THE ROLE OF RAILWAYS TARIFFS AND PERFORMANCE FOR ECONOMIC GROWTH IN UKRAINE

by

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Abstract

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This work examines the effect of the railroad tariffs on the transportation of good by Ukraine railway company using OLS estimation. Moreover, this paper shows the influence of assets on the performance of Ukrzaliznytsia. Based on the Ukrstat and the Main information center of Ukrainian railways data for 2002 – 2017, it is shown that the effect of the tariff is not big in magnitude. This is explained by the undervalued tariffs due to the dependence of UZ from government and politicization of increasing its tariffs. Regarding performances, a positive effect have average daily mileage of a locomotive, average load on a wagon and fleet of locomotives. These results imply that UZ could raise its tariffs and use its profit on the main assets.

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GLOSSARY

CFO – Chief Financial Officer

CPI – Consumer Price Index

IMF – International Monetary Fund

KSE – Kyiv School of Economics

NBU – National Bank of Ukraine

OLS – ordinary least squares. The most commonly used method of regression model estimation. It allows to find coefficients between linearly dependent variables through minimization of the sum of squared errors of the estimate

UKRSTAT – State Statistics Service of Ukraine

UZ – Ukrzaliznytsia (Ukrainian Railway Company)

WB – World Bank

Chapter 1

INTRODUCTION

Railroad is one of the leading parts in the Ukrainian infrastructure system. The main reilroad functions are cargo and passengers' transportation. In Ukraine, there is only one player on this market – Ukrzaliznytsia.

"Ukrainian Railways" or Ukrzaliznytsia (UZ) is a public joint stock company of general rail transport, a national carrier of goods and passengers, whose purpose is to meet the needs for safe and high-quality rail transportation in domestic and international communication, ensuring the efficient operation and development of rail transport. It controls a vast majority of railroad transportation in the country. In 2015 Ukrzaliznytsia was transformed from a state-owned enterprise into a public joint stock company owned by the state. Ukrzaliznytsia consists of 6 regional branches: Lviv, Odessa, Cisdnieper or Near-Dnipro, Southern with a center in Kharkiv, Southwestern with a center in Kyiv and Donetsk railway with a center in Lyman (temporarily, as Donetsk occupied by Russian Federation) – which does not have the status of a separate legal entity from 2015. Crimea railway is a part of Cisdnieper branch also temporarily occupied by Russian Federation.

Rail transport in Ukraine is the leading industry in the country's road transport system, which provides 82% of freight and almost 50% of passenger traffic carried by all modes of transport. The operational network of Ukrainian railways is almost 19,800 km (excluding occupied territories, the network of which is currently not used), of which more than 47,2% are electrified. It makes UZ 14th largest in the world in track-km. Ukrainian Railways is also the world's 7th largest freight transporter.

Passenger cars fleet consists of 4.54 thousand units, including a working park - 3.1 thousand cars. There are ten units of high-speed electric trains «Hyundai» and two units of high-speed electric trains "Tarpan." The total fleet of freight

cars is 82.5 thousand units. From the existing fleet of freight cars, the working park is 62.9 thousand wagons. Inventory park of locomotives makes 3.9 thousand units, including electric locomotives - 1.7 thousand units and diesel locomotives - 2,2 thousand units.

All types of the fleet are critically worn off. The depreciation of locomotives is around 95%. According to information provided by UZ, the average age of electric locomotives is 40.6 years at the norm of 30 years, main locomotives - 37 years at the standard of 20 years. The railroads itself depreciated by more than 80%.

Railways of Ukraine still provided the needs of the economy and the population in transportation. This was achieved thanks to the surplus of technical capacities created during the Soviet Union at the expense of centralized budget financing. Over the last 20 years, investments in the renewal of fixed assets have taken place exclusively at the expense of internal railway funds, which did not allow to update the rolling stock and infrastructure at the adequate level. Today, the technical resource of railways is practically exhausted. There is a threat of lack of rail transport in the future needs of the Ukrainian economy in transportation.

In the period from 1992 to 2015, the growth rate of prices for consumed products exceeded the growth of transportation tariffs, which did not allow to update the rolling stock and infrastructure at the expense of internal railway funds. The 1996 Law of Ukraine "On Railway Transport" did not allocate budget funds for the construction and modernization of trunk lines and the purchase of rolling stock for passenger transportation. Almost no funds were allocated from local budgets for the purchase of electric and diesel trains for the passengers transport in suburban traffic, losses from socially essential suburban passenger transport were not fully reimbursed.

Due to the catastrophic depreciation of rolling stock, the discrepancy between the acquisition and cancellation of freight cars and locomotives threatens the non-provision of industrial sectors needs of the economy in the transport of

goods, with the corresponding expenditures for the state budget, lowering indicators of the country's economic development.

