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SCENARIO ANALYSIS OF THE ASSESSMENT OF THE RAIL TRANSPORT IMPACT ON THE ECONOMIC GROWTH (ON THE EXAMPLE OF UKRAINE)

In the modern world, efficient transport infrastructure is one of the main factors ensuring economic growth in both countries and macro-regions. In this context, of particular interest are studies in states whose economies are in a state of crisis and are characterized by a high uncertainty of development parameters. To this aim, the influence of the rail transport on the economy of Ukraine was studied. The importance of Ukrainian railways in the system of international transport and communication links between the countries of Eurasia is considered. The use of scenario simulation to study the prospects for the development of the rail transport in conditions of high uncertainty has been substantiated. A SWOT analysis was performed, based on the results of which scenarios were constructed for rail transport in Ukraine. Scenario analysis showed that in the context of a systemic economic crisis, the rail transport can influence not the process of economic growth in the country, but its intensity, acting as a factor of acceleration or deceleration. Improvement of the situation is possible when developing a set of measures aimed primarily at improving the internal environment of rail transport.
JEL: C51; L92; R11

Introduction

One of the strategic directions for the development of the EU is to strengthen cooperation not only between European countries, but also within the Eurasian continent. The key element of this interaction is the transport infrastructure, which is the "circulatory system", the main purpose of which is the implementation of communication within individual states and continents as a whole due to the movement of people and goods. The significance of the contribution of the infrastructure to the economy is a recognized fact. Thus, an effective infrastructure – from transport systems, energy, telecommunications to water supply and sanitation – contributes to the development of the national economies, increasing the productivity of human and productive capital, creating new jobs and increasing population mobility. According to the estimates of the McKinsey Global Institute (2013), an annual

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saving of 1 trillion US dollars is possible by increasing infrastructure productivity by 60%, and potential savings from the rational development of infrastructure will be 15%. At the same time, an underdeveloped infrastructure can become a hindrance to the economic and social development of both individual states and regions as a whole due to an increase in growth "the penalty on ... growth" (Lind, 2009). According to estimates, in order to ensure the growth of global GDP by 2030, investments in infrastructure development should amount to 57 trillion USD and make up 4.1% of GDP (McKinsey Global Institute, 2013).

Infrastructure, including transportation, is a long-term, capital-intensive asset consisting of spatially related objects. A long duration of the life cycle of infrastructure facilities and a significant payback period of investments lead to a significant dependence of the growth rate of infrastructure and its state on the efficiency of the national economy, and the volume of investments from "market failures", that is, a situation when, due to the economic crisis, investments in infrastructure development become insufficient. According to the estimates of the European Investment Bank, the annual need for capital investments in the economic infrastructure is 688 billion euros (European Parliamentary Research Service (EPRS), 2018). At the same time, as the McKinsey Global Institute's studies show, the level of under-financing of existing infrastructure development needs in the EU countries is 16.1%, which exceeds the global average (7.3%) (Fig. 1). Thus, even now, insufficient infrastructure development is one of the braking factors for the European economies.

Such interdependence necessitates further research on the influence of the level of development and the state of infrastructure on economic growth in order to timely identify emerging negative trends in order to reduce their negative impact.

In this regard, studies are of particular interest in countries whose economies are in a state of crisis and are characterized by a high uncertainty of development parameters. To this end, the influence of the rail infrastructure on the economy of Ukraine was studied. In the study the following tasks were solved:

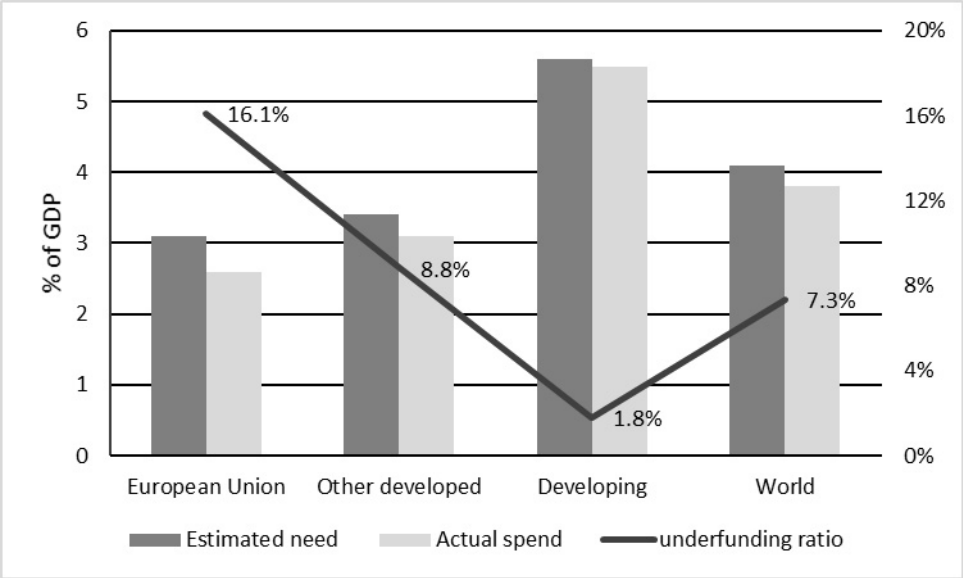
- Justification for the use of the scenario approach to studying the impact of the rail transport on the economy in conditions of high uncertainty;
- Constructing and analyzing future scenarios for the rail transport of Ukraine with a focus on assessing changes in its transportation capabilities;
- Assessment of the degree of influence of the rail transport on the growth of the national economy on the example of Ukraine.

The practical goal is to study the influence of the state of the rail infrastructure on economic growth in the country and the possibility of its stimulation in conditions of increased uncertainty.

The research sampling is formed from the data of industrial, economic and financial activities of JSC "Ukrainian Railways", which is the national carrier of goods and passengers and manages the rail infrastructure. The study is based on the analysis of the statistical information on the functioning of the rail transport of Ukraine for the period from 2000 to 2017.

