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Croatian Regional Development Journal | Vol. 4 No. 1 | 2023

Determinants of Profitability in Railway Transport of Selected Companies in the European Union

Toni Gligić
University of Zagreb, Faculty of Economics and Business, Zagreb, Croatia

Tomislav Herceg
University of Zagreb, Faculty of Economics and Business, Zagreb, Croatia

Abstract

This paper explores the factors affecting the net profit margins of railway companies, a relatively under-researched topic. The analysis focuses on ten railway companies within the European Union from 2010 to 2019. Historically, the railway has played a critical role in economic growth, especially during the first industrial revolution. Despite its influence waning in the latter half of the 20th century, it remains an integral component of the economy. The current rise of the green economy provides a vital motivation to focus on railways as a research subject. In this study, the authors examine the effect of six factors on the net profit margin of railway companies. The results indicate that the number of passengers, labour productivity, and the number of employees positively influence the net profit margin. Interestingly, the paper finds evidence of economies of scale in passenger transport but not goods transport. Furthermore, the study demonstrates that the number of employees positively affects the net profit margin, contradicting the widely held assumption about the low productivity of workers in the public sector and state-owned companies.

Keywords: railway; profitability; energy efficiency; green economy; labour productivity

Paper type: Research article

Received: 11 Jun 2023
Accepted: 5 Aug 2023

DOI: 10.2478/crdj-2023-0001

Introduction

Climate changes in the last few decades have put the issue of ecology in all segments of society. New directions regarding renewable energy sources and ecologically acceptable forms of transport stimulated new research about railways. In the new century, they brought numerous development plans and research about the importance of railways on the environment and the economy. Most papers on railways refer to the impact of railways on the economy. On the other hand, the factors contributing to the quality of railways have been poorly examined.

In this paper, the subject of research is the factors that contribute to the profitability of today's railway companies. The paper will examine the impact of several factors on the profitability of selected public railway companies. The main reasons for this analysis are poor financial results and low customer satisfaction with local railways in Croatia. This paper aims to gain insight into the profitability of railway companies in the European Union by analyzing the effects on the business of railway companies.

Two hypotheses are tested in the paper. The first hypothesis is that the increase in traffic of goods and passengers will contribute to the increase in profit margin. It is based on the assumption of exploiting economies of scale in railway transport. The second hypothesis is that the larger the number of employees, the lesser the percentage profit margin. The hypothesis about the number of employees is based on frequent opinions about the inefficiency of public services and companies and the excessive number of employees.

Literature overview

The current form of railways became economically significant in the second half of the 18th century, although rails had been used before. The improvement of the steam engine by James Watt, the British inventor and scientist, was the critical trigger for the future of the railways since it led to the invention of the steam locomotive in 1784. Until today, the railway has been one of the main factors in the development of the world's economy and has dramatically improved the transport of passengers and goods to distant markets, which positively affected international trade development. However, the railway was not the primary driver in any industrial revolution until now; almost every modernization in the last 200 years would not be possible (Bičanić, 2018).

The beginning of the mass use of railways in transport occurred in the first half of the 19th century and was primarily related to Great Britain. In that period, the industrial revolution in Great Britain has already gained significant momentum. The British introduced the first regular line in 1825 to transport coal. Other prominent countries of that time quickly saw the benefits of using railway transport, and France (in 1827), the Habsburg Monarchy (1832) and Bavaria (1835) soon introduced their regular railway lines (Bičanić, 2018). Rail transport was characterized by high speed, comfort, and resistance to bad weather conditions at that time. That comparative advantage over other forms of transport resulted in the railway quickly becoming the primary

mode of transporting goods and passengers in Europe in the 19th century (Tomes, 2008). The electrification of the railway in Liverpool in 1893 is the first example of the introduction of railway electrification, which became a regular practice in the 20th century (Lalić, 2011). Although railway electrification contributes to environmental protection, not a single country in the European Union has fully implemented the electrification of railways.