These days there are burning issues, requiring on immediate solutions by the governing body. According to Andriy Ryazantsev, – CFO of Ukrzaliznytsia – if UZ work at such rates as today, in 20 years out of 20 thousand km of the infrastructure, there will be only 5 thousand, and out of 2 thousand locomotives – only 200. Mr. Ryazantsev also considered that in order to update these fixed assets, the company needs to earn 1 trillion hryvnias for 23 to 30 years. Despite the fact that over the last years Ministry of Infrastructure of Ukraine increased tariffs of UZ several times, it is not enough to renovate the company and its assets. On the 7th of September 2018, Andriy Ryazantsev announced a larger increase in tariffs, as he said: "Today's rates of transportation are three times less than that which allows us to resume the lifetime of fixed assets. Therefore, we are quite well aware that increasing the cost of business three times for rail freight in today's situation is impossible to avoid."

As we can see in Figure 1, over the last 15 years, tariffs increased more rapidly than CPI.

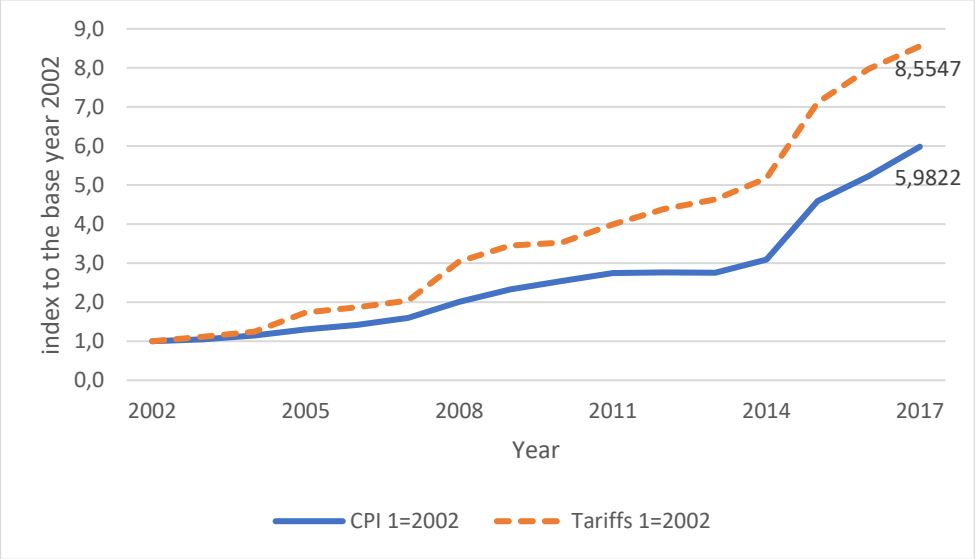

Figure 1. UZ tariff rate and CPI (2002 – 2017)

After that we can adjust tariff by CPI, to see tariff increase in real terms. This is shown in Figure 1.2

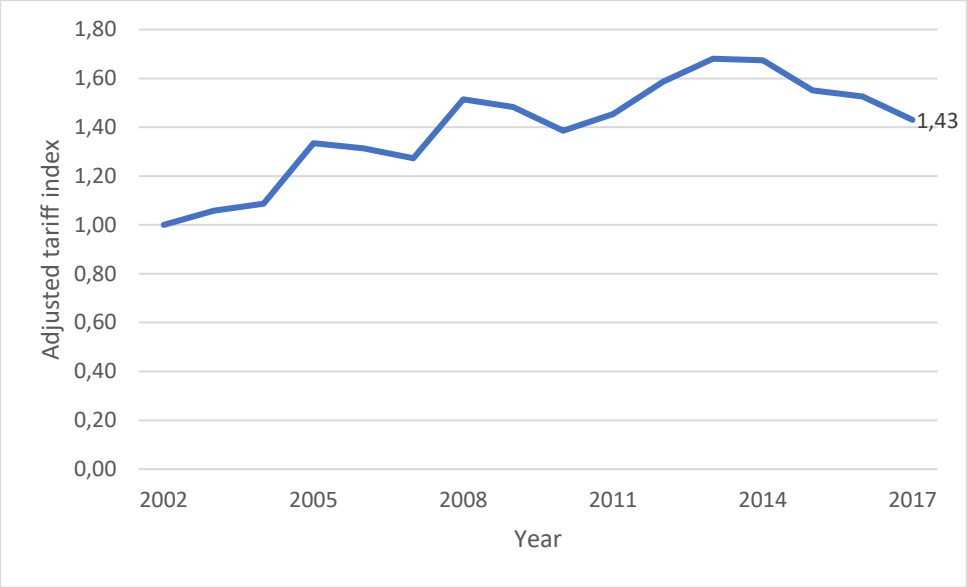

Figure 2. Adjusted tariff index (2002-2017)

Using adjusted tariff index, we can observe the crises. The highest rate of 1.67 was in 2013 and 2014. We can see the decrease caused by the crisis. The tariffs are set up by the Ministry of Infrastructure of Ukraine on the submission of UZ.