Figure 1

Infrastructure spending, % of GDP



Source: developed by the author (data from [19])

The literature review

The problem of the impact of the infrastructure development on the economic growth and economic security of states is at the centre of attention of both academic scientists and experts of the international organizations such as the United Nations, World Bank Group, Asian Development Bank Institute, McKinsey Global Institute and others. Although there is no consensus among researchers about the impact of the infrastructure on economic development, most authors note its positive impact on production efficiency, productivity and long-term growth rates.

The theoretical analysis of the impact of infrastructure on economic growth is carried out within the framework of the theory of growth. Arrow and Kurz (1970) viewed infrastructure as a component of the state capital, which was included in the aggregate production function of Ramsey-type exogenous growth models as an additional input.

Experts at the World Bank (Fay, Toman, Benitez and Csordas, 2010) point out that a modern economy cannot function without an infrastructure that provides a range of important services in determining the production economy and consumption opportunities. UN experts (2005) argue that there is a direct relationship between the quality of infrastructure and the achievement of social, economic and political goals. Inadequate infrastructure leads to lack of access to markets, jobs, information and training, and

becomes the main obstacle to doing business. At the same time, a highly developed infrastructure reduces the influence of distances between regions, ensures the integration of the national market and low-cost connection with the markets of other countries and regions. The studies conducted under the guidance of Libanova and Khvesik (2014), argue that the quality and development of infrastructure affect economic growth, reduce the disparity between income levels of the population in various ways, and contribute to the fight against poverty [7].

Stewart (2010) believes that a developed infrastructure is a major component of the success of a modern economy. He noted that infrastructure can influence production volumes (i) directly, that is, as a contribution of the infrastructure sector to the formation of GDP and as an additional contribution to the production process of other sectors of the national economy; and (ii) indirectly – by reducing operating and other costs.

Newbery (2012) focused on the relationship between investments in infrastructure development and in other sectors of the economy. He noted that insufficient investments in infrastructure restrain other investments and, thus, restrain growth, while over-investment does not have added value. Other researchers shared the same opinion (Aushauer, 1989; Calderon et al, 2011). Baldwin and Dixon (2008) note that an effective infrastructure is essential for the national security by maintaining economic growth and improving the quality of life of the population. Grundey (2008), Burinskiene and Rudzkiene (2009) also note that infrastructure development is one of the most important aspects of strategic planning, sustainable spatial and socio-economic development of the country.

In addition, on the example of the rail transport Mattoon (2004) showed that investment in infrastructure (expansion and innovative development of the rail network, which includes the railways and other infrastructure facilities necessary for transportation), in addition to the economic effect, also contributes to organizational changes. Sussman (the President Strategic Rail Finance & OnTrackAmerica, USA) emphasized the importance of railways for a well-functioning, modern society, comparing them with the availability of clean water and electricity [35]. Kravchenko O. (2013) noted that the poor condition of the rail infrastructure acts as a factor hindering the development of the national economy, by reducing the speed of movement of goods and services. In addition, "optimization" of the infrastructure by reducing it can have negative social consequences.

Palei (2015) attempted to systematize approaches to assessing the impact of infrastructure on development and identified 4 groups: (i) the contribution of infrastructure to the industrial growth, the result of an increase in production; (ii) the contribution of infrastructure to long-term economic growth; (iii) evaluating the effectiveness of the use of infrastructure and its institutional values; (iv) effect of infrastructure on income inequality (smoothing).

Modern research is reconsidering the contribution of infrastructure development to economic growth in the direction of reducing the effect (Romp and Haan, 2007 and others). However, the infrastructure is recognized as one of the 12 pillars of competitiveness (World Economic Forum, 2007) and 75% of the infrastructure that will operate in 2050 does not yet exist (United Nations, 2016). This necessitates the study of the influence of the state

and size of the infrastructure as a whole and its individual sectors on the economic growth of both macroregions and individual countries.

Research Methodology

Uncertainty always accompanies the future and exists at all times and in all circumstances (Finetti, 1974). The development of complex production and economic systems such as rail transport should be carried out purposefully and effectively to ensure the growth of the national economy.

At present, the drafting of a development strategy is "a complex scientific discipline with a multitude of subtle nuances, the attainment of which requires considerable effort" (Coyne and Subramaniam, 1996). One of the main difficulties in developing such a strategy is the understanding of uncertainty and risk as integral parts of the future. At the same time, the risks reflect the specific perception by interested economic entities of objectively existing uncertainties and conflicts, immanent processes of goal setting, management, decision-making, evaluation, which are burdened with possible threats and untapped opportunities (Vitlins′kyy, 2004).

In recent decades, the speed and intensity of change have significantly increased. The consequence of this was the formation of an opinion about the ineffectiveness of forecasting, which is unable to "resolve the issue of the domination of instability in the surrounding world..." (Keichel, 1982). A critical attitude to forecasting among some scientists continues to persist. So, Sherden (1998), dealing with the problems of forecast accuracy, notes that he does not see ways to improve economic forecasts, since this is impossible as a result of the political influence, macroeconomic changes and other factors that are reflected in the realization of forecasts. At the same time, forecasting allows reducing to a greater or lesser degree the level of environmental uncertainty by introducing certain hypotheses. Walonick (1993) notes that the prediction allows to modify the variables of the internal environment of the organization and, thereby, change ("prepare") the future, that is, the forecasts act as an invitation to make changes to the system.

The modern economy of Ukraine is characterized by sharp and poorly predictable changes in macroeconomic indicators, the dynamics of which do not correspond to the normal market cycle, but rather are inherent in crisis or post-crisis economic processes. Studies of economic processes in countries undergoing systemic transformation are always accompanied by significant problems related to the quality of time series, based on which forecasting is carried out (Skrypnychenko, 2012). In addition, in a non-stationary environment, the identified (existing) trends quickly lose their relevance: the value of prior experience decreases in inverse proportion to the rate of the structural changes.

