

## Rubric 4. TRANSPORT ECONOMICS

UDC [УДК] 656.025.4

DOI 10.17816/transsyst201952106-117

© S. A. Smirnov, O. Yu. Smirnova

Emperor Alexander I St. Petersburg State Transport University  
(St. Petersburg, Russia)

### MAGNETIC LEVITATION CARGO TRANSPORT ROLE IN WORLD ECONOMY

**Background:** Currently, the car, water, railway, air and pipe transports are used for cargo and goods transportation. Each kind of cargo transport has its own specific competitive advantages that provide its most effective application at various stages of logistics chain. The economic efficiency of cargo transportation influences the overall economic efficiency, in particular, the gross domestic product. The quality of economic growth as applied to transport branch and its input to the national economy is relevant, since with the current organisation of different transport modes interaction, there are still high transaction costs.

**Aim:** Study of influence of various modes of transport, including maglev transport, on the economy and economic growth.

**Methods:** Theoretical and empirical. The paper considers the influence of various modes of transport, that operate in the cargo transport sphere, on the country's economy. The comparison of existing modes of transport with the maglev transport from the point of view of desired effects is made.

**Results:** The maglev transport possesses new properties and advantages, which makes it possible to view it as viable and able to provide a qualitative economic growth and resource-based economy if realised.

**Conclusion:** The most efficient use of resources, the consumption of which should at least not increase and at most decrease, is achieved with the introduction of maglev transport into the transport system, as its economic properties already now excel those of the majority of other types of transport. It is obvious, as to the experts, that in transition to resource-based economy the maglev transport will be major transport for both cargo and passenger transit.

**Keywords:** gross domestic product, classical approach to cargo transportation, economic efficiency, multiplicative effect, additive effects, transport and logistics infrastructure, logistics chains, transport costs, cargo maglev.

## Рубрика 4. ЭКОНОМИКА ТРАНСПОРТА

© С. А. Смирнов, О. Ю. Смирнова

Петербургский государственный университет путей сообщения  
Императора Александра I  
(Санкт-Петербург, Россия)

### РОЛЬ ГРУЗОВОГО МАГНИТОЛЕВИТАЦИОННОГО ТРАНСПОРТА В МИРОВОЙ ЭКОНОМИКЕ

**Обоснование:** В настоящий момент для осуществления грузовых перевозок используются такие виды транспорта, как автомобильный, водный, железнодорожный, воздушный и трубопроводный. Каждый вид грузового транспорта обладает специфическими конкурентными преимуществами, обеспечивающими наиболее результативное его применение на разных этапах логистической цепи. Экономическая эффективность грузовых перевозок оказывает влияние на общую экономическую эффективность, в частности, на валовой внутренний продукт. Актуальной является проблема качества экономического роста применительно к транспортной отрасли и ее вкладу в национальную экономику, так как при текущей организации взаимодействия видов транспорта высокими остаются транзакционные издержки.

**Цель:** Изучение влияния различных видов грузового транспорта, в том числе магнитолевитационного, на экономику и экономический рост.

**Методы:** Теоретические и эмпирические. В статье рассматривается влияние различных видов транспорта, функционирующих в сфере грузовых перевозок, на экономику страны. Производится сравнение действующих видов грузового транспорта с магнитолевитационным транспортом с точки зрения получаемых эффектов.

**Результаты:** Магнитолевитационный вид транспорта обладает новыми характеристиками и преимуществами, что позволяет рассматривать его как жизнеспособный и позволяющий обеспечивать при его внедрении качественный экономический рост и ресурсоориентированность экономики.

**Заключение:** наиболее эффективное использование ресурсов с целью их неувеличения и сокращения достигается при введении в транспортную систему магнитолевитационного транспорта, поскольку его экономические характеристики уже сейчас превосходят экономические характеристики большинства видов транспорта. Очевидно, по мнению авторов, что при переходе к ресурсно ориентированной экономике Маглев будет основным видом транспорта в перевозках как грузов, так и пассажиров.

**Ключевые слова:** валовой внутренний продукт, классический подход к экономике грузовых перевозок, экономическая эффективность, мультипликативные эффекты, аддитивные эффекты, транспортно-логистическая инфраструктура, логистические цепи, транспортные расходы, магнитная левитация, грузовой Маглев.