According to this information, we can affirm, that the research on the influence of tariffs is reasonable.

The main questions of this thesis are:

- what is the tariff elasticity of demand on the services of Ukrzaliznytsia?
- what indicators have an effect on the performances of Ukrainian railways?
- how the three times increase of tariffs will affect the GDP of Ukraine provided by Ukrzaliznytsia?

The structure of this paper is the following: Chapter 2 describes the literature on the relationship between the railway development and GDP; Chapter 3 provides the methodology of the analysis and model specifications; data sources and issues are reviewed in Chapter 4; the main empirical results are presented in Chapter 5; Chapter 6 summarizes all key findings of the paper and develops ideas for further research.

Chapter 2

LITERATURE REVIEW

This chapter deals with the most relevant literature for my thesis. The effect of railroads tariffs on the GDP of the country has never been explored, but there are some compatible studies.

Demurger (2000) studied the relationship between the infrastructure investment and the growth of the economy in China. China has been one of the fast-growing economies in the world since 1978. Demurger used the panel data for 24 provinces of China from 1985 to 1998. After estimating the growth model, the author discovered that not only reforms, openness, and geographical location, but also infrastructure was significant in accounting the growth performance across provinces. Transport facilities were one of the main differentiating factors in explaining the growth gap between Chinese provinces.

Perkins et al. (2005) analyzed the relationship between the infrastructure and long-term economic growth in South Africa. The used database covers all sectors of the infrastructure, including railways, roads, and ports. The authors used PSS F-tests to identify directions of association between the infrastructure and economic growth. These indicate long-run relationships from the infrastructure investment and to GDP. The main finding, related to my research, is that the relationship between the infrastructure and economic growth runs in both directions, so that the incorrect investment in the infrastructure could create some bottlenecks and there would be nothing about the economic growth anymore.

Attack et al. (2010) used the geographic information database to study the impact of gaining an access to railway influences on urbanization and regional development in the American Midwest between 1850 and 1860. The researchers used a differences-in-differences analysis of a panel of 278 counties.

The authors found a large impact of railways on urbanization, but the insignificant effect of the infrastructure on population density.

Benerjee et al. (2012) updated their previous 2004 study using a bigger dataset. The authors estimated the effect of access to transportation networks on economic outcomes of regions in China. As a result, the authors discovered that transportation networks had a positive causal effect on the GDP level.

Pereira (2014) measured the impact of railways investment on economic growth in the United States in 1828 – 1860. Mr. Pereira used a bivariate dynamic time series methodology, based on the VAR model. The author's estimation shows that railways investment had a significant impact on economic growth during that period. To be more precise, one dollar invested in railways yields 4.2 dollars in GDP in the long-run.

Wijeweera et al. (2014) analyzed an unexpected shock in freight rate, business cycle, and international trade on rail demand in Australia, based on the annual data for 1970-2011. The authors used the VAR model, which showed that freight rate was one of the critical determinants.

Ismail and Mahyideen (2015) examined the infrastructure impact on the trade volume for chosen Asian countries. It was demonstrated that improvements in the infrastructure increased trade flows and, as a consequence, GDP. Also, it was studied that not only hard infrastructure (railways, roads), but also soft one (telephone lines, mobile phones, internet users) had a positive trade effect.

Wang and Wu (2015) also provided the evidence that infrastructure has a significant effect on the economic development of China. The Qingzang railway increased the GDP by about 33%. This effect was produced due to developing both manufacturing and agricultural sectors.

Donaldson (2008) estimated the economic impact of the railway network development from 1861 till 1930 in India. The author used the district-level data on yearly output, prices, and trade flows. The railway network is estimated to cause the transportation costs to fall by 73% on average. It causes the

increase in international trade. As a result, railways raised the agricultural income by 18%, causing GDP growth.

Donaldson (2016) also wrote a paper in which he examined the historical impact of railways on the American economy with a focus on the value of agricultural land in 1890. The author measured the market access by developing a network of railroads and waterways. As a result, agricultural land values increased essentially with the expanding of railroads in 1870-1890. If there were no infrastructure in 1890, the total value of agricultural land would be lower by 60%.

Donaldson (2018) undertook a similar study in 2008. In addition to previous results, Mr. Donaldson found a positive influence of the railroads developing on the real income levels and welfare.

Pittman (2017) is one of the few, who contributed some studies for Ukraine. Doctor Pittman made some recommendations on reforming and restructuring Ukrzaliznytsia. The author found that creating of a competitive freight train market could improve the system performance. Mr. Pittman proposed the American-style policy of horizontal separation, which also would improve the system performance. According to the article, this policy may be more suitable for such a country as Ukraine and such freight dependent railway company as UZ.