Such economic uncertainty necessitates a departure from traditional forecasting methods based on deterministic dependencies. This is due to the fact that the future is characterized by a multiplicity of possible options, the reduction of which to the only one is not correct. Then forecasting as the basis of the development strategy of any economic system should (i) provide for the complete identification and analysis of potential quantitative and

qualitative changes in the internal and external environment of the economic system to reduce the uncertainty of the future; (ii) suggest the possibility of a quick response to the occurrence of changes by adjusting forecasts.

These requirements are met by a scenario approach (scenario planning), which is not so much an approach to predicting the future, but rather to studying and monitoring the dynamics of the state of the institutional environment and its future impacts on the functioning and development of a specific economic system. The basis of this approach consists of scenarios that are a rational method for presenting probable future options in which decisions made by the organization can be realized (Schoemaker, 1995). In this case, scenarios are not forecast in the generally accepted sense and a description of a relatively predictable future from the standpoint of past and present but are closely related to the prediction of future states. In contrast to the formal methods of planning and forecasting, scenarios are not a linear or mechanistic description of the future but reflect the exponential combination of various factors (Wack, 1985).

Even though the main research on the scenario approach falls on the 80-90 years of XX century, it retains its effectiveness in conditions of increased uncertainty, which is typical now for the economy of Ukraine. Martelli (2001) noted that the popularity of scenarios is comparable to waves that correlate with the state of uncertainty in the business environment. The use of the scenario approach will allow (i) to explore the "difficult" future, that is, in the planning process, there is the opportunity to explore existing and future uncertainties, explore and evaluate future opportunities that are potential now, and identify absolutely new ones; (ii) to develop a flexible development strategy, that is, using key success factors and realistic thinking options, to create a strategy in which circumstances and necessary flexibility of decisions will be balanced in accordance with existing and potential uncertainties; (iii) to monitor possible deviations from the planned strategy: the use of an early warning system will help to identify deviations that have occurred and, as a result, make appropriate adjustments to strategic plans in a timely manner.

The development of scenarios will be understood as an integrated scientific study of the basic laws governing the development of a specific economic system, based on the scientific methods of understanding economic phenomena and processes, and determining its states in the implementation of various scenarios. Accordingly, the scenario is a scientific model of the future of a specific economic system, built on the basis of the factors determining the patterns of development of its external and internal environment.

The basis of the scenario approach is the isolation and analysis of the main driving forces, the purpose of which is the most complete identification of both existing and emerging trends in the external and internal environment. Then the set of scenarios $\left(S\right)$ can be described by the following expression:

$$S = \left\{ s_n : s_n = f\left(F_t, M_p, t\right) \right\}, \tag{1}$$

where: n – number of scenarios under development; M_p – purpose of building scripts; F_t – the set of factors selected for developing scenarios are such that

$$F_t = f\left(FV(t), FZ(t), t\right); \tag{2}$$

where: $FV\left(t\right)$ – the set of factors that characterize the internal environment of the infrastructure in the year *t*; $FZ\left(t\right)$ – the set of factors that describe the parameters of its external environment.

The set of scenarios are, on the one hand, a reflection of the experts' subjective perception of the possible development of both the infrastructure network and the national economy in the future. On the other hand, when developing scenarios, factors that are not directly amenable to measurement and formalization are also analyzed and taken into account, but assuming an objective interpretation by the experts.

The analysis of the driving forces involves the allocation of 2 groups of factors, events and trends, combining which possible scenarios are developed: predetermined elements (events and trends, the development of which can no longer be stopped or changed in the analyzed (planned) period) and key uncertainties (any factors and trends in external and the internal environment, which are decisive for this economic system). Predefined elements form the unchanged frame of scenarios, but there is the problem of determining the number of key uncertainties. The experiments made by Royal Dutch Shell have shown that to cover and consider, if possible, the fullest possible range of the expected future states, provided that the number of scenarios being developed does not interfere with the quality of the analysis, two key uncertainties and the construction of 4 scenarios are sufficient (Ringland, 2002).

As already noted, it is impossible to develop correct scenarios by means of a naive prospective extrapolation of the prevailing trends and automatic use of the predicted values that characterize a possible change in the selected factors. Therefore, it is advisable to implement the following steps, involving the integrated use of quantitative and qualitative methods of analysis: (i) the formation of a set of possible outcomes of key uncertainties and predetermined elements, taking into account the influence of factors determining them; (ii) combining key variables and developing scenarios for rail transport.

The formation of a set of possible outcomes of key variables and predefined elements should be based on an analysis of the factors that determine them, and assume several (at least two or three) of their outcomes, reflecting potentially possible alternatives to their changes in the future. At the same time, the development of such outcomes should both suggest the occurrence of events, the effect of which is not known now and should not exclude obvious ones from the consideration. The process of scenarios developing can be represented as a combination of the possible outcomes of key uncertainties, followed by a description of the scenarios.

To determine the indicators related to various scenarios, adaptive forecasting methods (Holt model) were used. This allowed (i) to continuously take into account the evolution of the

dynamic characteristics of processes; (ii) to adapt to this dynamics, assigning different informational value to data related to different points in time; (iii) take into account the accumulation of quantitative process changes to identify qualitative leaps; (4) update forecasts with minimal delay.

Rail Transport of Ukraine

In the modern world, one of the requirements for transport infrastructure is to ensure the mobility of people and goods. In this context, railways as a mode of transport play an important role. Over the past decades, its value has changed dramatically. By the end of the twentieth century, it was perceived as "a social burden", rapidly losing its share in passenger and freight traffic due to the road and air transport (Andrade, 2008). One of the consequences of the global financial crisis was the change in key determinants of economic development, including in the European countries. The proclamation of the re-industrialization policy has led to a change in the understanding of the rail transport as one of the "engines" of the development of national economies, as well as industrial cooperation of various countries (Mullich, 2017).

