AN ANALYSIS OF THE RELATIONSHIP BETWEEN ROAD FREIGHT TRANSPORT AND ECONOMIC GROWTH IN THE EUROPEAN UNION: A PANEL DATA APPROACH

Ivan Kristek
Josip Juraj Strossmayer University of Osijek, Croatia
E-mail: ivan.kristek@efos.hr

Received: July 10, 2023
Received revised: September 22, 2023
Accepted for publishing: September 25, 2023

Abstract

The objective of this study is to examine the relationship between road freight transport and economic growth in the European Union (EU) using a panel data approach. The study will use data from Eurostat for the period 2012 - 2021 and employ fixed effects regression models to estimate the causal effect of road freight transport on economic growth. The study will also examine the role of road infrastructure investment and transport employment in promoting economic growth in the EU. The results of this study will provide important insights into the factors driving economic growth in the EU and support policy decisions to promote sustainable economic development. The study will contribute to the literature on the relationship between transport infrastructure and economic growth and provide a basis for future research in this field.

Keywords: Road freight transport, Infrastructure investment, Economic growth, European Union, Panel data analysis

1. INTRODUCTION

The transport sector plays a crucial role in promoting economic growth and development by enabling the movement of goods and services between regions and facilitating trade. In the European Union (EU), road freight transport is an important part of the transport system and forms the backbone of the supply chain for various industries. The efficient and reliable movement of goods over road freight networks has a significant impact on the overall economic performance of European Union member states.

The relationship between road freight transport and economic growth has attracted considerable attention from policy makers, researchers and practitioners alike. Understanding the dynamics of this relationship is crucial for devising effective strategies to promote sustainable economic development in the European Union. This study aims to contribute to the existing literature by analysing the relationship between road freight transport and economic growth in the European Union using a panel data approach. Road freight transport involves the movement of goods by lorries on the road network. It provides the flexibility, accessibility and reliability necessary to meet the diverse needs of

different industries, including manufacturing, retail and agriculture. As European Union markets continue to integrate and trade activities expand, road freight transport has become an integral part of regional and international supply chains. Consequently, the performance and efficiency of road freight networks have a direct impact on the competitiveness and productivity of EU economies. Economic growth, characterised by an increase in the production and consumption of goods and services, is a priority objective of EU policy makers. Increasing economic growth promotes job creation, improves living standards and enables countries to effectively address social and environmental challenges. Given the significant contribution of road freight transport to the overall transport sector, it is essential to assess its relationship to economic growth in the EU context.

The panel data approach used in this study allows for a comprehensive analysis by taking into account both cross-sectional and temporal variations across European Union member states. The study was conducted over a ten-year period (2012-2021). By using data from Eurostat, which contains an extensive dataset on various economic indicators, road freight transport statistics and infrastructure investments, this study aims to shed light on the relationship between road freight transport and economic growth.

Investment in road infrastructure is a key determinant of the efficiency of road freight transport. Adequate infrastructure, including well-maintained roads, bridges and intermodal facilities, is critical for reducing transport costs, minimising delays and improving connectivity. Consequently, well-functioning road infrastructure supports the smooth movement of goods, leading to improved logistics operations and higher economic productivity.

In addition to infrastructure investment, employment in the transport sector is another important factor to consider when analysing the relationship between road freight transport and economic growth. The transport sector offers employment opportunities at various levels, from lorry drivers to logistics specialists and maintenance personnel. The availability of skilled and efficient labour in the transport sector contributes to the overall performance of road freight transport and consequently to the economic growth of European Union member states.

By analysing the relationship between road freight transport, investment in road infrastructure, employment in the transport sector and economic growth in the EU, this study aims to provide valuable insights for policy makers, industry stakeholders and researchers. The results of this study can help policy makers formulate strategies to improve the efficiency of road freight transport, allocate resources effectively and promote sustainable economic growth in the EU.

The relationship between road freight transport and economic growth in the European Union is a topic of great importance. This study uses a panel data approach to comprehensively analyse this relationship, taking into account the crucial factors of road infrastructure investment and employment in the transport sector. By providing insights into the dynamics of this relationship, this study aims to contribute to the literature and assist policy makers in formulating effective strategies to promote sustainable economic development in the EU.