Chapter 3

METHODOLOGY

In this chapter, we discuss the models, which will be applied in this paper. We separate this chapter into three parts. First is the tariff elasticity model, second is performance model and the third is the effect on the economy of Ukraine in general.

3.1 The tariff model

A price change of rail freight transport can, especially in the long run, have very diverse effects on rail freight transport, working through all kinds of behavioral mechanisms. These effects are often expressed in the form of elasticities.

The concept of elasticities was first thought by English economist Alfred Marshall. Elasticities give the ratio of a percentage change in demand or supply to a percentage change in one of the factors explaining demand or supply. The advantage of elasticities is that they are dimensionless, i.e., a change in the unit of measurement (for instance, from kilometers to miles) does not affect elasticities. Since the days of Marshall, many demand and supply models have been estimated, either with constant elasticities (double logarithmic specification), or from which implied elasticities at certain points can be calculated.

In this paper I use the following general definition of elasticity provided by De Jong and Gunn (2001): an elasticity gives the impact of a change in the independent (or stimulus) variable on the dependent variable, both measured in percentage changes.

First, we should choose the approach to measure the tariff elasticity of freight transportation. Different methodologies with different functional forms or alternative models may induce biases. This is a problematic issue since

comparative analyses on the same data set are rare. In the field of freight transport, Oum's paper (1989) makes such a comparison between the simple linear demand model, the log-linear model with the hypothesis of invariant elasticities and the trans-log model.

We use the same approach as Cooper, J. C. B. (2003). The double logarithm OLS regression is provided here:

$$Ln\ ton = \beta_0 + \beta_1 \ln t + \beta_2 \ln wagons + \beta_3 \ln exrate + \beta_4 \ln pop + \beta_5 \ln gdp + \beta_6 \ln unemp + \beta_7 sr + \beta_8 \ln lot + \beta_9 \ln el + \varepsilon, \quad (1)$$

where ton is total volume of transported cargo by UZ, t – tariff on distance, $wagons$ – quantity of appropriate wagons , $exrate$ – average annual exchange rate UAH/USD, pop – population of Ukraine, gdp – Gross Domestic Product, $unemp$ – annual unemployment, sr – share of rail freight transport in total inland freight transport, lr – total length of rails, el – length of electrified rail lines in total rail network, ε – random error term, ln – natural logarithm.

Out of this model, we can expect that the tariff elasticities will be:

$$\frac{\partial \ln(ton)}{\partial \ln(t)} = \beta_1 \quad (2)$$

3.2 The performance model

As we are also interested in the performance of Ukrzaliznytsia, we use another model to understand what indicators are the most effect on the overall performance.

$$Ln\ ton = \beta_0 + \beta_1 \ln l_1 + \beta_2 \ln l_2 + \beta_3 \ln l_3 + \beta_4 \ln l_4 + \beta_5 \ln l_5 + \beta_6 \ln l_6 + \beta_7 l_7 + \beta_8 \ln l_8 + \beta_9 \ln l_9 + \beta_{10} \ln l_{10} + \beta_{11} \ln l_{11} + \beta_{12} \ln l_{12} + \beta_{13} \ln l_{13} + \beta_{14} \ln l_{14} + \varepsilon, \quad (3)$$

where ton is total volume of transported cargo by UZ, l_1 – turnover of the wagon, l_2 – waiting of wagon at a power station, l_3 – waiting time of wagon at one operation, l_4 – average polling speed, l_5 – average train weight, l_6 – average daily mileage of the locomotive, l_7 – percentage of empty wagons to total, l_8 – average load on the wagon, l_9 – operational fleet of freight locomotives, l_{10} – working fleet of freight wagons, l_{12} – total time of stops, l_{13} – average productivity of the locomotive, l_{14} – average productivity of the wagon.

After the estimation, we can predicate, that beta-coefficients and its measures will show us which indicators have bigger effect on the performance of Ukrainian railways and which smaller.

3.3 The effect on the economy of Ukraine

We will run the regression, to find the influence of tariff of UZ on the export of goods. According to the data of the Ministry of Finance of Ukraine, the average quotient of export in GDP of Ukraine over the last 15 years is 48.78%. We assume that this part will be influenced by the tariff.

$$Ln\ exp = \beta_0 + \beta_1 \ln t + \beta_2 \ln wagons + \beta_3 \ln exrate + \beta_4 \ln pop +$$
$$+ \beta_5 \ln gdp + \beta_6 \ln unemp + \beta_7 sr + \beta_8 \ln lot + \beta_9 \ln el +$$
$$+ \beta_{10} \ln ton + \varepsilon, \quad (4)$$

Where exp is a export of special product in every year, ton is total volume of transported cargo by UZ, t – tariff on distance, $wagons$ – quantity of appropriate wagons , $exrate$ – average annual exchange rate UAH/USD, pop – population of Ukraine, gdp – Gross Domestic Product, $unemp$ – annual unemployment, sr – share of rail freight transport in total inland freight transport, lr – total length of rails, el – length of electrified rail lines in total rail network, ε – random error term, ln – natural logarithm.