Rail transport in Ukraine is of great importance both for the economies of the EU countries and Ukraine. The length of the Ukrainian railways is 19.8 thousand km. Three rail international Pan-European transport corridors pass through the territory of Ukraine, as well as international corridors of the Organization for Cooperation of Railways and the TRACECA international transport corridor with a total length of 3,162 km (deployed more than 6 thousand km). The infrastructure of the rail network in most indicators meets or exceeds the European requirements, except for train speed.

JSC "Ukrainian Railways" operates, manages and develops the rail infrastructure in Ukraine. The state is the owner of 100% of its shares, which are not subject to alienation. In Ukraine JSC "Ukrainian Railways" is a natural monopolist and can be identified with the rail transport. It is the main carrier of raw materials and industrial products. In 2018, freight rail transportation amounted to 56.2% of the total volume of transportation by all modes of transport (calculated on [31]).

Ukraine's rail transport is in a state of sluggish institutional changes associated with the need to separate the competitive (passenger and freight) and non-competitive (infrastructure management) sectors in accordance with EU directives. The situation is complicated by the fact that each new government has its own vision of the future rail transport. This does not contribute to "clarifying" its future, developing a rational development strategy capable of ensuring not only its effective functioning and, as a result, financial sustainability, but also the movement of transit cargo to / from Europe to Asia, as well as the economic security of Ukraine.

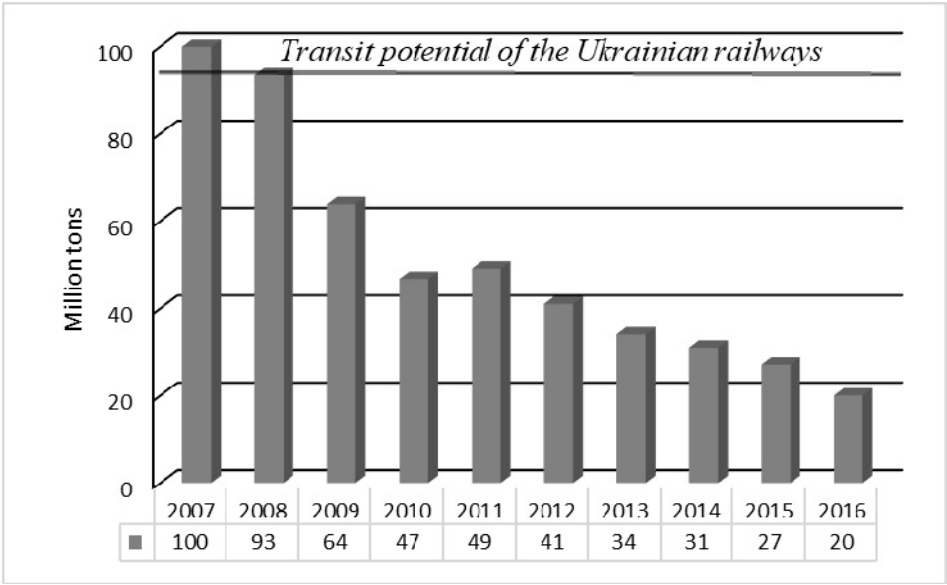
Ukraine in the system of the international transport and communication links objectively goes beyond the limits of the national interests due to its advantageous geographical position. It has significant transit potential, as its rail network has more than 40 international junctions and "fits in" with the railways of Russia, Belarus, the Republic of

Moldova, Poland, Romania, Slovakia, and Hungary. In Ukraine, rail transport is the only mode of transport that provides interregional and international transport and economic relations without significant competition from water and road transport (Makarenko et al., 2012). Cargo transit constitutes a significant part (up to 40%) in the structure of foreign trade cargo traffic passing through the territory of Ukraine (Sobkevych, Mykhaylychenko and Yemel′yanova, 2013). According to the international experts, the Ukrainian transport system has the highest transit ratio among the European countries – 3.11 (Stolbetsov and Tkachev, 2010). At the same time, in 2010, according to the World Bank, Ukraine ranked 102 in the ranking of transit countries (State Administration of Railway Transport of Ukraine, 2012), which indicates the underutilization of transit potential.

In recent years, the situation has only worsened: the volume of rail transit traffic has decreased significantly (Fig. 2). This was the result, first of all, of the worsening of relations with Russia, which was the main transit country for goods through the territory of Ukraine (more than 60% of transit traffic). Unfortunately, the rail network of Ukraine is not included in the ambitious One Belt One Road project ("Project of the Century"), aimed at improving cooperation between the countries of Asia, Africa and Europe and covering over 78 countries. However, Ukraine still has the opportunity to increase the transit volumes of goods and passengers, especially when implementing the predictable development strategy of the rail transport, switching to the European standards of speed, investments in rolling stock renewal and infrastructure modernization, as well as normalization of relations with major economic partners.

Figure 2

Dynamics of Transit Freight Traffic by the Rail Transport in Ukraine in 2007-2016



Source: developed by the author (data from [31])

The rail transport is of great importance for the economy of Ukraine. Thus, JSC "Ukrainian Railways" is one of the largest companies, which (i) provided in 2017 53.3% of the cargo turnover (calculated based on [31]) and has no competitors in freight transportation for industrial needs; (ii) is a natural monopolist and can be identified with rail transport; (iii) provided about 3% of the country's GDP; (iv) owned assets worth 10.19 billion US dollars (of which – 8.30 billion US dollars own capital); (v) was one of the largest taxpayers (in 2016 taxes in the amount of 566.19 million US dollars were paid).

In addition, it is of great importance for public stability in the state: it is (i) a key asset for ensuring population mobility – 43% of passenger traffic, including privileged categories of the population; (ii) the largest employer in Ukraine – 272 thousand workers or 1.5% of all employed in the national economy (State Statistics Service of Ukraine, 2018).

Thus, the rail transport of Ukraine has a great influence on the economy of Ukraine and the European countries. Therefore, the study of its impact (first of all, changes in carrying capacity and transportation capacity) on the economy of the country and the region as a whole seems necessary.