2. LITERATURE REVIEW

The literature review in this article aims to provide a comprehensive overview of existing research and academic contributions on the relationship between road freight transport and economic growth in the European Union. By examining relevant studies, theoretical frameworks and empirical evidence, this section aims to summarise the current state of knowledge in this area. Key themes, methodologies and findings are examined and gaps in the literature are identified, which this study seeks to address. The literature review provides a comprehensive synthesis of existing research on the relationship between road freight transport and economic growth in the European Union.

A large amount of literature has investigated the correlation between transportation and economic growth (Saidi, 2018). Whether the development of transportation promotes economic development or vice versa is still a matter of debate. A number of studies suggested transportation system development has a positive impact on economic growth (Khadaroo, 2008 and Beyzatlar et. al. 2014).

Research suggests that economic growth should be linked to freight demand (Bennathan et al., 1992). Their study on tonne-kilometres as an indicator supports the linear hypothesis between economic growth and freight demand. In his research paper Rothengatter (2011) believes that the prerequisite for economic recovery is the adjustment of the economic and transport structure, making transport more sustainable and environmentally friendly. Study from Moschovou (2017) investigates the relationship between tonne-kilometres and GDP and the study confirmed that transport services promote economic growth. The research results show that the economic crisis has had a negative impact on Greek road freight transport. Beyzatlar et al. (2014) analyses GDP per capita of domestic freight transport turnover per person and petrol consumption per capita in the road sector of 15 EU countries from 1970 to 2008 and concludes that there is a bidirectional relationship between GDP and freight transport.

As this study is based on panel data, we found other examples of research in the literature that reached conclusions based on similar (panel) data. For example, Feige (2007) uses an econometric analysis to test the relationship between GDP growth, transport costs and trade volumes. Some authors use time series data, for example Verny (2007), to test the relationship between freight, transport distance and economic growth. Some authors like Vilke et al. (2021) conducted a panel analysis for CEE countries and concluded that changes in the overall economy (value added and employment) have a significant and measurably strong impact on the freight transport industry. Paper from Sun et al. (2018) provided research in which they concluded that there is no significant relationship between transport investment and the national economy. The quantitative correlation between transport construction investment and GDP growth was analysed, but the study was unable to show the direct effect of regional lead industry through transport construction investment. In his research conducted by Shanshan (2021) using data for 31 provinces and cities in China from 1993 to 2018, he concludes that there is a co-integration relationship between GDP and freight transport volume, and national GDP increases by 0.954% for every 1% increase in freight transport turnover. Research by Alises et al. (2014) covering the period from 1999 to 2011 in Spain and the UK confirmed that the transition to more service-oriented economies brings with it a much lower demand for transport.

3. METHODOLOGY AND DATA

The aim of this research work is to investigate the relationship between economic growth and road freight transport. The objective of this work had determined the variables and methodology of the scientific research. To achieve this goal, and after a theoretical analysis of the research field, it seems appropriate to use regression analysis in the empirical part of the work. Regression analysis consists of using different methods to study the dependence of one variable on another or more variables, which is the case in this research. It is used for analytical and often predictive purposes and is applied in almost all professional and scientific fields. The regression model used to study the impact of road freight transport on economic growth is structured as follows:

$$GDP_{it} = \beta_0 + \beta_1 GTR_{it} + \beta_2 LMO_{it} + \beta_3 EIT_{it} + \beta_4 IME_{it} + \mu_{it}$$

where is:

- GDP – gross domestic product in euros
- GTR – total road transport in thousands of tons
- LMO – length of the road network (motorway) in kilometres
- EIT – number of persons employed in the transport industry
- IME – investments and maintenance costs in euros
- $\beta_0 - \beta_4$ – coefficients that need to be calculated by the regression model
- μ - residual deviations
- i – a country of the European Union
- t - year of observation.

The regression model was calculated using the software package STATA 18. All data used to calculate the regression coefficients are publicly available and can be downloaded from the Eurostat website (https://ec.europa.eu/eurostat/). The study includes data on 27 member states of the European Union for the period from 2012 to 2021. Economic growth is defined by the variable of gross domestic product (GDP) and set as the dependent variable in the regression model. The independent variables used to determine the impact on the dependent variable are determined by road freight transport. Total road transport in thousands of tonnes (GTR) as the independent variable represents the annual amount of goods transported by road. By reviewing previous research, this variable is expected to have a positive impact on the economic growth of the country. Thus, based on previous scientific findings, we predict the coefficient $\beta_1 > 0$. The independent variable length of road network in kilometres (LMO) is closely related to the volume of freight transport, and we predict it to have a positive influence on the country's economic growth. Therefore, we predict that the coefficient $\beta_2 > 0$. The number of employees in the transport sector as the third independent variable is defined by the movement in the number of employees in enterprises whose activity is the transport of goods. This variable is related to the variable for total road transport. Firms can be expected to employ more workers when

total traffic grows. Therefore, we can predict that the coefficient $\beta_3 > 0$. Investment and maintenance costs (IME) in the road network have a direct impact on the economic growth of a country. As is well known in the economic literature, the growth of investment also affects the growth of GDP, and we predict the coefficient $\beta_4 > 0$. Therefore, we assume that all independent variables have a positive impact on the economic growth of the country.

