DOI: 10.2478/vjbsd-2023-0013

STABILITY AND SUSTAINABILITY OF ENTERPRENEURSHIP – COMPLEMENTARITY OR SUBSTITUTION?

Ivana Faltová Leitmanová, Jiří Alina, Jaroslav Šetek, Nikola Kohoutová*

University of South Bohemia, Faculty of Economics, České Budějovice, Czech Republic

Companies in 2023 have to face many challenges and will have to face many challenges in the future, according to the current predictions of renowned agencies and institutions. The pursuit of financial stability for profit-seeking entities is undoubtedly one of the most critical. Achieving this is influenced by a number of factors, including sustainability factors. In addition to the generally applicable principles, respecting and implementing the sub-aspects of sustainability also has certain specificities. These may be determined, for example, by the sectoral affiliation of the company. The sector chosen in the following text will be the transport sector. The stability of the performance of this sector will be examined in relation to selected sustainability factors. As transport is one of the largest polluters of the environment, transport performance is examined in the context of air emissions. The examination is carried out at EU Member State level in the timeframe 2011 and 2021, in relation to the EU strategy for achieving the Sustainable Development Goals (SDGs).

Keywords: sustainability, road freight transport, international transport, greenhouse gases

Introduction

The paper focused on examining the relationship between sustainability and performance in European countries between 2011 and 2021. This relationship is examined in the context of freight transport, where sustainability is represented by the volume of greenhouse gas emissions in the selected sector of the economy, and the volumes of transport in road freight transport represented performance. The study results are essential for understanding the relationship between transport and the environment and can serve as a basis for future policy measures.

The starting point for these sustainability measures was the EU's Lisbon Strategy which was expanded in 2001 to include an environmental aspect in the Sustainable Development Strategy. Subsequently, in response to the 2030 Agenda for Sustainable Development adopted at the United Nations General Assembly in September 2015, the European Commission published in 2016 a document "Next steps for a sustainable European future – European action for sustainability", outlining how to integrate the SDGs into its policy priorities. In 2019, the European Commission presented the document "Towards a sustainable Europe by 2030" which sets out three scenarios for the future. The European Parliament has expressed its support for the scenario that proposes that all EU and Member State actions should be guided by defining concrete targets that will lead to the implementation of the Sustainable Development Goals (SDGs), that will propose and specify concrete outcomes by 2030, and that will establish a mechanism for reporting and monitoring progress towards the SDGs. The SDG targets that are linked to transport are main targets 8, 9, 11 and 12 (Goal 8, particularly sub-goals 8.1–8.3, Goal 9, in particular sub-goal 9.1, Goal 11, in particular, sub-goal 11 and Goal 12, in particular sub-goal 12.6).

The need to meet society's needs on a daily basis through the circular economy thus offers an opportunity to link business and environmental considerations. As a part of the supply chain, freight transport is considered a key economic activity (Chow et al., 2010). Population growth and the dynamism of economic activity have led to an increase in transport volumes and a faster growth in GHG emissions. Thus, transport is perceived as the economic activity that is most detrimental to the environment and society, with the level of emissions depending on the modes of transport (Fulzele and Shankar, 2021; Lamb et al., 2021; Mota, 2018). For these reasons, it is not feasible to operate freight transport in the current way, especially due to environmental aspects, efficiency, safety and increasing road congestion. According to Pamucar et al. (2022), an unimodal mode is the most suitable for freight transport. In unimodal road transport, the entire transit from one point to another is handled by a single vehicle, eliminating the requirement for a transit station. There are no additional transport costs or waiting times. The logistic complexity is thus lower than for multimodal transport. Problems and shortcomings resulting from inefficient use of transport resources, such as low vehicle load factors and too many vehicle journeys, addressed by various economic policy instruments and measures (e.g., fossil fuel taxes), impact the market for transport services. Browne et al. (2023) argue that because the value of transport varies across supply chain actors, the effects of these policies also vary and are difficult to predict.

Business activity is seen as a contributing factor to biodiversity loss (Roberts et al., 2023). In that context, transport is considered a high-risk sector, along with construction, energy, food and drug retailing, food processing, forestry and paper industries, tourism, mining, and utilities. At the same time, however, the sector discloses the least information on which to assess the degree of complementarity between biodiversity and the circular economy. The prospect of complete closure of material flows and examining the policy mix that leads to achieving this through the circular economy has also been explored by van den Bergh (2020). In the sub-segment 'geography and transport', he notes that recycling in economic systems takes the form of 'non-local recycling', which includes international trade in waste and secondary materials and goods.

Road freight transport companies operate in the EU common market and should operate under the same conditions. In this context, Poliak et al. (2021) highlight the growing demand for more accurate costing. Although efforts to evaluate performance and sustainability in freight transport are not quite a frequent topic, analyses and reflections on this topic can be found (Pathak et al., 2021). Kumar and Anbanandam (2022) proposed an index model for evaluating performance and sustainability. Avadi et al. (2022) addressed the spatial aspects of performance and sustainability. Abbasi and Nilsson (2016) saw sustainability in logistics operations that enable profit while minimizing environmental burden in the use of green transport corridors.