A significant effect of a positive externality on economic development was noticeable in the 19th and the first half of the 20th century (Bičanić, 2018). The advantages of using railways are reflected in reduced transport costs, which enables the placement and procurement of goods from more distant markets and, consequently, increased competition. Estimates are that the amount of value added from using railways in the British economy in 1865 was around 4.1% of gross domestic product. In France in 1872, the value added was 5.8% of the GDP, while in Spain in 1878, it was 4.4% (Herranz-Loncán, 2013).

The length of the railways reached its peak before the beginning of the Second World War, after which there was a gradual decrease in the use of railways. The reasons for the decrease in rail traffic usage were contained in the change in economic structure. Road and air traffic became more accessible and better-fulfilled society's and the economy's demands. The decline is particularly notable in the transportation of goods. Transported goods had a smaller volume, which made it possible to use alternative forms of transport, primarily road transport, while the advantage of the railway could only be achieved over longer distances (Tomes, 2008).

An additional problem arises because the track width differs across the European Union member states. The standard width of tracks in Europe is 1435 mm, but there are deviations from it in Finland, Portugal, Spain, the Baltic countries and Ireland. The difference in track width requires freight reload, which makes rail transport more expensive and complicated. Further costs arise due to the fragmentation of the European railway market. Each country of the European Union has its own company (or companies) that, in most cases, operate within their country's borders with very little access to foreign markets. The fragmentation significantly affects flexibility and increases freight transport costs (Tomes, 2008). The segmentation of the market in the European Union compared to the United States results in the average use of 7 times more wagons for the same amount of goods transported (Furtado & Bastos, 2013). Although the share of railways fell in the second half of the 20th century, the connection between the country's economic development and the introduction of railways is still present. Most of Europe's most developed countries were among the leaders in the introduction of railways in the 19th century, which enabled them to grow steadily. The economic advantage these countries achieved throughout the 19th and the first half of the 20th century is still present, and, according to economic indicators, these countries are ahead of European countries that were late in the railway introduction process (Urošević, 2019).

Despite the significant reduction in the usage of railways in the second half of the 20th century, with new directions in the development of the economy and an increasingly

significant impact of transport on the environment, the railways have once again come into the interest of research.

Numerous investments in railways in the 21st century show the importance of railways for the future of the European Union's economy. However, the state is the leading investor in almost all railway modernization projects (Bičanić, 2018). For example, the Germany and Deutsche Bahn government in 2019 announced the investment of € 86 billion. In the modernization of German railways in the following ten years. In addition, the government in Germany reduced VAT on train tickets from 19% to 7% to promote rail transport (Wellner & Lakota, 2020).

The railway adapts to today's demands of the economy by developing high-speed rails, which can reach speeds of over 300 kilometres per hour. The best example of High-Speed rail is TVG trains in France.

The European Union promote the sustainable development and use of renewable energy sources. Further investments and railway development represent an opportunity to realize these efforts because of the ecological advantage of the railway and the possibility of significant energy savings by using the railway compared to other forms of transport. The energy consumption of railways is up to 3.5 times lower than in road passenger transport. This advantage in freight transport is even more significant since road transport uses up to 8.5 times more energy for the same effect (Golubić, 1999). With an average consumption of one litre of fuel per ton of transported cargo, the railway covers an average distance of 204 kilometres, while road transport with the same consumption covers only 45 kilometres (Rodrigue, 2008).

In addition to the previously mentioned advantage of ecological aspects, the characteristic of rail traffic is the smaller area required compared to road traffic. For example, six highway lanes towards the city (three in each direction) require a total of 55 meters of width, while an efficient railway that can replace that highway with the same transport intensity is only five meters wide (Golubić, 1999). Additional advantages of modern railways compared to road traffic are speed, comfort, travel safety and economies of scale (Golubić, 1999). With the possibility of connecting several dozen wagons (in some instances, hundreds of wagons) to one locomotive, the railway achieves an incomparably higher number of transported passengers and cargo volume. The initial investments in railway transport are significantly higher than in road transport, which enables railways to have a lower marginal cost than road transport (Bucklew, 2011). However, it renders railways more of a public than a competitive good.