## Introduction

The magnetic levitation technologies over the recent years have acquired a special significance for the scientific and technical society. Discussions around them do not cease, and this is caused considerable improvement of these technologies and their practical application in a number of states (China, South Korea, Japan). The results of introduction of maglev-based technologies to transport industry vary depending on country peculiarities and influence on functioning of other modes of transport.

Currently, maglev is used only in passenger transit. Transportation of cargo is provided by car, water, railway, air and pipeline transport. Other modes of cargo transport have lost their importance (e.g. horse-driven transport) or did not acquire widespread application (e.g. conveyor transport). Cargo transportation can be of either mass or single scale [1, 2, 3].

## Analysis

Each type of cargo transport has its competitive advantages that ensure the most effective application of a transport at each stage of logistic chain. In some cases transport modes can be interchangeable, and be integrated into multimodal transportation having very high efficiency.

The most considerable features of various types of cargo transport are listed in the Table 1. The main difference between the types of cargo transport lies in the infrastructure used. The infrastructure performs an important role in logistic chains and affects cargo transportation economics [4, 5].

Table 1. Characteristic features of cargo transport types

| Characteristics of cargo transport | Type of cargo transport   |  |  |  |   |
|------------------------------------|---|--|--|--|---|
|                                    | <i>Car</i>  | <i>Water</i>                                     | <i>Railway</i>                                       | <i>Air</i>   | <i>Pipeline</i>                             |
| Infrastructure peculiarities       | Common roads  | Basically, natural waterways; ports required     | Special infrastructure, weight limits                | Natural way; airports required                       | Special infrastructure                      |
| Transportation peculiarities       | Door-to-door without special schedule                           | Between ports, considering port of call schedule | Between cargo stations, according to strict schedule | Between airports, according to strict schedule       | Between input and output points, continuous |
| Transport mode peculiarities       | Wide range with different load capacities and container volumes | Large capacity                                   | Standardised rolling stock                           | Standardised transport means of limited nomenclature | No transport means                          |
| Nomenclature of goods transported  | Wide, limited by sizes and lifting capacity                     | No limitations                                   | Wide, limited by sizes and lifting capacity          | Wide, limited by sizes and lifting capacity          | Liquid, granular cargo, gases               |
| Traffic peculiarities              | Free schedule   | As per navigation conditions                     | As per train schedule                                | Timetable  | Continuous                                  |
| Stability                          | Dependence on weather and road conditions                       | Dependence on weather conditions                 | Dependence on weather conditions                     | Dependence on weather conditions                     | High  |
| Safety                             | High accident risks   | Relatively high                                  | Mean   | Relatively high                                      | High  |
| Sustainability                     | Large emission volumes  | Mean emission volumes                            | Mean emission volumes                                | Mean emission volumes                                | Low emission volumes                        |

Examples of cargo logistics and transport infrastructure, which is a technological complex for organisation of cargo traffic and rendering of transport and logistic services, are illustrated in Fig. 1.



Fig. 1. Examples of cargo transport and logistics infrastructure

The configuration of logistic chains is formed by transport and logistic infrastructure types, and transportation conditions and requirements. From the point of view of logistics, the most complicated stages are those touching distribution of cargo, and the major transport is often not in the focus of attention [6]. This is explained by the necessity to achieve local operational efficiency, which dominates in the classical approach towards cargo transportation economics (Fig. 2).

The classical approach towards cargo transportation economics takes into account the main cost centres and various effects that influence the transport costs. The effects are divided into a group of additive effects and a group of multiplicative effects (Fig. 2). Additive effects concern extensive transport costs factors, that enable improvement of service quality, but require additional capital investment and operational costs.