Out of this model, we can expect that the influence of UZ tariff on the export will be:

$$\frac{\partial \ln(exp)}{\partial \ln(t)} = \beta_1 \quad (5)$$

This coefficient is expected to show us the influence of the tariff on the GDP of Ukraine.

To avoid the multicollinearity, which could probably occur, we use the VIF test after all the regressions. VIF stands for variance inflation factor. As a rule of thumb, a variable whose VIF values are greater than ten may merit further investigation. Tolerance, defined as 1/VIF, is used by many researchers to check on the degree of collinearity. A tolerance value lower than 0.1 is comparable to a VIF of 10. It means that the variable could be considered as a linear combination of other independent variables. The we drop these variables

from the model one by one till the moment, when all the variables will have VIF value less than 10.

In the end, we will get the estimates, which will be used to make a conclusion.

Chapter 4

DATA DESCRIPTION

In this chapter, we discuss our data. The data contain specific indicators related to railroads as well as the general indicators of the economy of Ukraine. I will divide this chapter into three parts, as there was taken two datasets of main UZ indicators, which have some differences and the all-purpose indicators, which are present in all models of mine.

First of all, there are four main sources of the data, used in this thesis:

- State Statistics Service of Ukraine (Ukrstat)
- SE "The Main information center of Ukrainian railways" (Branch "Main information computational center» of the joint stock company "Ukrainian railways")
- International institutions (IMF and WB)
- NBU

To avoid the bias of hyperinflation, which takes place in Ukraine's economy in 1991-1996 and being limited by the availability of information, the period chosen for our research is 2002-2017 (15 years). 2018 was not considered, because of the lack of some data.

4.1. Dataset divided by freight type

First of all, I have to mention, that Ukrzaliznytsia divides freight transportation into ten main groups:

1) Coal
2) Iron and manganese ore
3) Mineral Construction Cargo
4) Ferrous metals
5) Oil and its products

6) Chemical and mineral fertilizers
7) Coke
8) Grain Cultures
9) Forest goods
10) Cement

Table 1 provides statistics on the tariff indexes. The base year is 2002.

Table 1. Tariff statistics (2002-2017)

Product	Tariff index in 2017	The average year to year increase
Coal	7.1723	0.1365
Iron and manganese ore	7.8704	0.1443
Mineral construction cargo	10.5697	0.1700
Ferrous metals	9.2463	0.1578
Oil and its products	8.9561	0.1551
Chemical and mineral fertilizers	5.7632	0.1219
Coke	8.0369	0.1462
Grain cultures	7.8986	0.1464
Forest goods	8.9223	0.1555
Cement	8.6574	0.1543
Total average	8.3093	0.1488

The tariff policy is conducted for each group separately. They are not created by the market. The tariffs are set up by the Ministry of Infrastructure of Ukraine on the submission of UZ. In the elasticity model, tariff index is a control variable. All tariffs were taken from Ukrstat.

As we can see from the table above, tariffs on mineral construction cargo increased the most, by more than 10.5 times, while tariffs on chemical and mineral fertilizers increased by 5.75 times. The average tariff in 2017 was 8.31 times higher than in 2002. The average year to year increase of tariffs is 14.88%.

The data on the volume of freight transportation divided by types of the product was provided by SE "The Main information center of Ukrainian railways." In table 2, we see if the volume on different product increase over 15 years or decreased.

The biggest decrease we observe in oil and the volume of its products. Today's volume is only 22.61% of the volume in 2002. On the other way, the volume of grain cultures increased by more than 4.5 times. This shows us that the agricultural sector of Ukraine has developed with a very good rate.

The overall volume of transported cargo by UZ decreased by 16% in 15 years. The volume of one of the most important product, coal, decreased twice. This change happened due to the occupation of the East of Ukraine, where the main mining centers are located. On the other hand, the transportation of iron ore increased by 15%, as well as the volume of mineral construction cargo. Also, we observe positive changes in cement transportation and a small change in the volume of forest goods transportation.

Table 2. Volume statistics (2002-2017)

Product	Min	Max	2017 to 2002
Coal	43 857.30	104 378.90	47.80%
Iron and manganese ore	56 403.70	76 616.20	115.03%
Mineral construction cargo	35 379.00	68 336.60	112.56%
Ferrous metals	20 829.20	41 768.90	65.52%
Oil and its products	2 711.20	27 394.40	22.61%
Chemical and mineral fertilizers	3 493.50	8 013.60	70.18%
Coke	5 024.30	12 405.90	48.87%
Grain cultures	6 168.30	35 711.40	466.07%
Forest goods	2 662.50	4 988.20	104.35%
Cement	3 879.10	10 881.90	153.23%
UZ	277 288.9	415 910.6	83.98%

Also, we have calculated the total value of export and import of these types of product. We used HS92 (Harmonized System) IDs to aggregate appropriate products to the UZ's types. After the types were chosen, they were added to each other by groups, which UZ separates. The complete list is provided in table 3.