Modelling Scenarios for the Development of the Rail Transport of Ukraine

Model Representation of the Subject Area of Scenarios

Scenarios suggest the selection and description of the subject area, that is, parts of the real world, which will be affected by the level of development of the rail transport. One of the infrastructure features is a high level of capitalization, rather high labour and material costs for its creation. The consequence of this is the significant influence of the prehistory of development and the relationship between the national economy and the specific (rail) infrastructure sector–on its size and physical condition. Then the domain model can be described through the following parameters:

$$SC(t) = \langle V(t-2), E(t), C(t-1), \psi, \upsilon, \eta, t \rangle, \quad (3)$$

where: $V(t-2) = \{v_i(t-2)\}$ – the set of input domain parameters formed by the internal and external environment of the infrastructure sector; $E(t) = \{e_j(t)\}$ – the set of output parameters of the subject area (indicators of production, economic and financial activities of the infrastructure sector, as well as parameters of the national economy); $C(t-1) = \{c_j(t-1)\}$ – the set of possible states of the domain in the future (many developed scenarios); ψ – the family of reactions of the subject area to the input parameters; υ – the family of the state transition functions; η – the family of functions that characterize the reaction of one element of the subject area depending on the change of another element, that is, changes in the infrastructure sector as a reaction to the state of the environment and vice versa; t – period of time.

The set of input parameters of the subject area $V(t-2)$ should be formed on the basis of the developed strategy for the development of the infrastructure sector, control and analytical data on its operation in previous periods of time, information on current investment needs, restrictions and conditions imposed by the institutional environment, etc.

The domain must implement the mapping of the set $V(t-2)$ into the set $E(t)$ through the development of the set of scenarios $C(t-1)$, the development of which can be represented as a functional of the following type:

$$C(t-1) = f(V(t-2), S_z(t-1), Y_z(t-1), Y_e(t-1), t), \quad (4)$$

where: $S_z(t-1)$ – operating parameters of the rail transport, reflecting the characteristics of the circulation of resources in the system (the composition and structure of assets ⇒ the generation of incoming and outgoing cash flows ⇒ financial results ⇒ volumes and directions of investment activity); $Y_z(t-1)$ – the set of existing trends in production, economic and financial aspects of the functioning of the rail transport; $Y_e(t-1)$ – the set of identified trends in environmental parameters, which are key factors for the development of the infrastructure sector.

As the infrastructure develops evolutionarily, the subject area should be considered as a dynamic system, $SC(t) \subset V(t-2) \times E(t)$, for which there are three families of mappings:

1) family of reactions of the subject area to the incoming parameters, which can be represented as follows:

$$\psi = f(V(t-2), C(t-1), t) = [\psi(t) : V(t-2) \times C(t-1) \to E(t)]; \quad (5)$$

2) family of transition functions of the system states, which can be represented as follows:

$$\upsilon = f(C(t), V(t+1), t) = [\upsilon(t, t+1) : C(t) \times V(t+1) \to C'(t+1)], \quad (6)$$

where: $C'(t+1)$ – revised scenario;

3) family of functions that characterize the reaction of one element of the domain depending on the change of its other element:

$$\eta = f(\psi(t), \upsilon(t+1), t) = [\eta(t, t+1) = \psi(t) \times \upsilon(t+1) \to \psi(t+1)]. \quad (7)$$

The mapping families ψ, υ and η completely describe the trends and interactions that exist both within the infrastructure sector and with the external environment, which will find its reflection in the developed scenarios.

Highlighting the driving forces of the rail transport development as a base for future scenarios

To highlight the predefined elements and key uncertainties, a SWOT analysis of the Ukrainian rail transport was carried out (Table 1). It showed that the strengths and weaknesses, as well as opportunities and risks of development, are derived from (i) its technological features and development history; (ii) the state is the most influential and interested stakeholder with active leverage in the operation of the rail transport, both through direct influence on tariff policy and indirectly, as a result of political decisions taken. This determines the need to single out one predetermined element in the internal environment of the infrastructure sector, and the second – in the external environment.

It should be borne in mind that

1) improving the competitiveness of the rail transport is possible only as a result of a gradual and consistent change in the state of infrastructure and rolling stock, as well as the introduction of the modern transport technologies;
2) demand for the rail transportation is associated both with its technological features and the volume of manufactured industrial products;
3) a sharp increase in the transportation capacity of the rail transport cannot occur as a result of both the lack of the necessary financial, material and labour resources, and the impossibility of stopping or significantly reducing the transportation process for the period of reconstruction;
4) investments in infrastructure development and rolling stock renewal will be formed only at the expense of the depreciation fund and the net profit received by JSC "Ukrainian Railways". The possibility of obtaining funds from the budget or from private investors can be neglected due to both the low probability of their receipt and the insignificance of volumes;
5) freight transportation, as a transportation market segment, will be a key area of investment activity; and
6) features of rail transport are the high interconnection between the technological parameters of its infrastructure and the rolling stock (mobile railway units intended for the transportation of goods and passengers by railways).

Then the actual size of the rail infrastructure will be the predetermined element, the key uncertainty 1 is the demand for rail transportation (transit, freight and passenger), the key uncertainty 2 is the reform of the rail transport.

Table 1

SWOT analysis of the Ukrainian rail transport

Strength	*Weakness*
High density of railways and a single technological process	Hard binding to the rail network
Possibility of year-round transportation	High infrastructure maintenance costs
Possibility of mass transport over long and medium distances	Need for large investments in infrastructure and rolling stock
Stable demand for freight and passenger traffic	High moral and physical deterioration of capital assets
Stable nomenclature of freight traffic	Weak use of the transit potential of Ukraine
High environmental friendliness and safe transportation	Cross-subsidization of passenger traffic
High reliability and durability of rolling stock	Low management efficiency of the rail transport
Opportunities	*Threats*
High transit potential due to favourable geographical position	Imbalance of supply and demand in the rail transport
Increased need for transit	Reducing the competitiveness of passenger and freight traffic
Growing demand for intermodal and multimodal transportation	Strict government regulation of the rail transport
Transport market unsaturation	State intervention in operations

Source: developed by the author based on [14, 15].