After we have set up the regression model, we must decide between using the fixed effects model and the random effects model. Which model we will use, and which is more appropriate depends on what kind of panel data we have. If we can consider each individual as a randomly selected representative of the total population and they do not differ significantly from other individuals in all their characteristics, then the random effects model would be more appropriate. The fixed effects model describes each individual and is well suited when we need information about each individual because it is specific to itself. By analysing the panel data, we can very easily conclude that this model is applicable in our study. To test this assumption, we conducted the Hausman test. This test is one of the most important tools to determine which panel model is the best for us, i.e. with which panel model we obtain a more efficient result. The null hypothesis of the Hausman test assumes that there is no significant difference in the estimated coefficients, i.e. in this case the random effects model should be applied. The Hausman test was calculated using the STATA 18 software package and the results are shown below.

Figure 1 Hausman test

```
. hausman fixed random, sigmamore
```

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
gtr	-.3935429	-.2396064	-.1539366	.0442238
lmo	233.7772	73.85131	159.9259	54.08836
eit	904.2792	1022.314	-118.0352	119.8072
ime	53.10527	52.33073	.7745458	2.993629

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

Test of H0: Difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 16.59
Prob > chi2 = 0.0023

Source: Author's calculation using STATA 18 software

The result of the Hausman test for the panel data used in this study confirmed our expectations and showed that the fixed effects model was more appropriate. The previously defined regression model was calculated using the fixed effects model and the results and analysis of the regression coefficients are presented in the following title.

4. RESEARCH RESULTS AND DISCUSSION

The study is based on panel data for a ten-year period (2012 – 2021) for 27 member states of the European Union. To be able to analyse the available data more easily and more precisely, descriptive statistics of the secondary data were first presented before the regression analysis with the fixed effects model was carried out.

Figure 2 Descriptive statistics of regression variables

Variable	*Mean*	*Std. Dev.*	*Min.*	*Max.*
GDP	474 473	749 667	7 364	3 601 750
GTR	498 721	692 326	14 402	3 208 232
LMO	2 781	4 213	0	15 860
EIT	376	482	9	2 141
IME	3 377	5 177	8	36 387

Source: Author's calculation with the software STATA 18

The dependent variable (GDP) is the only variable in the study for which we have all the data (27 countries for ten years is a total of 270 observations). Its average value is 474 billion euros. Malta has the lowest value of GDP of 7.3 billion in 2012, while Germany has the highest value of 3 601 billion euros in 2021. This variable shows the smallest variation between ranks in EU member states. When we look at the ranking of countries according to the value of GDP, we can see that Germany has the largest amount of GDP in all ten observed years, followed by France, Italy, Spain, and the Netherlands. All the first five countries in the ten-year period maintain their ranking. Total road transport (GTR), expressed in thousand tonnes, has a mean value of 498 721 and is lowest in Cyprus (2015), while it is highest in Germany in 2019. The variable length of the road network (LMO) refers to the length of motorways. This variable is related to the degree of economic development, the population density and the size of the territory of a particular country (similar to GDP). Its mean value is 2 781 kilometres, but it should be noted that its smallest value is zero. The member state of the European Union that has the longest highways is Spain. In 2021, the length of their highways is 15 860. The independent variable number of employees in the transport industry (EIT) is expressed in thousands of persons and its mean value is 376 thousand persons. It should be noted that this variable includes all persons working in transport companies. Therefore, this variable is not limited to road transport only, as accurate data on road transport for individual EU member states are not publicly available. The largest number of employees in the transport industry is in Germany, while the smallest is in Estonia. Road infrastructure investment and maintenance costs (IME) are expressed in millions of euros. The highest value of this variable was recorded in the Czech Republic in 2012 and amounted to 36 billion euros while the lowest value is reserved for Bulgaria in year 2012.