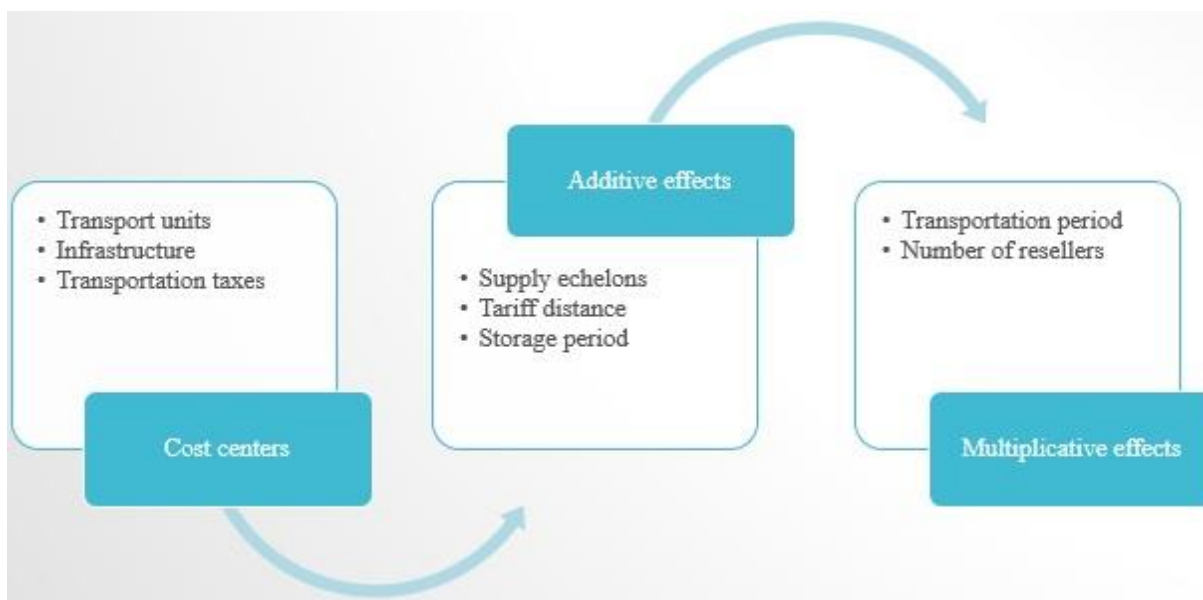


Fig. 2. Cargo transportation economics

The main idea is that the price for logistic chain is added up with all of its stages. The stage price is influenced by its main characteristics. For transport echelons, it is a distance, for warehouses it is storage life.

The multiplicative effects are of different nature and have interest rate as their main rate. These effects have a greater influence on the final product price. For instance, the single month transport interest rate makes up to 0.5% out of the cargo price. At the distribution stages that follow, both increase of interest rate and value added tax is observed, which leads to increase of the final product price. It is these effects that this study focuses on.

The configuration of the transport market participants is given in Fig. 3. In consideration of the market on a broader scale, the number of participants is much bigger, than the number of participants directly involved in the

transportation process. The integral participants of the transport market are also the sender and the receiver.