The monopoly in the railway industry is one of the main characteristics of the railway sector. One of the main reasons for monopoly structure is the significant initial investments that represent an entry barrier to the market. Building railway infrastructure is costly, and economies of scale are needed to achieve a return on investment (Gomez-Ibanez & de Rus, 2006). Significant investments in infrastructure are the main reason all significant railway companies are state-owned in almost all European countries. Interestingly, the first investments in railways were made by private capital. In the second half of the 19th century, aftermarket failures in railway transport and the realization of the importance of railways for the entire economy,

Governments became the leading participants in railway transport, and the state ownership of the railway network became an overwhelming form of railway ownership. In the 1990s, the European Union passed a series of regulations aiming to liberalize the railway market in Europe, motivated by the inefficiency of the state-owned railway companies and the reduction of the share of railways in total transport. Such thoughts were encouraged in the 1980s by Margaret Thatcher, who believed that it was necessary to privatize as many public companies as possible to increase the efficiency of these companies. She believed public companies are inefficient primarily because of the excess number of employees. (Gomez-Ibanez & de Rus, 2006).

Preston, Whelan, and Wardman (1999) researched the liberalization of the railway market. They have shown specific positive effects on the freight transport market but without positive effects on passenger transport, which remained heavily subsidized. The need for state subsidies showed the advantages of consolidated railway ownership. Such results encouraged the opinion that a natural monopoly's structure is more efficient in passenger transport (Nash, 2006). The grouping of infrastructure, capacity, and workforce in one company, concerning several of them, enables the exploitation of the economies of scale and brings significant savings since competition doubles a part of the costs, which leads to the inefficient use of resources. Additional savings occur through more efficient allocation, lower investments, and lower unit costs (Grant & Bamford, 2006). European operating costs are four times higher than in the United States for the same effect in transported volume and distance (Furtado & Bastos, 2013).

The railway sector is characterized by a complex system, which makes it difficult to predict profitability. Previous models that have tried to analyze profitability have not proven reliable. Railway companies could achieve profitability through careful spending in planning, building, acquiring and maintaining infrastructure, reducing operating costs and encouraging increased passenger transportation (Feigenbaum, 2013).

Investing in the modernization of railways is not always based on economic analysis, so it will not always bring an accounting profit for the project.

Therefore, the success of investment in railways will depend on the economy's capacity to generate social benefits. By generating these benefits, the economy will compensate for the costs incurred during construction, maintenance, and operation. Economic benefits are manifested in time savings, regional development, positive environmental effects, and other positive effects.

Due to the impossibility of measuring all the potential benefits of railways for society, the potential analysis of the rationality of investments in railways becomes unclear and imprecise. Many successful investment projects in railways have been unsuccessful due to only the financial aspect, but they have brought significant progress to regional development (de Rus & Nombela, 2007).

Data and Methodology

Based on previous research introduced in the Literature overview, two hypotheses are set in the paper. The first hypothesis is that the number of passengers and the volume of transported goods in railway transport in selected countries of the European Union in the period from 2010 to 2019 is positively related to the net profit margin, which indicates the existence of the economies of scale.

One can indicate two parts of this hypothesis: the number of passengers and the volume of transported goods. The difference between the two was noticed in several papers, for example, Preston, Whelan, & Wardman (1999) and Nash (2006).

The second hypothesis is that the number of employees in the selected railway companies in the European Union from 2010 to 2019 caused a decrease in the net profit margin. It is based on public companies' inefficiency, which was one of the main reasons for the liberalization of the railway market in the second half of the 20th century. This hypothesis is also put forward given the general attitude that the number of employees in public companies is too large (Bartel & Harrison, 1999; Giordano, Lanau, Tommasino, & Topalova, 2020). Furthermore, the railways in the United States show higher profitability with fewer workers for the same performance (Furtado & Bastos, 2013). Therefore, as expected, the effect of the number of employees should hurt profitability.