The purpose of these corridors is to reduce the environmental impact and increase safety and energy efficiency through the use of sustainable logistics solutions, intermodality and advanced technologies (Aman et al., 2022; Caramia et al., 2020; Blinge, 2014; Hunke and Prause, 2013). Moreover, as the transport sector is faced with regulations that vary from country to country, generalizations of partial findings are necessary to address sustainability globally. The optimal size of a firm is associated with the size of its turnover (Hronkova, 2022), companies with an average turnover of 194 –388 thousand EUR are identified as efficient in freight transport.

One approach to addressing the environmental and economic aspects of sustainable transport is intelligent transport systems based on implementing information and communication technologies. Kadlubek et al. (2022) consider increasing the efficiency of transport systems with the use of digital technologies in relation to greener energy, higher efficiency of transport vehicles and better and safer use of transport networks. In addition to direct government interventions, Tamannaei et al. (2021) propose two indirectly induced interventions. One may be government support for the expansion of intermodal system services and the subsequent national marketing of the system, which will contribute to subsidy savings. The other may be a reduction in economic expectations of all transport systems, especially the road system.

Material and methods

Road freight transport was the sector chosen to investigate the relationship between sustainability and performance. Its performance was related both to the volume of road freight transport and to the volume of net international transport. The volume of greenhouse gases emissions implicitly represented sustainability. Data from selected EU countries (N = 24, Croatia was excluded as there is no data from 2011; further, due to its island location, Cyprus and Malta were not included) were examined in 2011 and 2021.

Basic statistical data on inland transport have provided a numbers of European Union legal acts – Council Directives on road goods transport statistics 78/546/EEC and 89/462/EEC, Regulation (EU) 70/2012. According to the Regulation, international road transport is composed of categories international dispatch and receipt, when the place of loading or unloading of goods in declaring country and place of unloading in a different country, dale cross-trade, when place of loading and place of unloading of goods in two different countries outside the declaring country a take cabotage, when place of loading and unloading of goods in the same country outside the declaring country. In our analysis, we measure net international transportation every single tonne loaded in a country of observation and unloaded in another country, or loaded in another country and unloaded in country of observation, excluding cross-trade and cabotage.

Several steps can be taken to analyse the link between transport performance and GHG emissions in each country in 2011 and 2021, as well as between 2011 and 2021.

Input data: Air pollutants and greenhouse gases (Tonne) was used for observation of greenhouse gases emissions in section Transportation and storage by Statistical classification of economic activities in the European Community (NACE Rev. 2), which is wider as activities of transport performance in next analyses, because includes the provision of passenger or freight transport, by rail, pipeline, road, water or air and associated activities such as terminal and parking facilities, cargo handling, storage etc. Consequently, Road freight transport (thousand tonnes) and Net international transportation (thousand tonnes) were used for observation of transport performance.

Data preparation: First, we need to do data preparation. This involves calculating the change in GHG emissions and transport performance between 2011 and 2021.

Correlation analysis: We can use correlation analysis to evaluate the link between transport performance and GHG emissions. The correlation coefficient shows how strong the linear relationship is between two variables (in this case, transport performance and emissions).

The assessment of that relationship was based on hypothesis testing:

- Hypothesis A
  - H0 (null hypothesis): there is no relationship between TOTAL traffic performance and greenhouse gases emissions.
  - H1 (alternative hypothesis): There is a positive relationship between transport performance and greenhouse gases emissions.
- Hypothesis B:
  - H0 (null hypothesis): There is no relationship between NET international transport and greenhouse gases emissions.
  - H1 (alternative hypothesis): There is a positive relationship between NET international and greenhouse gases emissions.

Results and discussion

The following Figures 1, 2 and 3 demonstrate the changes in the observed variables between 2011 and 2021.

The assessment of the absolute volume of road freight transport shows an uneven development in individual countries, with the countries with high volumes of road freight transport – Germany, Poland, and Spain – showing a significantly higher increase in the period under review than was observed in most of the countries surveyed. In contrast, France and Italy showed a significant decrease. A relative comparison, taking into account the size of the individual countries, shows that Luxembourg and the Netherlands have the highest road freight 'loads', with Belgium and Germany showing roughly half the level of this relative volume, followed by the Czech Republic. In the other countries surveyed, less than 5,000 tonnes of freight are transported per km^2.

In terms of net international transport, i.e., the amount of freight which was loaded in the country of observation and unloaded in another country or loaded in another country and unloaded in the country of observation, Poland showed the highest level, which together with Spain showed the most dynamic increase, while Germany showed a decrease in the volume of net international transport. The relative comparison in this case showed a similar situation to that of road freight transport. The highest volumes of tonnes of net international transport on 1 km^2 were again reported by Luxembourg, the Netherlands, and Belgium. The values of net international transport on 1 km^2 in Greece, Finland, and Sweden, on the other hand, were almost negligible, mainly due to their size and geographical location.