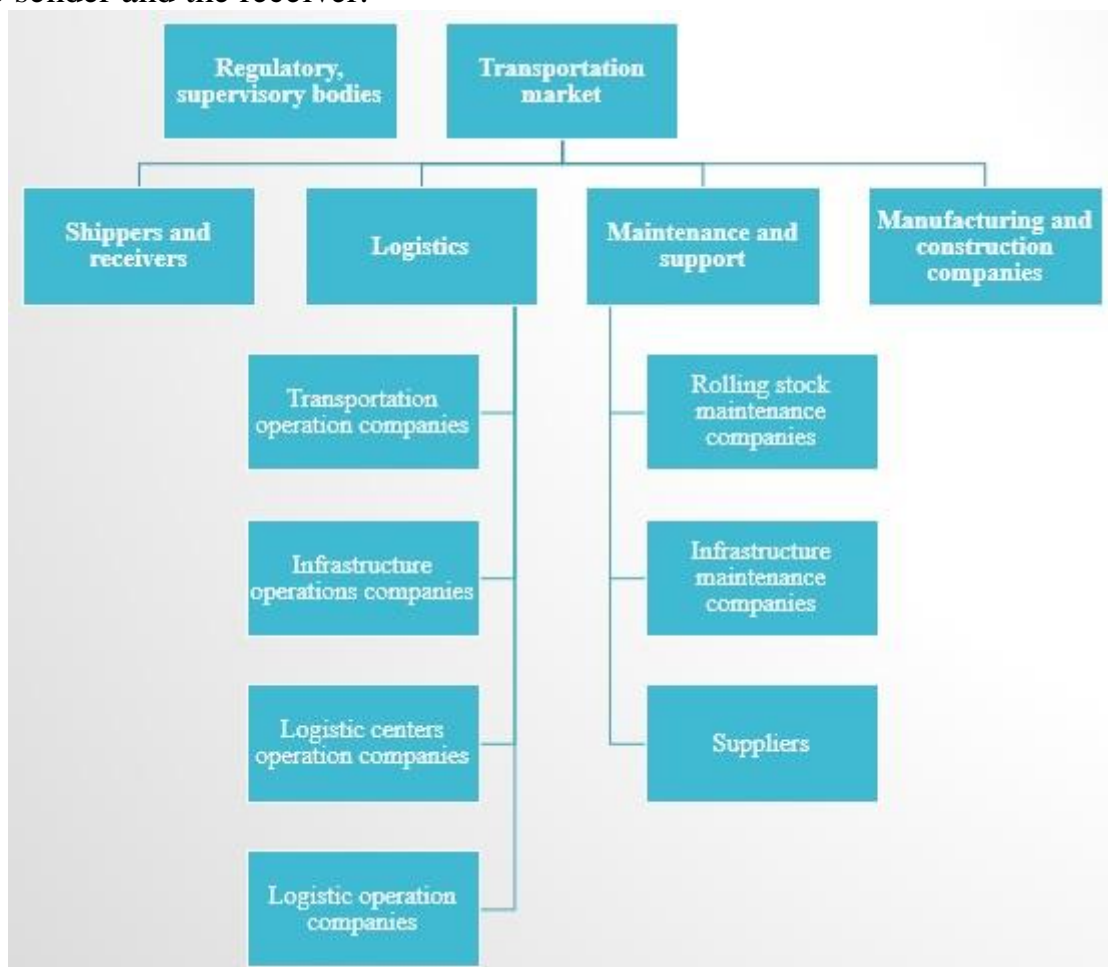


Fig. 3. Transport market participants

The market participants interact with each other in the issues relating to transport and logistics infrastructure, rolling stock and vehicles, resources, and raw materials. The market is regulated by regulatory framework, which determines its development and peculiar features of operational activity [7, 8].

The interests of operating companies, on the one hand, and those of service companies, manufacturers and suppliers, on the other hand, are the opposite. The conflicts are observed in the following aspects:

- infrastructure stability;
- availability of rolling stock and vehicles;
- life cycle of rolling stock and vehicles;
- resources and raw materials.

There is also a potential conflict connected with extension of transport and logistics infrastructure. The situations when one and the same company operates, services the infrastructure and thus takes all internal conflicts are not considered. All conflicts are compromise point where all companies seek

appropriate balance. The rest of the companies are not involved in the process and, despite the rules, suffer from transaction costs.

The final product price is determined by a group of various interconnected costs. The multiplicative effect manifests itself in the increase of price for each following stage of transportation process due to increase of price for each of the preceding stages.

Each transport echelon includes the costs of various types of services, including the profitability of service companies. The cost of service includes the cost of raw materials and resources, including the manufacturers' rate of return and the cost of transportation, as well as the rate of return of transport companies.

Transportation costs are clearly not the largest part of the cost of the final product, but they can lead to a rise in costs by several per cent.

Thus, at first glance, the problem described negatively influences the economy. However, further analysis shows that the situation is much more complex.

The role of transport in the Gross Domestic Product (GDP) as the main factor characterising the final price for all services rendered and products manufactured in the country, is extremely high (Fig. 4).



Fig. 4. GDP and cargo transportation

The share of cargo transportation in GDP may reach 25 %, transport costs in the product price – 10 %. The transport itself consumes up to 25 % of production capacity.

The essence of economic growth is presented in Fig. 5. Traditionally, economic growth is the mirror of GDP growth. At the same time, irrespective of the approach used to calculate GDP (whether it is cost or value added based (production method), the result is the same value.