By applying the regression model presented in the methodology section, regression coefficients were calculated to explain how a single independent variable affects the dependent variable. The results of the calculated coefficients are shown in the table.

The values of all calculated coefficients are statistically significant, the p-values of all coefficients are smaller than 0.05. This was also confirmed by the test (F), which checks whether all coefficients of the model are different from zero. The results obtained are only partially as expected. All the coefficients obtained are positive, which means that they have a positive impact on economic growth, except for the coefficient explaining the impact of goods transported (GTR) on the independent variable. The results surprised us, because based on previous research that was mentioned in the literature review, we expected the effect to be positive. The coefficient β_1 has a value of -0.39, indicating a decrease in GTR of 393,000 euros when road freight transport increases by one thousand tonnes. We are 95% confident that the interval (-0.5961, -0.19099) includes the mean of total road transport in thousands of tons in research period. There is a 5% chance that this inference is incorrect, i.e. that this range of values does not include the population mean. The reason for this result can be found in the consequences of the Corona virus pandemic. During the pandemic, the flow of goods was interrupted for a greater relative amount than other economic activities, which affected obtained result.

Figure 3 Value of regression coefficients

Coefficient	Value of coefficient	Standard error	p-value	95% conf. interval	
β_1	-0.39354	0.10236	0.000	-0.5961	-0.19099
β_2	233.777	54.766	0.000	125.41	342.14
β_3	904.2792	198.082	0.000	512.34	1296.22
β_4	53.1052	8.0964	0.000	37.08	69.125
β_0	-572557	158834	0.000	-886839	-258275

Source: Author's calculation using STATA 18 software

The coefficient β_2 of the model is 233.77, implying a positive impact on the dependent variable. An increase in the length of motorways by one kilometre has a positive impact on the gross domestic product, which increases by 233 million euros. The independent variable, the number of employees in the transport sector, has the greatest influence on the dependent variable. This result should be interpreted with caution, because the variable refers to all persons working in the transport industry and not only to those working in road transport. The value of the coefficient defining the influence of this variable on the country's economic growth is $\beta_3 = 904$. Increasing the number of people employed by one lead to an increase in gross domestic product of 904 million euros. The variable that has the smallest positive impact on the dependent variable is investment and road infrastructure maintenance costs ($\beta_4 = 53.1$). The gross domestic product will increase by 53 million euros if investments and maintenance costs increase by one million euros.

5. CONCLUSION

The shortcomings of the research are the absence of values for certain variables, and we highlight the absence of data for persons employed in the road freight transport industry. These are variables that were not publicly available, which certainly had an impact on the outcome of the research. Although there are shortcomings, the model is statistically significant, the confidence level is set at 95%.

The results of the research do not fully correspond to our expectations that we had before the creation of this paper. From four variables, three have a positive impact on economic growth, while the variable of road freight transport has a negative impact on economic growth. This result can be partially explained by the impact of the corona virus pandemic, as we have already pointed out. It should also be taken into consideration the fact that the European Union is increasingly investing in the transport of goods by rail, even though most of the cargo in the European Union is currently transported by road (almost 77% of the total cargo). Obviously, the desire to reduce carbon in the freight transport sector has had an impact on road freight transport. The European Union is trying to shift cargo from more polluting road transport to rail and inland waterways. The European Commission has set goals, but they are not binding, so the countries of the European Union follow their own goals that are not aligned with those of the European Union. The European Union currently wants to double rail traffic and increase the use of waterways by 50% by 2050. Efforts to reduce road freight are hampered by, among other things, outdated regulations. It is to be expected that in the future in the European Union, most of the cargo transportation will be transferred from road to railway and waterways, which foreshadows the result we reached in the research.

Therefore, in future research, the time period of the research should be increased, and the research should include variables from the domain of rail freight transport and freight transport by inland waterways.

While the present study has its limitations, including the absence of certain variables and the unavailability of data on those engaged in road freight transport, it has produced statistically significant quantitative results. Although the results are not entirely in line with our initial expectations, they highlight the complex dynamics at play, which may be influenced by factors such as the ongoing COVID pandemic and the EU's focus on transitioning to more sustainable modes of transport. Therefore, this study lays the groundwork for further research and encourages further research on the multi-layered relationship between freight modes and economic growth. By broadening the analysis and taking into account new trends and policy initiatives, future research can contribute to evidence-based decision-making and the formulation of effective strategies to promote sustainable economic growth in the European Union and beyond.