The amount of greenhouse gases emissions per km^2 completely replicates the situation for Luxembourg and the Netherlands in terms of net international transport on 1 km^2. Nevertheless, at least one deviation can be noted. In the case of Luxembourg, although there is a decrease in the volume of net international transport on 1 km^2 in the years under review, the amount of greenhouse gases on 1 km^2 is increasing. There is also an exception in the case of Denmark, where low volumes of net international transport on 1 km^2 are associated with high levels of greenhouse gas emissions per 1 km^2. This is probably because GHG in Denmark's transport sector is predominantly produced by water or air and associated activities such as terminal and parking facilities, cargo handling, storage, etc. Higher levels of emissions

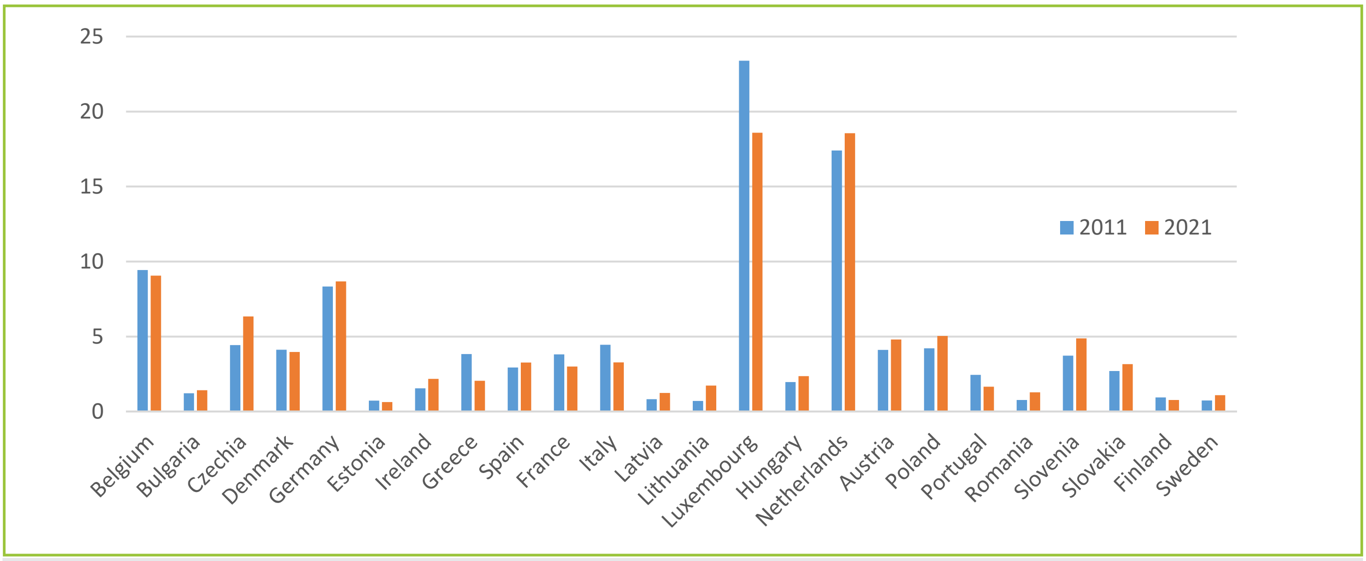

Figure 1 Road freight transport (thousand tonnes/km²) year 2011 and 2021
Source: the author's own editing based on Eurostat data