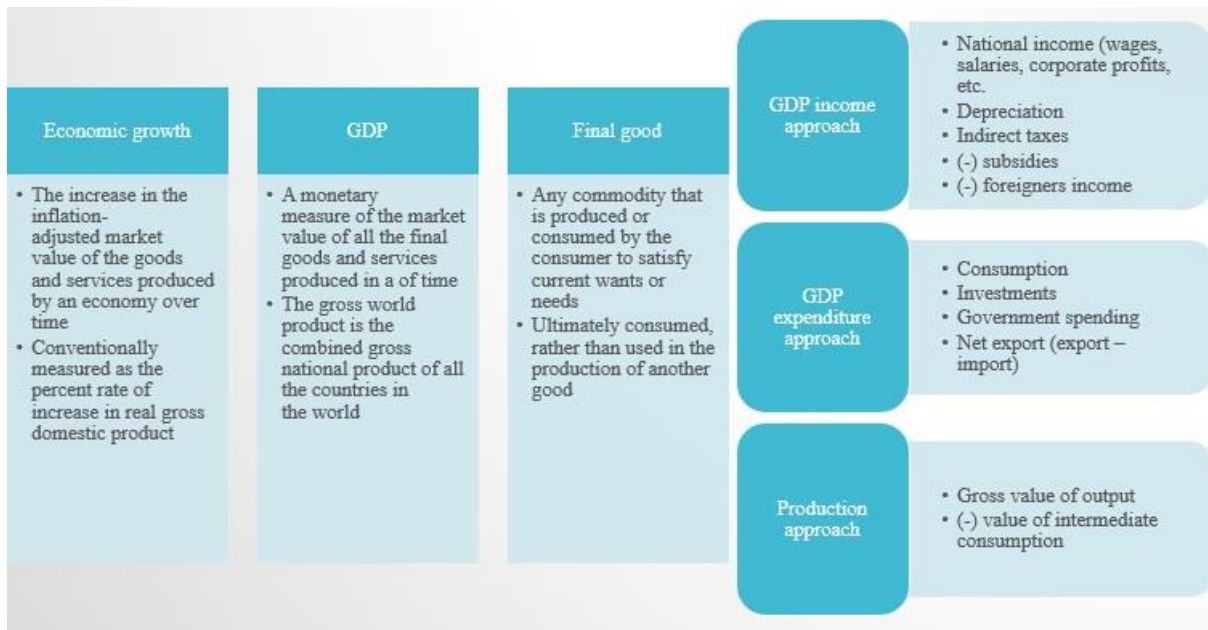


Fig. 5. Economic growth

The economic efficiency of cargo transportation influences the overall economic efficiency. However, inefficient system, from the viewpoint of transaction costs, leads to GDP growth (Fig. 6). Notwithstanding the employment rate and consumption from the viewpoint of prices and increase of investment are observed, the negative side is the lower quality economic growth and different level of efficiency of the market participants [10].

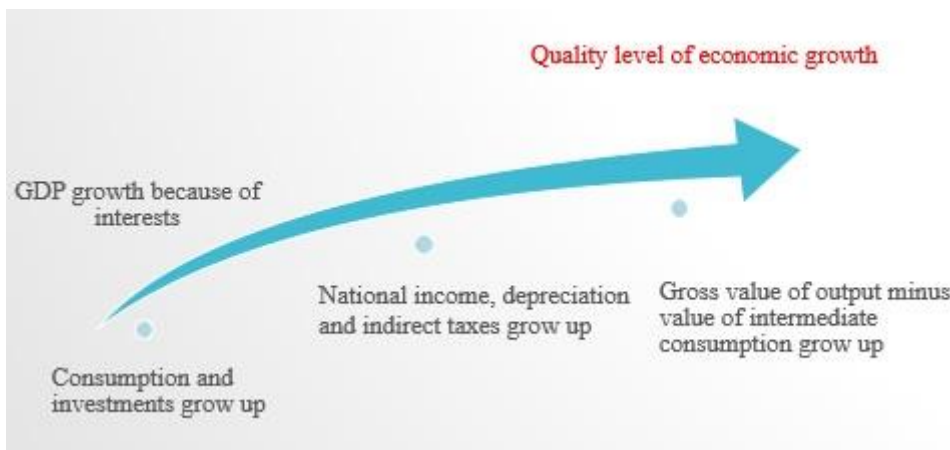


Fig. 6. GDP growth due to market participants' interests

The influence of maglev transport on the cargo transportation market and, consequently, on GDP considerably differs from the same influence of the currently operated modes of transport (Table 2). Measurement of positive effects, such as economic growth quality and intermediate consumption, is a complicated task [11]. Whereas, the level of negative outcomes (reduction of wages fund in service field, investment, depreciation, company's profit in maintenance and construction, and resources consumption) is calculated.