In order to test the hypotheses, a panel data model was estimated. The data used in the model were collected from the public financial reports of railway companies and the Eurostat database. The cross-section component of the panel data consists of railway companies, the largest companies in the railway transport sector in their countries. The common characteristic of all companies is that they are state-owned (>50%). Considering these characteristics and the availability of data, the following ten railway companies are included in the research: ÖBB-HOLDING AG (Austria), České dráhy Group (Czechia), Danske Statsbaner (Denmark), Latvijas dzelzceļš (Latvia), MÁV Hungarian State Railways (Hungary), PKP Polskie Linie Kolejowe S.A. (Poland), Železničná spoločnos Slovensko, a.s. (Slovakia), Slovenske železnice, d. o. o. (Slovenia), Entidad Publica Empresarial Renfe (Spain) and SJ (Sweden). The time component consists of the annual data from 2010 to 2019. The 2020 dropped out due to the Covid-19 pandemic, which also influenced transport in 2021. Due to the pandemic, there were significant deviations in the financial results of the railway companies in these two years. Therefore, these results are excluded from the analysis; in 2020, European railways lost over € 24 billion in the passenger transport segment compared to the previous year. The decrease in passenger transportation was 42% of revenue, while the decrease in freight transport was 12%.

Table 1 shows the tested models' dependent and all independent variables. The model's dependent variable is railway companies' profitability, measured by the Net profit margin. Net profit margins of selected companies are measured as the ratio of net profit to total revenues.

Table 1. List of variables

Symbol	Variable name	Explanation / Measurement
Dependent variable		
NPM	Net profit margin	Calculated as the ratio of net profit to total revenues according to companies' financial statements. (%)
Independent variables		
NoE	Number of Employees	Average number of employees during the year according to the financial statements of companies. (number of employees)
NoP	Number of passengers	Total number of transported passengers in selected country in a year according to Eurostat database (millions of passengers)
GT	Goods transported	Total weight of transported goods in the selected country in a year according to Eurostat database. (millions of tons)
GDP	GDP per capita	Data according to Eurostat database. (€/inhabitnant)
Pro	Productivity	Calculated as the ratio of total revenues to the number of employees according to companies' financial statements. (€/employee)
Sub	State subsidies	Total subsidies on transport according to Eurostat database. (millions of €)

Source: Authors' work

The independent variables in the models are Number of employees, Number of passengers, Goods transported, GDP per capita, Productivity and State subsidies for transport. According to the companies' annual financial statements, the number of employees shows the average number during the year. The variable number of passengers shows the total number of transported passengers in a year and is collected from the Eurostat database. It is measured in millions of passengers. The variable Goods transported shows the total weight of transported goods and is collected from the Eurostat database. It is measured in millions of tons. Independent variable Productivity is measured as the ratio of total revenues to the number of employees according to data from companies' financial statements. The variable GDP per capita is collected from the Eurostat database and represents the country's development and wealth. The Data on State subsidies are collected from the Eurostat database as total state expenditure on all kinds of transport. Data on variable State subsidies is one of the possible limitations of this paper since there is no precise figure for all countries that refers only to railway sector subsidies. Due to the lack of that data, the data for total transport subsidies are used in the analysis.

In analyzing the effect of selected variables on the profitability of railway companies, an econometric analysis of panel data is used with the application of a static panel with fixed effects, with all the necessary tests being conducted.

In the analysis, six different models were constructed to examine the influence of different combinations of independent variables on NPM, to examine the set hypotheses about the effect of the economies of scale on railway profitability and the hypothesis about the efficiency of workers in the public sector and companies (Table 2).