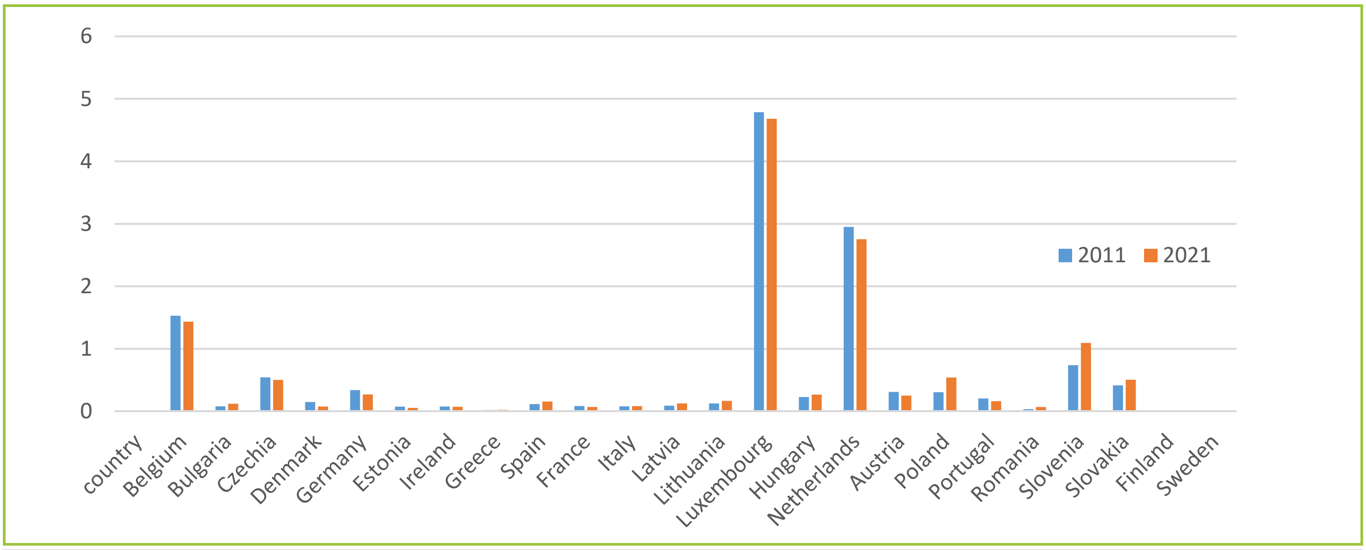

Figure 2 Net international transport (thousand tonnes/km²) year 2011 and 2021
Source: the author's own editing based on Eurostat data

per 1 km² can only be recorded for the Luxembourg mentioned above, which is again primarily due to its geographical location.

The following table 1 shows the percentage changes of used variables between 2011 and 2021. GHG emissions in tonnes of all countries decreased from 417,683,873 tonnes in 2011 to 357,508,433 tonnes in 2021, which represents a decrease of -14.41%. The total road freight transport of all countries increases from 13,410,188 thousand tonnes in 2011 to 13,538,754 thousand tonnes in 2021, which means an increase of 0.96%. Net international transport was in the year 2011, 719,619 thousand tonnes, and in year 2021, was 786,584 thousand tonnes, it means an increase by 9.31%.

The above comparison illustrates a positive trend in terms of both sustainability and performance, as greenhouse gases emissions fell over the period under review, and the performance of road freight transport, but especially net international transport, grew, although the development was not exactly the same from country to country.

Comparing the dynamics of greenhouse gases emissions and road freight transport in Figure 4 shows that in some countries, as road freight transport increased, greenhouse gas emissions increased (but this was a sub-proportional increase), while in others, the reduction in greenhouse gas emissions was matched by a decrease in road freight transport. In most of the countries studied, however, GHG emissions decreased despite the increase in road freight transport. Only in the case of Luxembourg and Greece, despite a decrease in road freight transport, was there an increase in greenhouse gases emissions.

A partial explanation of the findings can be seen in relation to both the level of net international transport on total freight and the evolution of the share of net international transport on total freight (see Figure 5). While, in terms of the level of the share of net international transport on total freight, considerable differences can be seen between countries, with countries such as Greece, France, Italy, Finland, Sweden, Norway showing only a 1% to 2% share, while Luxembourg, Slovenia, Belgium, and Slovakia showed a share