In this study, two potential outcomes (optimistic and pessimistic) were developed for each identified key uncertainty for obtaining four scenarios for rail transport. At the same time, the pessimistic option will be understood as the persistence of existing negative trends in the internal and external environment of the rail transport, and the optimistic one is the appearance of their most desirable states and trends. Consider the possible implementation of the selected driving forces for the development of the rail transport in Ukraine with an assessment of possible consequences.

The predetermined element is the size of the rail infrastructure. Now there is a process of rapid deterioration in the quality of the rail infrastructure: according to the World Economic Forum in 2016, the rail infrastructure of Ukraine was in 34 positions from 139 countries (compared to 27 in 2012) [40]. This was the result of the insufficient intensity of the introduction of new infrastructure instead of morally and physically obsolete due to lack of funding. Thus, according to the data of JSC "Ukrainian Railways", since 1992, the need for investment was satisfied only by 25–30% [30]. Thus, (i) the size of the rail infrastructure is enough to provide domestic and transit traffic and there is no need to increase it; (ii) infrastructure capacity can be increased by updating and modernization of its facilities.

The size of the rail infrastructure will be reduced, since it is redundant and designed for significantly larger volumes of domestic and transit traffic. There are two options for optimizing the size of the rail infrastructure in Ukraine.

Alternative 1 – implementation of the existing rail transport reform program, considering the Agreement on the EU Association and Ukraine, which involves the separation of transportation processes from infrastructure management. This option should be considered pessimistic, since the process of reforming the rail transport of Ukraine is not carried out systematically. The consequence will be a rapid decrease in rail infrastructure and a violation of its integrity.

Alternative 2 – the evolutionary development of rail transport, considering possible directions for optimizing the use of rail infrastructure. This alternative can be considered as optimistic. Its implementation provides for the evolutionary development of the industry and the gradual decommissioning of underutilized sections of the rail network.

Table 2 shows the forecast for financing rail infrastructure, calculated for optimistic and pessimistic alternatives. In table 2 and further in the text, 2017 is the base year, 2018-2019 are transitional (pre-scenario) years, 2020-2024 are the years for calculating the scenarios.

Table 2

Forecast estimates of rail infrastructure financing needs in Ukraine

Indicators	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
	Pessimistic alternative							
Operational length of railways, thousand km	21,7	20,3	18,7	17,2	15,7	14,3	12,8	11,27
Maintenance of the rail network, billion $	0,69	0,65	0,59	0,54	0,49	0,45	0,40	0,35
	Optimistic alternative							
Operational length of railways, thousand km	21,7	21,4	20,8	20,3	19,9	19,4	19,0	18,5
Maintenance of the rail network, billion $	0,69	0,66	0,65	0,64	0,62	0,61	0,59	0,58

Source: calculated by the author based on [30, 31, 33,]

Key uncertainty 1 – demand for the rail traffic (formed by the external environment). The main services provided by rail are freight and passenger traffic, the volumes and profitability of which are determined by the factors of different nature and degree of influence. Domestic freight transportation in Ukraine has a stable range, which determines the high dependence of the number of transported goods on the production volumes of the mining, chemical and metallurgical industries. Transit freight traffic is a more competitive transport sector and depends not only on transportation needs, but also political decisions taken (incorrect statements and irrational actions of officials of the Ministry of Infrastructure led to the redirection of transit cargo and passenger traffic bypassing the territory of Ukraine). Passenger traffic in the suburban and long-distance communications are stable.

Alternative 1 – pessimistic – preserving current trends, that is, reducing traffic due to the crisis in the Ukrainian economy, political decisions and ineffective policies. The result of the implementation of this alternative will be a reduction in the revenue base of JSC

"Ukrainian Railways", an attempt to make it larger by increasing tariffs, which, in a crisis, will lead to a slowdown in economic development in Ukraine. The implementation of this alternative is very dangerous, since the maintenance and the development of rail infrastructure in Ukraine are carried out for the income received from freight transportation.

Alternative 2 – optimistic – the development and implementation of evidence-based economic policies aimed at the growth of the national economy. The result of the implementation of this strategy will be an increase in the production volumes of the main industries and, as a result, rail transportation, as well as the income of JSC "Ukrainian Railways" and its ability to finance the modernization of the rail infrastructure, which will increase the attractiveness of transit through the territory of Ukraine.

Table 3 shows the forecasts of demand for various types of transportation and the expected income from their implementation.

Table 3

Forecast estimates of demand for rail transportation of various types

Indicators	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
	Pessimistic alternative							
Potential demand for freight transportation, million tons	407,4	398,5	389,7	393,2	396,8	400,3	403,9	407,6
including transit	40,9	38,9	36,9	35,1	33,3	31,6	30,1	28,6
The possibility of satisfaction, %	100,0	100,0	100,0	100,0	98,0	95,2	91,8	87,5
Profit, billion $	2,06	1,87	1,51	1,21	1,13	1,06	1,01	1,03
Potential demand for passenger transportation, million	519,4	512,2	505,0	497,7	490,5	483,2	476,0	468,8
The possibility of satisfaction, %	100,0	100,0	90,7	83,4	82,2	81,1	75,1	68,9
Profit, billion $	-0,80	-0,82	-0,85	-0,88	-0,90	-0,93	-0,95	-0,97
Total profits, billion $	1,26	1,05	0,66	0,33	0,23	0,13	0,06	0,06
	Optimistic alternative							
Potential demand for freight transportation, million tons	407,4	398,5	389,7	393,2	396,8	400,3	403,9	407,6
including transit	40,9	40,9	40,9	40,9	40,9	40,9	40,9	40,9
The possibility of satisfaction, %	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Profit, billion $	2,06	2,03	2,00	2,03	2,04	2,06	2,08	2,11
Potential demand for passenger transportation, million	519,4	491,8	478,0	464,5	451,2	438,2	425,5	413,1
The possibility of satisfaction, %	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Profit, billion $	-0,80	-0,64	-040	-0,24	-0,15	-0,04	0,09	0,25
Total profits, billion $	1,26	1,39	-38	1,79	1,89	2,02	2,17	2,36

Source: calculated by the author based on [30, 31, 33].