Table 2. Models tested in analysis

Model	**Model equation**
Model 1	NPM = $\beta_0 + \beta_1$NoE + β_2NoP
Model 2	NPM = $\beta_0 + \beta_1$NoE + β_2NoP + β_3GT
Model 3	NPM = $\beta_0 + \beta_1$NoE + β_2NoP + β_3GT + β_4GDP
Model 4	NPM = $\beta_0 + \beta_1$NoE + β_2NoP + β_3Pro
Model 5	NPM = $\beta_0 + \beta_1$NoE + β_2NoP + β_3GT + β_4Pro + β_5SS
Model 6	NPM = $\beta_0 + \beta_1$NoE + β_2NoP + β_3GT + β_4GDP + β_5Pro + β_6SS

Source: Authors' work

Model 1 includes the following independent variables: Number of employees and passengers. Model 2 is expanded for the Transported goods. Compared to Model 2, Model 3 is expanded for the variable GDP per capita variable as a control variable. Model 4 is constructed to examine the connection between the productivity and profitability of the company in addition to the two significant variables from the previous three models. Government subsidies for transport were added to Models 5 and 6, considering that the railway sector is highly dependent on government subsidies.

Previous research on profitability did not result in a reliable model that can be used to calculate the profitability of railway companies (Feigenbaum, 2013). For this reason, the paper does not test any specific existing model from previous research but tries to test the effect of selected variables through panel analysis. Through the review of previous literature on this topic, the selected variables showed possible connected effects on profitability. Some variables are related to the existing effects in railway traffic, while the others were selected based on general assumptions about public companies, considering that all companies are majority or entirely owned by the state.

From the review of the literature, it can be assumed that previous research has shown that economies of scale will positively affect profitability (Feigenbaum, 2013). Therefore, the variables Number of passengers and Goods transported are included in constructed models. Furthermore, the literature has shown the need for state subsidies in passenger transport (Preston et al., 1999). Therefore, the State subsidies variable is included in some of the models. The other three variables are selected in the models based on general research on public companies. According to previous research, GDP per capita as a measure of state development should positively affect profitability since public companies from more developed countries generally showed

greater efficiency. The variables Number of employees and Productivity are related to previous research and frequent opinions on the inefficiency of public companies (Bartel & Harrison, 1999) (Gomez-Ibanez & de Rus, 2006). Additionally, railways in the United States have shown greater profitability with fewer employees for equal transportation performance (Furtado & Bastos, 2013), concluding that employee growth should harm NPM while higher productivity should have a positive effect.

Based on previously presented data, the tested models are constructed according to the expectations of the effects of selected variables on the Net profit margin. The basic idea of the constructed models is to test the validity of the set hypotheses, which were constructed based on assumptions about the importance of economies of scale in railways (H1) and the inefficiency of work in public companies (H2).

Results

Financial reports show that during the ten years covered by the model, the companies achieved an average annual net profit of 3.75 million euros. The average net profit margin was only 0.24%. The best net profit margin was achieved by the Swedish company SJ, whose average net profit margin was 4.8%, while the highest average annual profit of 87.9 million euros was achieved by the Austrian company ÖBB. The worst results were achieved by the Polish company PKP Polskie Linie Kolejowe. Its average annual loss was 105.6 million euros, while its profit margin averaged -8.7%.

The selection between models with random and fixed effects was made using the Hausman test, which showed that in all six models, the test's null hypothesis was rejected at a significance level of 1%, and therefore, fixed effects were used in all models. Table 3 shows the results of the econometric analysis for the six selected panel models of the net profit margin. Models 1 and 4 are well-defined regarding the test results. In those models, all tested independent variables were found to be significant. Models 2, 3, 5 and 6 contained at least one non-significant variable and are therefore discarded from further analysis. Because Model 4 is an extended version of Model 1, the results of Model 4 are used in further analysis.