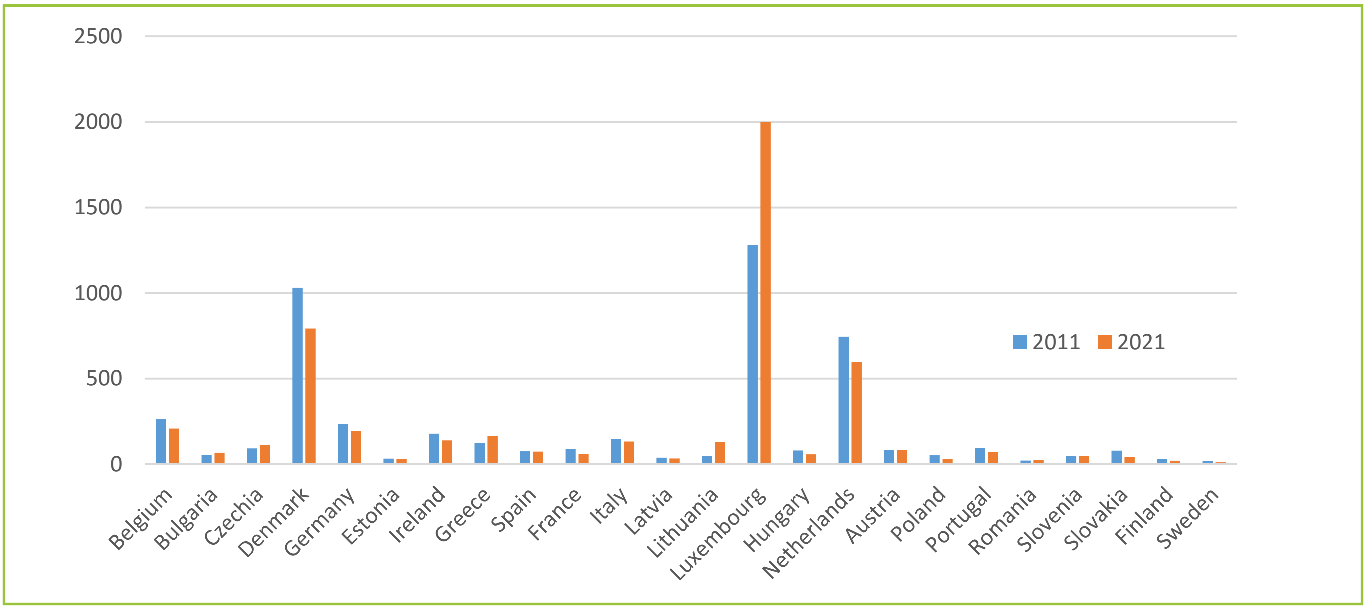

Figure 3 Greenhouse gases (tonnes/km²) year 2011 and 2021
Source: the author's own editing based on Eurostat data

Table 1 Percentage changes of used variables between 2011 and 2021

	% change from 2011 to 2021		
	net international transport	**road freight transport**	**greenhouse gases**
Belgium	-6.30%	-3.93%	-20.75%
Bulgaria	50.36%	16.29%	22.16%
Czechia	-7.52%	43.23%	20.81%
Denmark	-47.89%	-3.62%	-23.15%
Germany	-20.14%	4.06%	-16.99%
Estonia	-26.88%	-12.21%	-6.57%
Ireland	-5.28%	39.95%	-21.70%
Greece	18.77%	-46.44%	31.96%
Spain	36.94%	10.93%	-2.41%
France	-20.27%	-21.13%	-33.50%
Italy	4.90%	-26.32%	-9.58%
Latvia	39.46%	51.22%	-12.90%
Lithuania	32.46%	145.84%	177.40%
Luxembourg	-2.20%	-20.53%	56.27%
Hungary	16.43%	20.28%	-27.73%
Netherlands	-6.63%	6.68%	-19.74%
Austria	-18.40%	17.05%	-1.07%
Poland	76.77%	19.53%	-42.01%
Portugal	-21.19%	-32.29%	-23.65%
Romania	100.00%	66.80%	22.43%
Slovenia	48.56%	30.81%	-1.46%
Slovakia	21.62%	16.68%	-45.95%
Finland	-28.32%	-18.48%	-34.58%
Sweden	-8.21%	48.79%	-42.95%