Table 3. Appropriate HS92 IDs to types of products

UZ product type	HS 92 ID
Coal	2701
Iron and manganese ore	2601, 2602
Mineral construction cargo	2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522
Ferrous metals	7201, 7202
Oil and its products	2709, 2710
Chemical and mineral fertilizers	2801, 2802, 2803, 2804, 2805, 2806, 2807, 2808, 2809, 2810, 2811, 2812, 2813, 2814, 2815, 2816, 2817, 2818, 2819, 2820, 2821, 2822, 2823, 2824, 2825, 2826, 2827, 2828, 2829, 2830, 2831, 2832, 2833, 2834, 2835, 2836, 2837, 2838, 2839, 2840, 2841, 2842, 2843, 2844, 2845, 2846, 2847, 2848, 2849, 2850, 2851
Coke	2704
Grain cultures	1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008
Forest goods	4403, 4404, 4405, 4406, 4407
Cement	2523

All the data of export and import value is provided by United Nations Comtrade.

To get more precise quantity of wagon, we have matched the type of wagon to the type of product. We assume that coal, iron and manganese ore, ferrous metals and coke are transported in the wagon with the open roof; minerals in mineral collector; oil and its products in tanks; chemicals in special wagons; grain cultures in grain carriers; forest goods on flat wagons; cement in cement carrier. Quantity of working park of wagons has increased over 15 years. In 2017 the park contained 135 792 wagons.

4.2 Data divided by branches of Ukrzaliznytsia

As we already mentioned, Ukrzaliznytsia consists of 6 regional branches:

- Lviv
- Odessa
- Near-Dnipro
- Southern
- Southwestern
- Donetsk

According to it, SE "The Main information center of Ukrainian railways" provides data for each of them separately. We used this data, to estimate the efficiency of Ukrzaliznytsia.

Table 4 provides descriptive statistics and units of measure of UZ indicators.

Table 4. Descriptive statistics of UZ indicators (2002-2017)

indicator	units	min	max	average	st.dev
Turnover of the wagon	days	4.34	9.60	6.76	1.65
Wagon waiting time at one operation	hours	23.00	66.01	43.29	14.20
Average polling speed	km per hour	34.50	39.70	37.33	1.72
Average train weight	tons	3268.00	3437.00	3357.94	57.70
Average daily mileage of a locomotive	km	424.40	500.80	470.94	19.26
Average productivity of locomotive	thd ton-km	1154.00	1446.00	1312.44	82.98
Percentage empty wagons to total	%	37.50%	41.40%	39.61%	1.01%
Average load on the wagon	tons	61.52	64.33	62.95	0.93
Average productivity of wagon	thd ton-km	3591.00	6932.00	4959.69	958.48
Operational fleet of freight locomotive	units per day	588.64	1000.77	751.63	111.06
Loaded on wagons	units per day	11996.00	18359.00	15490.88	1933.37

4.3 All-purpose indicators

The exchange rate was calculated as an annual average of monthly data, provided by NBU on its official website.

$$A_t = \frac{\sum_{i=1}^{12} M_i}{12} \quad (6)$$

where A_t is an annual exchange rate in year t, M_i is monthly average rate.

The overall data of Ukraine is shown in table 5. Data is provided by international organizations and Ukrstat.

Table 5. Descriptive statistics of the data (2002-2017)

Indicator	Units of measure	aver	st.dev	min	max
Exchange rate	UAH per USD	10.236	7.324	5.036	26.710
Unemployment rate	%	8.15%	1.09%	6.35%	9.63%
Population	thd people	45323.3	1782.8	42217.0	47823.0
GDP	mln uah	1186035	762947	234138	2983882
Share of rail freight transport in total inland freight transportation	%	46 .53%	2 .10%	42.46%	49.80%
Length of tracks	km	21464.0	706.9	19790.0	22079.2
Electrified tracks	km	9706.3	324.9	9306.2	10267.5

The unemployment rate was taken from the World Bank database. GDP at current prices and the population is provided by Ukrstat. Also, we added a dummy variable, which reflects the occupation of the Crimea and the part of Donbass, WTA, and crisis 2008-2009. The length of rail tracks and electrified tracks is provided by the Ukrzaliznytsia.

Chapter 5

EMPIRICAL RESULTS

This chapter describes the estimation results of three main models stated in Chapter 3. We will proceed in 3 steps:

1) showing the result for the elasticity model,
2) showing the results of performances of Ukrzaliznytsia,
3) showing the results of influence on the economy.