The existence of autocorrelation was tested with the Durbin-Watson test. According to the test result, it can be concluded that there is no autocorrelation problem in Model 4 at a significance level of 1%. The existence of heteroskedasticity was tested with White's test. The test results show that at a significance level of 1%, 5% and 10%, we cannot reject the null hypothesis and conclude that there is no heteroskedasticity in Model 4, so performing standard error corrections in Model 4 is unnecessary.

Table 3. Results of the econometric analysis of the Net profit margin model in selected railway companies from 2010 to 2019

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable						
Number of employees	0.00016**	0.00015**	0.00015**	0.00020***	0.00019***	0.00019***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of passengers	0.11135***	0.10556***	0.09495**	0.09107**	0.08787**	0.08753*
(In millions)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)
Goods transported		0.11397	0.10631*		0.09887	0.09862
(In millions of tons)		(0.07)	(0.06)		(0.06)	(0.06)
GDP per capita			0.00023			0.00001
			(0.00)			(0.00)
Productivity				0.00006*	0.00005	0.00005
				(0.00)	(0.00)	(0.00)
State subsidies					-0.00001	-0.00001
					(0.00)	(0.00)
Constant	-24.569***	-31.225***	-33.928***	- 27.519***	-33.009***	-33.111***
	(5.58)	(5.46)	(8.74)	(5.34)	(5.86)	(9.36)
Observations	100	100	100	100	100	100
F-test	0.0050	0.0018	0.0033	0.0005	0.0004	0.0005
Hausman test	0.0001	0.0002	0.0009	0.0005	<0.0001	0.0002
Durbin-Watson d-statistic				1.734***		
d_L				1.461		
d_U				1.625		
White test				0.181		

*Notes: Significance Levels: *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors are in brackets*

Source: Author's work

Model 4 showed a positive effect of three variables, the Number of employees, Number of passengers and Productivity, on the Net profit margin. The level of significance in Model 4 for the variable Number of employees is 1%, for the Number of passengers 5%, while the significance of the variable Productivity is 10%. The constant is significant in the model at the 1% level. The estimated Net Profit Margin model according to Model 4 is:

$$NPM = -27.519 + 0.0002 \times NoE + 0.09107 \times NoP + 0.00006 \times Pro + \varepsilon \quad (1)$$

Model 4 assumes that the net margin increases by 0.09107 percentage points for every million passengers. An increase in the number of employees by 1000 causes an increase in the net profit margin by 0.2 percentage points, while an increase in productivity (measured by revenue per employee) in the amount of 1000 euros causes an increase in the net profit margin by 0.06%, keeping the other variables constant.

Model 4 fails to reject the first hypothesis in the passenger transport segment, while it is rejected in the goods transport segment because the variable goods transported were found to be significant in none of the models. In other words, in the period from 2010 to 2019, the effect of economies of scale was confirmed in passenger rail traffic, while in goods traffic, the existence of the effect of economies of scale was not proven, which contradicts the previous research (e.g. Preston et al., 1999). The positive relationship between the Net Profit Margin and the Number of Passengers confirmed

Feigenbaum's (2013) assumption about the increase in the number of passengers as one of the bases of the financial profitability of railway investment.

Model 4 showed that an increase in the number of employees increases the net profit margin in the railway transport of selected European Union countries in the period from 2010 to 2019, which is precisely the opposite of hypothesis H2 and the generally accepted assumption about the inefficiency of workers in the public sector. Furthermore, the positive effect of the variable Productivity on Net profit margin is expected, as is shown in previous research that showed higher profitability of companies in the United States, among others, due to higher productivity.

Conclusion

This paper analyzed the effect of six factors on the net profit margin of selected railway companies using an econometric analysis and applying a static panel model. The variables used in the models are the Number of employees, Number of passengers, Goods transported, State subsidies, Labor productivity and GDP per capita. Based on these six variables, six different models were constructed. The analysis has shown that only the variables Number of passengers, Number of employees and Productivity are significant in the Net profit Margin model. The results confirmed the presence of economies of scale in passenger traffic. The economy of scale has not been confirmed in the railway transport of goods.

