | 1 640 |
| Portugal         | 2 737 | 2 737 | 2 988 | 3 035 | 3 065 | 3 065 | 3 065 |
| Romania          | 332   | 350   | 550   | 644   | 683   | 747   | 747   |
| Slovenia         | 768   | 768   | 769   | 770   | 770   | 773   | 773   |
| Slovakia         | 416   | 419   | 419   | 420   | 420   | 463   | 463   |
| Finland          | 779   | 790   | 780   | 810   | 810   | 811   | 811   |
| Sweden           | 1 971 | 1 957 | 2 004 | 2 044 | 2 088 | 2 119 | 2 118 |
| United Kingdom   | 3 672 | 3 686 | 3 733 | 3 756 | 3 760 | 3 768 | 3 764 |
| Norway           | 381   | 393   | 392   | 392   | 392   | 392   | 392   |
| Switzerland      | 1 406 | 1 415 | 1 419 | 1 419 | 1 429 | 1 440 | 1 447 |

The development and length of road infrastructure is different for individual EU countries. It is possible to assert that almost all states have been recorded with the growth of the infrastructure. For some countries, growth was weak or not. The most significant growth was in the Czech Republic. The drop is recorded only for the United Kingdom and Estonia. However, this decrease is negligible.

![Development of motorway infrastructure together](image1)

In graph (Fig. 1) is possible to see that the length of infrastructure for these states has grown together gradually. This would also mean the growth of transport performance.

In tab. 1 is the data on the length of the motorway network in the EU.

### 3. Development of Transport Performance in European Countries

The development of transport performance in road freight was not uniform. The most significant growth was in Poland. It can be noticed that the western EU countries have experienced a decline (eg Spain, France, Italy). On the other hand, the countries of the eastern EU recorded growth (Romania, Bulgaria, Hungary). The most noticeable growth was recorded by Poland, where despite the crisis the transport performance grew.

![Development of road freight transport performance](image2)

When we compare the development of transport performance and road transport infrastructure, it is possible to estimate that they have a similar pattern since 2012. It is also important to examine the transport performance relationships with the length of the infrastructure for each country. The following chapter deals with this relationship.

Table 2 show the statistical data on transport performance in case of freight road transport. Data are expressed individually for selected European countries. Outputs are expressed in millions of tonne-kilometers. The tonne-kilometer ratio is a more reliable indicator because the performance measured only in the tonne of transferred tonnage does not take into...
account the number of kilometers driven by the transport infrastructure with use of loaded vehicle. The expression in tonne-kilometers (transport performance) expresses the multiple of the weights of things and the distance traveled with these things. For this reason, we will discuss only the transport performance expressed in tkm.

4. Research on Relationship Between Road Freight Transport and Infrastructure in European Countries

In the context of research on the relationship between freight transport performance and transport infrastructure in EU countries, methods of regression and correlation were used:
- correlation analysis,
- regression analysis.

The variables in the correlation and regression analyses were chosen as follows:

| Country | Correlation coefficient | Determination coefficient | Coefficient a | Coefficient b | P-value a | P-value X | Significance r |
|---------|------------------------|--------------------------|--------------|--------------|-----------|-----------|---------------|
| France | 0.9883 | 0.9906 | 0 | 12.321 | X | 0.0000 | 0.0000 |
| Bulgaria | 0.9831 | 0.9911 | 0 | 25.549 | X | 0.0000 | 0.0000 |
| Hungary | 0.9565 | 0.9730 | 15.162 | 12.429 | 0.005 | 0.000 | 0.000 |
| Slovenia | 0.9594 | 0.9977 | 0 | 7.171 | X | 0.0000 | 0.0000 |
| Poland | 0.9065 | 0.9838 | 105.390 | 97.654 | 0.016 | 0.000 | 0.000 |
| Estonia | 0.8731 | 0.9765 | 141.155 | 495.362 | 0.012 | 0.000 | 0.000 |
| Italy | 0.9220 | 0.9814 | 0 | 57.327 | X | 0.0000 | 0.0000 |
| Greece | 0.8267 | 0.7938 | 29.181 | 10.741 | 0.039 | 0.000 | 0.000 |
| Germany | 0.8137 | 0.6905 | 12.253 | 21.537 | 0.017 | 0.000 | 0.000 |
| Turkey | 0.7750 | 0.9542 | 0 | 10.584 | X | 0.0000 | 0.0000 |
| Lithuania | 0.6432 | 0.9831 | 0 | 81.324 | X | 0.0000 | 0.0000 |
| Austria | 0.5375 | 0.9955 | 0 | 11.566 | X | 0.0000 | 0.0000 |
| Luxembourg | 0.5221 | 0.9872 | 0 | 27.157 | X | 0.0000 | 0.0000 |
| Slovakia | 0.4646 | 0.9830 | 0 | 53.410 | X | 0.0000 | 0.0000 |
| Spain | 0.4614 | 0.9788 | 0 | 15.711 | X | 0.0000 | 0.0000 |
| Czech Rep. | 0.4089 | 0.9800 | 0 | 10.570 | X | 0.0000 | 0.0000 |
| Norway | 0.4322 | 0.9334 | 0 | 2.920 | X | 0.0000 | 0.0000 |
| Finland | 0.4445 | 0.9936 | 0 | 11.700 | X | 0.0000 | 0.0000 |
| Sweden | 0.4644 | 0.8156 | 0 | 6.512 | X | 0.0000 | 0.0000 |
| United K. | 0.4937 | 0.8971 | 0 | 10.984 | X | 0.0000 | 0.0000 |
| Portugal | 0.6753 | 0.8040 | 109.215 | 141.080 | 0.017 | 0.000 | 0.000 |
| Cyprus | 0.6161 | 0.9990 | 0 | 53.410 | X | 0.0000 | 0.0000 |
| Denmark | 0.5221 | 0.9872 | 0 | 27.157 | X | 0.0000 | 0.0000 |
| Malta | 0.5375 | 0.9955 | 0 | 11.566 | X | 0.0000 | 0.0000 |

Individual countries are ranked according to the correlation coefficients in Table X. From the strongest direct dependence to the strongest indirect dependence. If the locating constant was insignificant, it was eliminated from the regression model.

Results of the analyses (table X) show that the interconnection of infrastructure with the development of road freight transport performance is different in the countries observed. Based on our established criteria for determining the strength of the correlation, strong direct dependence was found in Austria, Bulgaria, Hungary, Slovakia, Poland, Slovenia, Romania, Croatia, Estonia.
Average direct dependence was observed with Sweden, Lithuania, Ireland, Luxembour, Norway. Spain has a weak direct dependence.

We see weak indirect dependence on the United Kingdom and Germany. Intermediate strong dependence is reached by Cyprus, Portugal, Czec Republic, Finland and Italy. Strong indirect dependence is observed in the states of Netherland, Switzerland and France.

The significance level of the whole model (Significance F), coefficients a (P-value a) and b (P-value x) was less than 0.05 for each examined relationship. The determinative factor in 17 countries was higher than 0.9. The lowest determinant was in Italy (0.58).

The year-to-year correlation between transmission capacity and infrastructure length for selected countries were calculated as the next step.

The contribution showed that the growth of road infrastructure lengths (motorways) also increases transport performance, but the correlation decreases with only moderate direct dependence (0.7411). This means that transport performance will increase despite the fact that the length of motorways does not increase. It should be noted that, especially in Western European countries, the length of motorways does not increase significantly but increases their permeability by increasing the number of lanes, introducing intelligent transport systems, etc. In the Central and Eastern European countries, large volumes of transport performance are mainly carried out on Class I roads. Also, the increase in transport performance in road freight transport is strongly linked to the growth of gross domestic product [X]. The pace of construction in some countries unfortunately does not copy GDP growth and revenue into the state budget. The shift of construction dates and the completion of contiguous sections of motorways may, in particular, in international road freight transport, influence the direction of transit traffic if other corridors exist.

Especially in road freight transport, it would be interesting to examine the dependence between the length of the motorways and the transport performance by individual states, respectively. Exploration to be extended to lower category journeys where road haulage can be carried out.

5. Conclusions

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