5.1 Tariff elasticity on freight transportation

Using OLS log-log regression, we have estimated our model (1). This model aims to find the tariff elasticity on UZ services demand.

The estimations are based on the dataset with different types of product. The first model has shown us that most of the variables were insignificant. We made a VIF test, the mean of which was equal to 20.33, which means multicollinearity. After we removed it, we got the results.

The coefficient we are interested in is the tariff. The result has predicted sign, which is negative. The change in the tariff index rate by 1 point will decrease freight transportation by 0.0304%, holding other factors equal. For example, if UZ increases its average tariff, which index in 2017 was 8.3093, by 20%, the tariff index will increase by 1.66 points, and it will lead to decrease the total transported tonnage by 0.0504%. This means that the effect of tariffs on the volume is small in its magnitude.

This predicted effect was expected as, according to CFO of UZ, the tariffs are underestimated. Firms are willing to pay more. Therefore, the tariff increase will not change demand much. In table 6, we have shown the results of the model.

Table 6. Elasticity model estimation

Variable	Coefficient	St. errors
Tariff	-0.0304*	0.0135
Unemployment	-8.641**	2.895
Share of UZ in total freight transportation	1.2056	2.0862
Electrified tracks	0.4324*	1.3395
Products (coal – base):		
Iron and manganese ore	-0.2172	0.1173
Mineral construction cargo	-0.5764***	0.1186
Ferrous metals	-1.0138***	0.1178
Oil and its products	-2.1171***	0.1177
Chemical and mineral fertilizers	-2.7442***	0.1174
Coke	-2.191***	0.1173
Grain cultures	-1.721***	0.1173
Forrest goods	-3.0305***	0.1177
Cement	-2.5428***	0.1175

Note: Dependent variable: total tonnage of the product, transported by UZ. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Among other coefficients, we can see a positive influence of the length of tracks on transportation. Unemployment, which can be identified as economic wellbeing of the country, show us, that every percent of unemployment decreases the volume of transportation by more than 8.5%, holding other factors equal.

5.2 Efficiency of Ukrzaliznytsia

As well as in the first part of this section, we used OLS log-log regression to estimate our model (3). The aim is to find which indicators are more important to increase the efficiency of UZ, and which are less. This estimation is based on the dataset from different branches of UZ.

In this model, we faced the same problem of multicollinearity, which is not surprising, as some of these indicators are strongly based on the others. The estimations after overcoming this problem are provided in table 7.

The estimations have predicted sign. As we can see, the highest influence have average tons loaded on a wagon and average daily mileage (daily distance), which locomotives make. For example, holding other factors equal, if locomotives make 1% more distance per day, the transported tonnage will increase by 1.22%. An increasing fleet of locomotives also increases efficiency.

On the other hand, a 1% increase in empty wagons to total rate, will decrease the efficiency by 0.026%, holding other factors equal. Donetsk railway is the most efficient, despite the fact of occupation. The coefficient on occupation is not significant at the 10% level so we cannot say something about its effect. Still, it was only 2.5 years after the occupation, and its effect could be no noticeable enough in 2017.

Table 7. Efficiency model estimation

Variable	Coefficient	St. errors
Occupation (1=yes)	0.4957	0.0434
WTA (1=yes)	0.0625	0.0342
Crisis 2008-2009 (1=yes)	-0.0090	0.0282
Waiting time of wagon at one operation	0.0231	0.0518
Average daily mileage of a locomotive	1.2211***	0.1401
Percentage empty wagons to total	-0.0259**	0.0073
Average load on a wagon	1.3238**	0.4585
Fleet of locomotives	0.8352***	0.0702
Total time of stops	-0.0123	0.0139
Branches of UZ (Donetsk base):		
Near Dnipro	-0.476***	0.0458
Southern	-1.117***	0.0568
Southwestern	-1.557***	0.0767
Odessa	-1.826***	0.0700
Lviv	-1.297***	0.0839
Constant	-4.4454***	1.7835

Note: Dependent variable: total tonnage of the product, transported by UZ. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

5.3 The effect of tariffs on the economy of Ukraine

Using the same approach as in two parts of this chapter, we have estimated the influence of tariffs on the economy of Ukraine.

Table 8. Influence of the tariff on the economy of Ukraine

Variable	Coefficient	St. errors
WTA (yes=1)	1.3844	0.7067
Tariff	-0.1667*	0.0741
Tonnage turnover	0.1300	0.1243
Number of units of wagon in the UZ park	0.2457**	0.0912
Unemployment	13.4947	17.1144
Share of freight transported by UZ	-15.7972	12.3633
Length of electrified tracks	14.8365*	6.5215
Constant	-114.1175*	56.2756

Note: Dependent variable: export * $p<0.05$, ** $p<0.01$, *** $p<0.001$

This result shows us the influence of the tariff on the export of Ukraine. Hence, we can calculate the predicted influence of tariff on GDP.