Furthermore, the model showed that the number of employees positively correlates with the net profit margin despite the established hypothesis based on the established assumption of low productivity of employees in public companies. Specifically, it was found that for each million passengers, the net profit margin increases by 0.09107 percentage points, keeping the other variables constant. An increase in the number of employees by 1000 causes an increase in the net profit margin by 0.2 percentage points, while an increase in productivity (measured by revenue per employee) in the amount of 1000 euros causes an increase in the net profit margin by 0.06% points, keeping the other variables constant.

Although previously conducted research showed that the effect of market liberalization in the European Union was successful in goods transportation, this paper has not found evidence for it, meaning that things have changed in the recent decade. Part of the previously conducted research showed that investments in modern railways will never pay off by looking only at the accounting profit. Despite this, further investments are present in all analyzed countries since the benefits of railways are multiple, mainly in positive external effects, such as increased transport speed, lower transport prices, and lower energy consumption per unit of transported goods and passengers.

The results of this paper show the need for further promotion of the railway among passengers to increase the use of the railway considering the positive effect of the variable Number of passengers on profitability. In addition, in the development plans, the European Union emphasized passenger transport, which shows that the authorities are aware of the positive externalities of the use of railways in the

transportation of passengers and continue with investments in that segment despite the financial losses of railways companies.

Since the research included only 10 out of 27 European Union countries, this is a paper limitation. Furthermore, more precise information on state subsidies given to railways would only give a better insight into the impact of state subsidies on companies' net profit margins.

This analysis opens possibilities for new analyses regarding the need for further investments in railway modernization following the requirements of modern economy and society. The analysis results indicate the need for a separate observation of the effects of passenger and goods transport in rail traffic in further research because of different variables, such as the number of passengers and goods transported and profitability. Finally, to achieve the full potential of the goods transport, the interconnection of the water transport (rivers and sea) with the railways should be achieved, which is still not present.

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About the authors

Toni Gligić graduated in 2022 from the Faculty of Economics in Zagreb. During his studies, he spent a study year at the University of Vienna and actively participated in the work of the Financial Club. He was hired as an external associate at the Department of Economic Theory at the Faculty of Economics in Zagreb. The author can be contacted at **tgligic@net.efzg.hr**

Tomislav Herceg was born on August 24, 1981 in Požega. He graduated from the Faculty of Economics of the University of Zagreb in 2005 with a thesis on "Mathematical Modeling of General Equilibrium in International Trade". He obtained the academic degree of Master of Science in 2010 with the master's thesis "Analysis of the impact of capital account liberalization on international capital flows" at the Faculty of Economics in Zagreb, where he received his doctorate in 2012 with the dissertation "Total factor productivity in the manufacturing industry". He speaks English, German, Italian, French and Spanish. He is employed at the Faculty of Economics in Zagreb at the Department of Economic Theory. He teaches at the Integrated Undergraduate and Graduate Studies in Economics and Business Economics (Fundamentals of Economics, Microeconomics, Microeconomic Theory and Applied Microeconomics), the Bachelor Degree in Economics and Business (Microeconomics, Principles of Economics, Microeconomic Theory), the Master Degree in Economics (Advanced Microeconomics), Postgraduate Doctoral Studies in Economics and Business Economics (Microeconomic Analysis) and Doctoral Studies "Economics in a Digital Environment" of the University of Dubrovnik (Microeconomics, Innovations, Technology and Industrial Policy). He deals with the research of technological progress, the processing industry and theoretical microeconomics in the field of decision-making. The winner of the Ljubomir Martić Award for the university textbook in microeconomics and the Mijo Mirković Award for the textbook in Fundamentals of Economics for his scientific work. He is the director of the Eurokarbon factory and the deputy director of the Eurocom company. The author can be contacted at **therceg@net.efzg.hr**