Key uncertainty 2 – reforming the rail transport (formed by the internal environment). The need to reform the rail transport in Ukraine is not in doubt either among the transport industry researchers or the practitioners. The situation with the reform of the rail transport in Ukraine is already compared with the treatment of a patient who was diagnosed a long

time ago and was prescribed an operation, but his doctors are constantly changing and each new one offers to do the surgery in a different way. Doctors do not start decisive actions, therapeutic treatment does not help, and the patient continues to suffer and limp (Sychov, 2013).

The main results of reforming the rail transport in Ukraine should be: (1) the delimitation of the economic and public administration functions; (2) the formation of vertically integrated structures by type of activity; (3) increased competition; (4) the formation of a competitive potential in the external market of transport services; (5) ensuring equal access of all entities to infrastructure facilities; (6) improvement of the tariff regulation system for rail transport services; and (7) development and implementation of innovative transport and logistics technologies.

Alternative 1 – the implementation of the provisions of the Association Agreement between Ukraine and the EU (2014) in the field of the rail transport. This alternative, for all its attractiveness, should be regarded as pessimistic. This can be explained by the fact that the provisions of the Agreement do not consider the technological features of the rail infrastructure of Ukraine, its size, the possibility of reformatting during the specified periods (5-8 years) and the amount of necessary investments. The result of the implementation of this alternative will be a violation of the integrity of the rail network, which could have disastrous consequences for the economy of Ukraine.

Alternative 2 – the optimistic – the evolutionary development of the rail transport of Ukraine within the framework of "1520 area", which includes the countries of the Customs Union, the Baltic States, and Finland. Implementing this alternative with sufficient investment will allow preserving the value of Ukraine's rail network as a link between Europe and Asia, not ending up in a technological vacuum, preserving the value of the main element of the transport infrastructure of Ukraine, and also avoiding unproductive capital investments.

Table 4 shows the projected costs for the implementation of the reform program of the rail transport of Ukraine considering the expected costs of updating the infrastructure and rolling stock.

Development and analysis of scenarios for the rail transport of Ukraine

Possible scenarios were determined based on the scheme representing a plane, the axes of which will be determined by key uncertainties (reforming JSC "Ukrainian Railways" and the demand for rail transportation), and the poles by two most important and possible outcomes (Fig. 3). Reflecting the predefined element on the diagram is not necessary, as they will form a constant basis for all the developed scenarios.

In accordance with the proposed scheme, four possible scenarios were developed for Ukraine's rail transport: pessimistic, current, negative and optimistic. The results of the implementation of these scenarios are presented in Table 5.

Table 4

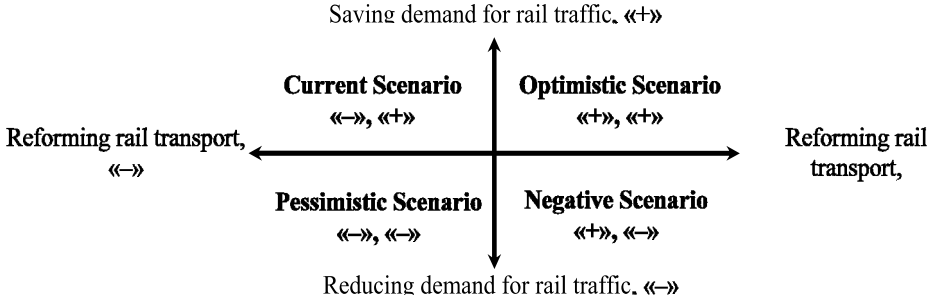
Forecast estimates of costs for the implementation of the reform program of the rail transport of Ukraine, billion $

Indicators	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
	Pessimistic alternative							
Infrastructure upgrade costs	4,35	4,32	4,27	4,22	4,17	3,75	3,71	3,66
Rolling stock upgrades costs	4,40	4,40	4,40	4,40	4,40	4,40	4,40	4,40
Costs associated with the implementation of the reform program	0,02	0,02	0,02	0,02	0,01	0,01	0,01	0,01
Total cost	8,77	8,74	8,69	8,64	8,58	8,16	8,12	8,07
	Optimistic alternative							
Infrastructure upgrade costs	4,35	3,50	1,71	1,70	1,69	1,67	1,66	1,64
Rolling stock upgrades costs	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80
Costs associated with the implementation of the reform program	0,02	0,02	0,02	0,02	0,01	0,01	0,01	0,01
Total cost	8,77	6,32	4,53	4,52	4,50	4,48	4,47	4,45

Source: calculated by the author based on [30, 31, 33,]

Figure 3

Scenario development scheme for rail transport of Ukraine



Source: developed by the author

The results of the implementation of these scenarios are presented in Table 6. As can be seen from the calculations, the cumulative financial result from operating activities for the three scenarios (pessimistic, current and negative) during the forecast period will decrease, and for the pessimistic (since 2022) and negative (since 2023) it will become negative, which means the actual termination of the functioning of the rail transport of Ukraine. This will be the result of not only a reduction in the demand for transportation, primarily freight, but also a shortage of non-current assets in the form of rolling stock (locomotives, semi-cars, passenger cars, etc.).