The result has predicted sign, which is negative. The change in the tariff index rate by 1 point will decrease export by 0.1667%, holding other factors equal. For example, using the same approach as in first part of this chapter, if UZ

increases its average tariff, which index in 2017 was 8.3093, by 20%, the tariff index will increase by 1.66 points, and it will lead to decrease the total transported tonnage by 0.2767%. As we mentioned in part 3.3, the average quotient of export in GDP of Ukraine over the last 15 years, according to the Ministry of Finance, is 48.78%. The export of the goods, which are transported by UZ, make up 26.91% of the total export of Ukraine or 13.13% of the GDP. Therefore, holding other factors equal, the 20% increase in tariff will decrease GDP of Ukraine by 0.0219%.

Chapter 6

CONCLUSIONS

This paper investigates the effect of the Ukrzaliznytsia tariffs on the volume of the cargo, which this company transports. It also looks into the performance of Ukrainian railway company and the effect of tariffs on the economy by and large. Regular OLS regression was used to analyze all the interconnections.

The findings of this paper offer a contribution to the big family of researches about efficiency and influence of the railroad on the development and economy. As far as we know, this is the first paper to provide the analysis of the railroad tariffs on the economy of the country. The methodology we introduced can be replicated in other countries, the railway tariff of which changes year to year.

Our results could be used by Ukrzaliznytsia and Ministry of Infrastructure of Ukraine to estimate the possible influence of their actions on tariff policy. Moreover, our estimation is one more evidence that the tariffs are understated.

The effect of the tariff is negative, but small in magnitude. The increase of the average tariff rate by 1% provides about 0.0025% decrease in freight turnover if other factors are fixed. The influence of increasing tariffs on the economy is also negative, as it provides to decreasing of export, which is an important factor in the formation of GDP.

According to our model, the efficiency of Ukrzaliznytsia depends mostly on average tons loaded on a wagon and average daily mileage (daily distance), which locomotives make and on the fleet of locomotives. 1% increase in these indicators enhance productivity by 0.85 – 1.25 percent.

These findings suggest that Ukrzaliznytsia and the government should increase tariff on the railroad and using profit buy more locomotives and other assets.

As a further development and upgrade of this study, we offer the improvement of the model as well as several variables, such as different financial performances of the transport sector, could be added.

WORKS CITED

Atack, Jeremy, Fred Bateman, Michael Haines, and Robert A. Margo. 2010. Did railroads induce or follow economic growth?: urbanization and population growth in the American Midwest, 1850–1860. *Social Science History* 34, no. 2: 171-197.

Banerjee, Abhijit, Esther Duflo, and Nancy Qian. 2012. On the road: Access to transportation infrastructure and economic growth in China. *National Bureau of Economic Research* No. w17897.

Démurger, Sylvie. 2001. Infrastructure development and economic growth: an explanation for regional disparities in China?. *Journal of Comparative economics* 29, no. 1: 95-117.

Donaldson, David. 2010. Railroads and the Raj: the economic impact of transportation infrastructure. *NBER Working Paper* 16487.

Donaldson, D., R. Hornbeck. 2016. Railroads and American economic growth: A "market access" approach. *The Quarterly Journal of Economics*, 131(2): 799-858.

Donaldson, Dave. 2018. Railroads of the Raj: Estimating the impact of transportation infrastructure. *American Economic Review* 108, no. 4-5: 899-934.

Ismail, Normaz Wana, Jamilah Mohd Mahyideen. 2015. The Impact of infrastructure on trade and economic growth in selected economies in Asia. *ADBI Working Paper* 553

Pereira, Rui M., William J. Hausman, and Alfredo Marvão Pereira. 2014. Railroads and Economic Growth in the Antebellum United States. *College of William and Mary, Department of Economics, Working Paper Number* 153

Perkins, Peter, Johann Fedderke, and John Luiz. 2005. An analysis of economic infrastructure investment in South Africa. *South African Journal of Economics* 73, no. 2: 211-228.

Pittman, Russell. 2017. Reforming and restructuring Ukrzaliznytsia: a crucial task for Ukrainian reformers. *Nauka i prohres transportu. Visnyk Dnipropetrovs'koho natsional'noho universytetu zalizнychnoho transportu* 1 (67): 34-50.

Wang, Yang, and Binzhen Wu. 2015. Railways and the local economy: evidence from Qingzang railway. *Economic Development and Cultural Change* 63, no. 3: 551-588.

Wijeweera, Albert, Hong To, and Michael Charles. 2014. An empirical analysis of Australian freight rail demand. *Economic Analysis and Policy* 44, no. 1: 21-29.