Source: the author's own calculations based on data from Eurostat

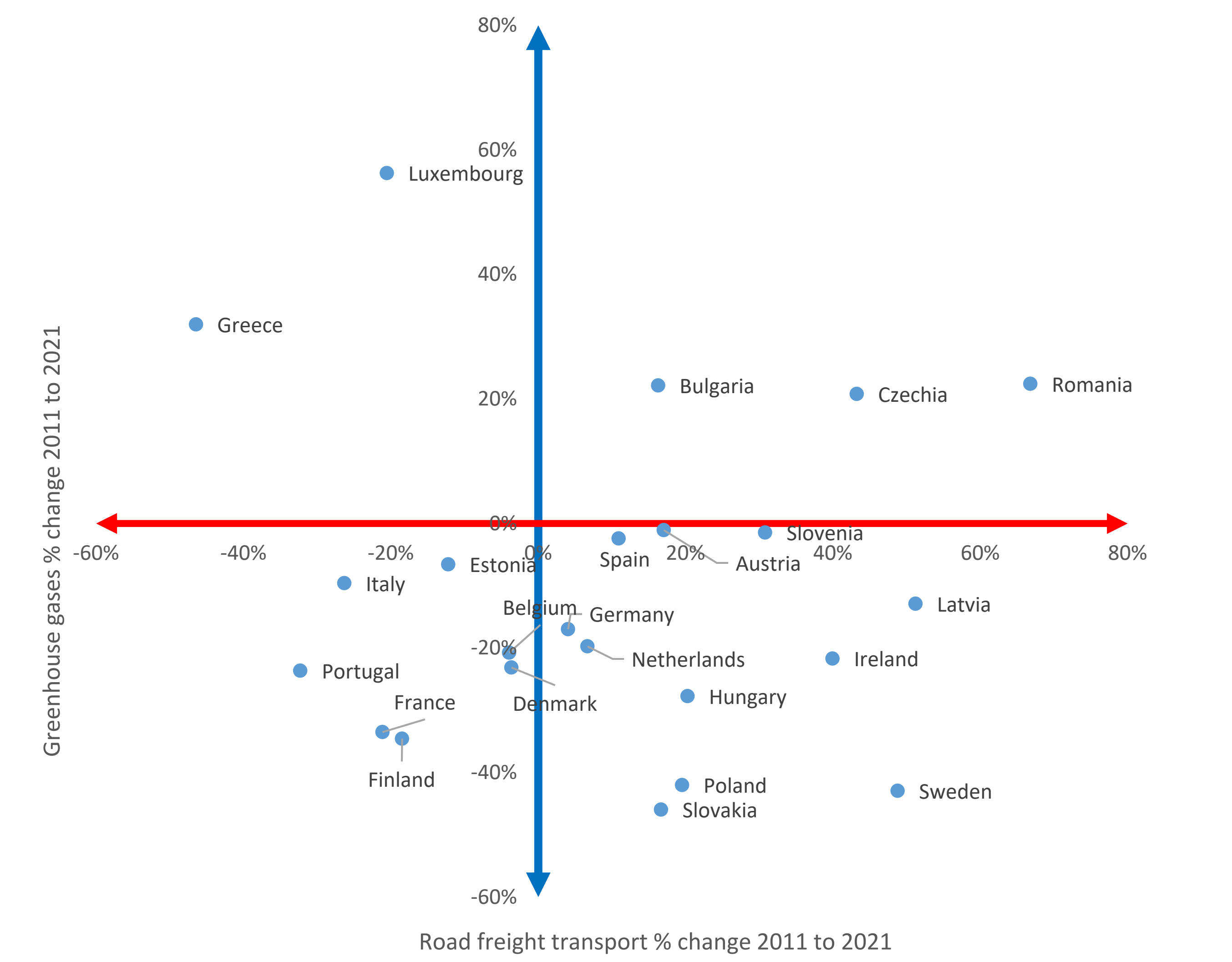

Figure 4 Percentage change in Greenhouse gases and Road freight transport between years 2011 and 2021
Source: the author's own editing based on Eurostat data

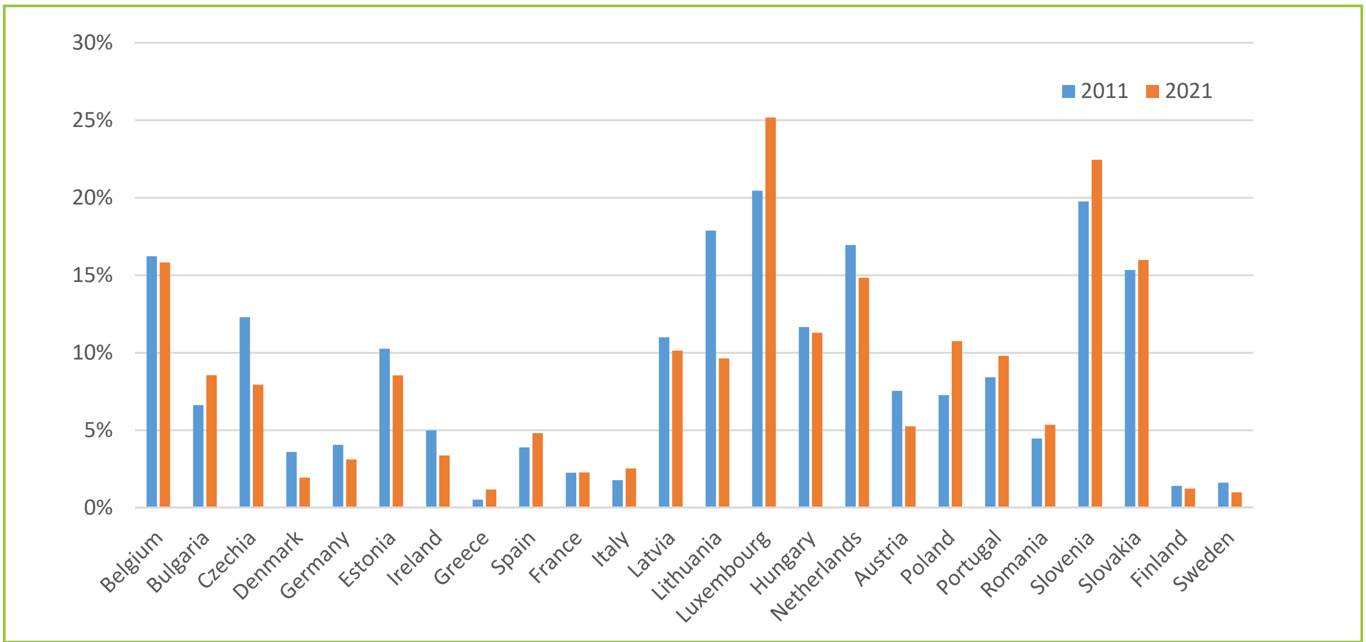

Figure 5 Percentage share of net international on total freight (2011 and 2021)
Source: the author's own editing based on Eurostat data

Main results:

Table 2 Results of analysis from Statistica software

N = 24	Regression summary for dependent variable: greenhouse gases 2011 $R = 0.88406892$; $R2 = 0.78157786$; adjusted $R2 = 0.77164958$ $F(1.22) = 78.722$; $p < 0.00000$; Std. error of estimate: 9798E3					
	b*	Std. err. of b*	b	Std. err.of b	t(22)	*p*-value
Intercept			3,891,390	2,513,886	1.547958	0.135898
Road freight transport 2011	0.884069	0.099641	24	3	8.872564	0.000000
N = 24	Regression summary for fependent variable: greenhouse gases 2021 $R = 0.82159557$; $R2 = 0.67501927$; adjusted $R2 = 0.66024742$ $F(1.22) = 45.696$; $p < 0.00000$; Std. error of estimate: 9766E3					
	b*	Std. err. of b*	b	Std. err.of b	t(22)	*p*-value
Intercept			4,372,962	2,529,209	1.728984	0.097822
Road freight transport 2021	0.821596	0.121540	19	3	6.759905	0.000001
N = 24	Regression summary for dependent variable: greenhouse gases 2011 $R = 0.60775652$; $R2 = 0.36936798$; adjusted $R2 = 0.34070289$ $F(1.22) = 12.886$; $p < 0.00163$; Std. error of estimate: 1665E4					
	b*	Std. err. of b*	b	Std. err.of b	t(22)	*p*-value
Intercept			6,614,449	4,536,908	1.457920	0.158991
Net international transport 2011	0.607757	0.169308	360	100	3.589657	0.001632
N = 24	Regression summary for dependent variable: greenhouse gases 2021 $R = 0.37676892$; $R2 = 0.14195482$; adjusted $R2 = 0.10295277$ $F(1.22) = 3.6397$; $p < 0.06956$; Std. error of estimate: 1587E4					
	b*	Std. err. of b*	b	Std. err.of b	t(22)	*p*-value
Intercept			9,823,255	4,190,694	2.344064	0.028513
Net international transport 2021	0.376769	0.197489	155	81	1.907793	0.069555

Source: the author's own editing based on Eurostat data

of more than 15% of net international on total freight, which continued to increase over the period (except for Belgium, where it stabilized).

Part of this development can be traced to factors related to individual countries' size and geographical location. These, together with the structure of the economy and the instruments and measures applied in the field of economic policy, especially in its environmental, transport, fiscal, and other segments, are reflected in the volume of transport, not marginally in the volume of international transport. This is evident from the different shares of net international transport on road freight transport. For example, Greece, despite a decrease in road freight transport and a very low share of net international on-road freight transport (the lowest of all the countries surveyed), showed an increase in GHG emissions. In contrast, despite showing a decrease in road freight transport and an increase in emissions, Luxembourg showed the highest share of net international on road freight transport (about 25%), representing an increase of almost 5 percentage points over the period under review.

A/ Impact of Total Transportation on Greenhouse Gas Emissions:
A strong positive correlation between total transport performance and GHG emissions was observed in both 2011 and 2021. In 2011, the correlation value was 0.88 with a very low *p*-value (0.000002); in 2021, the correlation value was 0.82 with a low *p*-value (0.00001). This shows that growth in total freight transport was associated with an increase in GHG emissions.

B/ Impact of Net International Transportation on GHG Emissions:
In 2011, a strong positive correlation was found between net international shipping and GHG emissions, indicating that increased international shipping contributed to the increase in emissions. The correlation value was 0.6, which is quite high, and the *p*-value was significant at the 0.0016 level.

In 2021, the correlation was slightly lower (0.38) but still significant (*p*-value 0.07). This result means that, despite implementing several measures in the context of sustainability over the decade, international transport still influenced GHG emissions, its impact becomes less significant over time.

The assessment of this relationship was based on hypothesis testing. Based on the tests conducted, rejecting the null hypothesis H0 for hypothesis A and accepting the alternative hypothesis H1 was possible. Similarly, for hypothesis B, the null hypothesis H0 was rejected, and alternative hypothesis H1 was supported.

Conclusions

The paper's results clearly show that road freight transport significantly impacts greenhouse gas emissions in European countries. In particular, total transport performance and its international segment – international transport – contribute to these emissions. This effect was observed both in 2011 and in 2021, indicating that this is a more permanent and still relevant problem. However, it is noticeable that over the past decade, GHG emissions in the countries studied are less the result of road freight transport or net international transport. Moreover, addressing this issue is a commitment under both the EU's 2001 Sustainable Development Strategy and the 2015 UN Millennium Development Goals.

Future Development:

- In view of the increasing volume of goods transported, which exceeds 14 billion tonnes per year, it is essential to focus on more sustainable freight transport alternatives. This includes promoting greener transport technologies, such as electric vehicles and hydrogen fuel, and investing in more efficient logistics solutions.
- At the same time, European countries should consider regulations and measures that could reduce greenhouse gas emissions associated with freight transport, such as emission standards for trucks and support for rail freight transport.
- Care must be taken to ensure that emissions reductions do not mean a loss of economic growth, and therefore, a balance must be struck between transport and the environment. Clearer and more effective policy measures and investments in greener transport technologies can help achieve this goal and reduce the impact of road freight transport on climate change.

Acknowledgment

Financial support from University of South Bohemia and Faculty of Economics, grant number GAJU EF-120-GAJU-103/2023/S-Škodová is gratefully acknowledged.