Table 5

The results of the implementation of scenarios for rail transport in Ukraine

Pessimistic scenario
1. Progressive deterioration of fixed assets. 2. A sharp decline in transportation revenues and, as a result, the growing deficit of its own current assets. 3. The need to attract additional financial resources to finance operating activities. 4. The excessively high cost of attracting investment resources. Result: reduced capacity and transport capacity as a result of the integrity of the rail network.
Current scenario
1. Continuing the trend of increasing physical and moral depreciation of fixed assets. 2. Covering the deficit in financing operating activities at the expense of short-term bank loans. 3. Lack of rolling stock (locomotives and wagons) for freight and passenger traffic. 4. The high cost of attracting financial resources to finance investment needs. *Result*: reduced transportation capacity due to a shortage of rolling stock and deteriorating infrastructure.
Negative scenario
1. Reduced revenue due to lower demand for transportation. 2. The growing shortage of own current assets. 3. Lack of long-term borrowed funds due to the low investment attractiveness of the rail transport. 4. The impossibility of timely financing the program of reforming the rail transport. Result: reduced transportation capacity of the rail transport due.
Optimistic scenario
1. The difficulties of financing the modernization of the rail infrastructure due to lack of financial resources and lack of government support. 2. Maintaining a shortage of rolling stock and, as a result, a decrease in the share of the freight and passenger traffic market. 3. The lack of long-term borrowed funds to ensure the development of the rail transport due to its low investment attractiveness. 4. Minor improvement of infrastructure and rolling stock due to investments in maintaining them in working condition. Result: restoration of transportation capacity and carrying capacity as a result of investments in infrastructure and rolling stock.

Source: developed by the author.

As a result, the shortage of current assets is growing, which negatively affects the investment opportunities of JSC "Ukrainian Railways" and provokes a further deterioration in the condition of fixed assets involved in the provision and implementation of transportation activities. At the same time, the need for external crediting of the rail transport is increasing to meet the need for financing operating activities and capital investments. This will be accompanied by an increase in the cost of attracted financial resources (now the cost of long-term and short-term rail transport loans exceeds the market average, which does not contribute to the modernization of its infrastructure. The implementation of these scenarios will reduce the level of satisfaction of demand for rail transportation: for the pessimistic scenario since 2021, current – since 2022, and negative – since 2020, despite the fact that the implementation of scenarios 1 and 3 already implies a decrease in demand for rail transport due to reduced industrial production.

Table 6

Forecast for the designed scenarios of the future rail transport of Ukraine, billion $

Indicators	Years					Years				
	2020	2021	2022	2023	2024	2020	2021	2022	2023	2024
	Pessimistic scenario					*Current scenario*				
Deficit of own current assets	2,7	3, 6	4,3	4,6	4,6	—	—	1,0	1,6	1,9
Total profits, billion $	0,33	0,23	0,13	0,06	0,06	1,79	1,89	2,02	2,17	2,36
Maintenance of the rail network, billion $	0,54	0,49	0,45	0,4	0,35	0,64	0,62	0,61	0,59	0,58
Infrastructure upgrade costs	4,22	4,17	3,75	3,71	3,66	4,22	4,17	3,75	3,71	3,66
Rolling stock upgrades costs	4,4	4,4	4,4	4,4	4,4	4,4	4,4	4,4	4,4	4,4
Deficit of own resources	-8,83	-8,83	-8,47	-8,45	-8,35	-7,47	-7,3	-6,74	-6,53	-6,28
Satisfaction of demand for transportation, %	100,3	94,3	94,9	95,7	90,5	100,0	100,0	98,0	95,2	91,8
	Negative scenario					*Optimistic scenario*				
Deficit of own current assets	2,8	3,7	4,6	5,4	5,8	—	—	—	—	—
Total profits, billion $	0,33	0,23	0,13	0,06	0,06	1,79	1,89	2,02	2,17	2,36
Maintenance of the rail network, billion $	0,54	0,49	0,45	0,4	0,35	0,64	0,62	0,61	0,59	0,58
Infrastructure upgrade costs	1,7	1,69	1,67	1,66	1,64	1,7	1,69	1,67	1,66	1,64
Rolling stock upgrades costs	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8
Deficit of own resources	-4,71	-4,75	-4,79	-4,8	-4,73	-3,35	-3,22	-3,06	-2,88	-2,66
Satisfaction of demand for transportation, %	94,4	84,3	80,6	77,2	68,9	100,0	100,0	100,0	100,0	100,0

Source: calculated by the author

If the optimistic scenario is implemented, there will not be a shortage of own working capital to finance operating activities. At the same time, JSC "Ukrainian Railways" will not have enough own funds to maintain and develop the infrastructure. It necessitates the attraction of significant financial resources from the external sources. A positive moment in this scenario is that the demand for transportation will be fully satisfied. This scenario is conditionally optimistic, since there will be enough own resources to maintain the infrastructure in working condition, but not to develop it.

Conclusions

The analysis of the constructed scenarios showed that in crisis conditions the rail transport would not become a factor stimulating the growth of the national economy of Ukraine ("the locomotive of the economy"). This is primarily due to the development of crisis phenomena in the JSC "Ukrainian Railways". And even in the situation of increasing demand for rail transportation due to the growth of industrial production, it will, on the contrary, be a deterrent due to the "loss" of transportation capacity and carrying capacity due to a decrease in the number of cars and locomotives, as well as the integrity of the network.

Thus, the rail transport can influence not the process of economic growth in a country, but its intensity, acting as a factor of acceleration or deceleration.

To improve the situation, it is necessary to develop a set of measures aimed primarily at the internal environment. In the case of Ukraine, such a complex should involve the development of a scientifically based strategy for reforming the rail transport, based on rational egoism. This will allow for its effective modernization, considering the priorities of the development of the national economy and without at the same time entering into direct conflicts with the main partners, primarily the EU countries and the Russian Federation. In addition, in order to avoid problems with the financing of transportation activities, it is necessary to introduce stringent requirements for the order of financial activities, namely (i) the priority of financing operating activities; (ii) the high priority of investments in the renewal of rail facilities and rolling stock; (iii) prioritizing the use of credit resources for the implementation of operating and investment activities; (iv) the focus of financial planning on maintaining the financial stability of a monopolist – JSC "Ukrainian Railways".

The further studies of the impact of infrastructure on the economic growth should be directed to (1) the development of a set of measures to strengthen its stimulating effect, taking into account the institutional characteristics of a particular country (region); (2) study of the impact of the level of innovation of individual infrastructure sectors on the economic growth; (3) consideration of the problems of increasing the interoperability of the rail networks on the Eurasian continent.

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