6. REFERENCES

Åhman, M. (2004). A Closer Look at Road Freight Transport and Economic Growth in Sweden - Are There Any Opportunities for Decoupling? *Naturvardsverket*, (report no: 5370).

Alises, A., Vassallo, J. M., & Guzmán, A. F. (2014). Road freight transport decoupling: A comparative analysis between the United Kingdom and Spain. *Transport Policy*, *32*, p. 186–193.

Bennathan, E., Fraser, J., & Thompson, L. S. (1992). What determines demand for freight transport? World Bank Publications, (Vol. 998).

Beyzatlar, M. A., Karacal, M., & Yetkiner, H. (2014). Granger-causality between transportation and GDP: A panel data approach. *Transportation Research Part A: Policy and Practice*, *63*, p. 43–55.

https://doi.org/https://doi.org/10.1016/j.tra.2014.03.001

European Commission. (2001). European transport policy for 2010: time to decide [available at: http://ec.europa.eu/transport/strategies/doc/2001_white_paper/lb_com_2001_0370_en.pdf access June 2, 2023]

European Commission. (2018). EU Energy in Figures: Statistical Pocketbook 2018. *Publications Office of the European Union*.

Feige, I. (2007). *Transport, Trade and Economic Growth - Coupled Or Decoupled?: An Inquiry Into Relationships Between Transport, Trade and Economic Growth and Into User Preferences Concerning Growth-oriented Transport Policy*. Heidelberg: Springer.

Gleave, S. D., & Eder, P. (2003). Freight transport intensity of production and consumption. *Sevilla: IPTS. Report EUR*, *20864*.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, *46*(6), p. 1251–1271. https://doi.org/10.2307/1913827

Hausman, J. A., & Taylor, W. E. (1981). Panel Data and Unobservable Individual Effects. *Econometrica*, *49*(6), p. 1377–1398. https://doi.org/10.2307/1911406

Hurlin, C. (2004). Testing Granger causality in heterogeneous panel data models with fixed coefficients. *Document de Recherche LEO*, *5*, p. 1–31.

Khadaroo, J.; Seetanah, B. (2008). Transport and economic performance: The case of Mauritius. *J. Transp. Econ. Policy*, 42, 255–267.

McKinnon, A. C., & Woodburn, A. (1996). Logistical restructuring and road freight traffic growth: an empirical assessment. *Transportation*, *23*, p. 141–161.

Moschovou, T. P. (2017). Freight transport impacts from the economic crisis in Greece. *Transport Policy*, *57*, p. 51–58. https://doi.org/https://doi.org/10.1016/j.tranpol.2017.04.001

Rothengatter, W. (2011). Transport Moving to Climate Intelligence: New Chances for Controlling Climate Impacts of Transport after the Economic Crisis: Economic crisis and consequences for the transport sector. New York: Springer. p. 9–28.

Saidi, S., Hammami, S. (2018). Modeling the causal linkages between transport, economic growth and environmental degradation for 75 countries. *Transp. Res. Part D Transp. Environ.*, 53, 415–427

Shanshan, C. (2021). Empirical Study on the relationship between freight volume and economic development of provinces and cities in China. *E3S Web of Conferences*, *253*, 01038.

https://doi.org/10.1051/e3sconf/202125301038

Stead, D. (2001). Transport intensity in Europe — indicators and trends. *Transport Policy*, *8*(1), p. 29–46. https://doi.org/https://doi.org/10.1016/S0967-070X(00)00034-2

Sun, J., Li, Z., Lei, J., Teng, D., & Li, S. (2018). Study on the Relationship between Land Transport and Economic Growth in Xinjiang. *Sustainability*, *10*(1). P.1-17. https://doi.org/10.3390/su10010135

Tapio, P. (2005). Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001. *Transport Policy*, *12*(2), p. 137–151. https://doi.org/https://doi.org/10.1016/j.tranpol.2005.01.001

Verny, J. (2007). The importance of decoupling between freight transport and economic growth. *European Journal of Transport and Infrastructure Research*, *7*(2), p. 105-120.

Vilke, S., Mance, D., Debelić, B., & Maslarić, M. (2021). Correlation between freight transport industry and economic growth–panel analysis of CEE countries. *Promet-Traffic&Transportation*, *33*(4), p. 517–526.

Wang, H., Han, J., Su, M., Wan, S., & Zhang, Z. (2021). The relationship between freight transport and economic development: A case study of China. *Research in Transportation Economics*, *85*, 100885. https://doi.org/https://doi.org/10.1016/j.retrec.2020.100885