References

Aman, A. – Rafiq, M. – Dastane, O. – Sabir, A. A. 2022. Green corridor: A critical perspective and development of research agenda. In Frontiers in Environmental Science, vol. 10, 2022.

Ayadi, H. – Hamani, N. – Benaissa, M. – Kermad, L. 2022. Conceptual Framework for Assessing Sustainability of Urban Freight Transport. In IFAC-PapersOnLine, vol. 55, 2022, no. 10, pp. 251–256.

Blinge, M. 2014. Policy measures to realise green corridors – A stakeholder perspective. In Research in Transportation Business & Management, vol. 12, 2014, pp. 55–62.

Browne, M. – Dubois, A. – Hulthén, K. 2023. Transportation as a loosely coupled system: A fundamental challenge for sustainable freight transportation. In International Journal of Sustainable Transportation, vol. 17, 2023, no. 7, pp. 804–814.

Caramia, M. – Dell'Olmo, P. – Caramia, M. – Dell'Olmo, P. 2020. Green supply chain management. Multi-objective Management in Freight Logistics: Increasing Capacity, Service Level, Sustainability, and Safety with Optimization Algorithms, 2020, pp. 53–83.

Chow, J. Y. – Yang, C. H. – Regan, A. C. 2010. State-of-the art of freight forecast modeling: lessons learned and the road ahead. In Transportation, vol. 37, 2010, pp. 1011–1030.

Fulzele, V. – Shankar, R. 2021. Performance measurement of sustainable freight transportation: a consensus model and FERA approach. In Annals of Operations Research, 2021, pp. 1–42.

Hronková, I. 2022. Optimal turnover of companies in road freight transport as a tool of efficiency and competitive advantage. In Polish Journal of Management Studies 2022, vol. 26, 2022, no. 1, pp. 76–91.

Hunke, K. – Prause, G. 2013. Management of green corridor performance. In Transport and Telecommunication, vol. 14, 2013, no. 4, pp. 292.

Kadłubek, M. – Thalassinos, E. – Domagała, J. – Grabowska, S. – Saniuk, S. 2022. Intelligent transportation system applications and logistics resources for logistics customer service in road freight transport enterprises. In Energies, vol. 15, 2022, no. 13.

Kumar, A. – Anbanandam, R. 2022. Assessment of environmental and social sustainability performance of the freight transportation industry: An index-based approach. In Transport Policy, vol. 124, 2022, pp. 43–60.

Lamb, W. F. – Wiedmann, T. – Pongratz, J. – Andrew, R. – Crippa, M. – Olivier, J. G. et al. 2021. A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018. In Environmental research letters, vol. 16, 2021, no. 7.

Mota, B. – Gomes, M. I. – Carvalho, A. – Barbosa-Povoa, A. P. 2018. Sustainable supply chains: An integrated modeling approach under uncertainty. In Omega, vol. 77, 2018, pp. 32–57.

Pamucar, D. – Deveci, M. – Gokasar, I. – Martínez, L. – Köppen, M. 2022. Prioritizing transport planning strategies for freight companies towards zero carbon emission using ordinal priority approach. In Computers & Industrial Engineering, vol. 169, 2022.

Pathak, D. K. – Shankar, R. – Choudhary, A. 2021. Performance assessment framework based on competitive priorities for sustainable freight transportation systems. In Transportation Research Part D: Transport and Environment, vol. 90, 2021.

Poliak, M. – Poliakova, A. – Svabova, L. – Zhuravleva, N. A. – Nica, E. 2021. Competitiveness of price in international road freight transport. In Journal of Competitiveness, vol. 13, 2021, no. 2, pp. 83.

Road freight transport methodology 2016 edition. doi:10.2785/605303 KS-GQ-16-105-EN-N

Roberts, L. – Georgiou, N. – Hassan, A. M. 2023. Investigating biodiversity and circular economy disclosure practices: Insights from global firms. In Corporate Social Responsibility and Environmental Management, vol. 30, 2023, no. 3, pp. 1053–1069.

Statistics Eurostat. (n.d.). Retrieved 2 September 2023, from https://ec.europa.eu/eurostat/databrowser/view/ROAD_GO_TA_TOTT__custom_7469913/default/table

Statistics Eurostat. (n.d.). Retrieved 4 September 2023, from https://ec.europa.eu/eurostat/databrowser/view/ENV_AC_AINAH_R2__custom_7466915/default/table

Tamannaei, M. – Zarei, H. – Rasti-Barzoki, M. 2021. A game theoretic approach to sustainable freight transportation: Competition between road and intermodal road–rail systems with government intervention. In Transportation Research Part B: Methodological, vol. 153, 2021, pp. 272–295.

van den Bergh, J. C. 2020. Six policy perspectives on the future of a semi-circular economy. In Resources, Conservation and Recycling, vol. 160, 2020.

Contact address

Jiri Alina, University of South Bohemia, Faculty of Economics, Department of Applied Economics and Economy, Department Secretary, České Budějovice, Czech Republic

jalina@ef.jcu.cz