*Table 2. Level of interaction of maglev transport with other participants of operation as compared to other types of cargo transport*

| <b>Object / stakeholder</b>            | <b><i>Rolling stock maintenance</i></b> | <b><i>Rolling stock maintenance</i></b> |
|--|---|---|
| Infrastructure operation company       | Higher stability                        | Lower risks of emergency situations     |
| Transportation operation company       | Optimal routes                          | Less maintenance of rolling stock       |
| Manufacturing and construction company | Less contracts                          | Less maintenance                        |
| Rolling stock maintenance company      | Less damage to rolling stock            | Less maintenance                        |
| Infrastructure maintenance company     | Less maintenance                        | Less damage to infrastructure           |
| Supplier                               | Lower demand                            | Lower demand                            |

Thus, the economic growth issue in terms of transport industry and its contribution to national economy requires searching for a combination of the most efficient modes of transport. This, in its turn, requires changing the economic paradigm to a resource-based one, where the long-term interests providing social proliferation will be brought to the foreground. The model in which the short-term interests are stood for, which damage economy and society, should belong to the past, as not viable from the strategic standpoint [12, 13, 14, 15].

### **Conclusion**

The volume of consumption of resources by humanity has long outweighed their recovery capacities. In this regards, one of the most significant tasks of transport and industry is to minimise consumption of natural resources, as well as to minimise the impact of emission on environment. This requires structural modifications in the transport industry, that is implementation of innovative modes of transport.

The need to reduce consumption of resources so as to eliminate the emerging problems in the ecosystems, will inevitably foster broad implementation of maglev transport, that possesses relevant advantages over other means of cargo and passenger transport. Since economic characteristics of maglev transport, including that being operated in several countries, and that whose technical and technological parameters are being developed, already now excel economic properties of the most types of transport, it can be stated that during transition to resource-based economy maglev transport will be the main transport in both cargo and passenger transportation.

### **Acknowledgment**

The work has been completed with support of Scientific Educational and Engineering Cluster “Russian Maglev”.



**The authors make it expressly clear that:**

1. No conflict of interests has taken or may take place;
2. The present article does not contain any researches with people as the objects involved.

**БИБЛИОГРАФИЧЕСКИЙ СПИСОК / REFERENCES**

1. Зайцев А.А., Антонов Ю.Ф. Магнитолевитационная транспортная технология / Под ред. В.А. Гапановича. – М: Физматлит, 2014. – 476 с. [Zaitsev AA, Antonov YuF. Magnitolevitatsionnaya transportnaya tekhnologiya. Gapanovich VA, editor. Moscow: Fizmatlit, 2014. 476 p. (In Russ.)].
2. Зайцев А.А. Магнитолевитационный транспорт: ответ на вызовы времени // Транспортные системы и технологии. – 2017. – Т. 3. – №1. – С. 5–13. [Zaitsev AA. Magnetothevitational transport: response to time challenges. *Transportation Systems and Technology*. 2017;3(1):5-13. (In Russ.)]. doi: 10.17816/transsyst2017315-13
3. Зайцев А.А., Соколова Я.В., Морозова Е.И., Талашкин Г.Т. Магнитолевитационный транспорт в единой транспортной системе страны. – СПб: НП-Принт, 2015. – 140 с. [Zaitsev AA, Sokolova IV, Morozova EI, Talashkin GT. *Magnitolevitatsionnyi transport v edinoi transportnoi sisteme strany*. St. Petersburg: NP-Print; 2015. 140 p. (In Russ.)].
4. Транспортная стратегия Российской Федерации на период до 2030 г.: утв. Распоряжением Правительства Российской Федерации от 22.11.2008 г. № 1734-р [Интернет]. Доступно по:  
[http://www.mintrans.ru/documents/detail.php?ELEMENT\\_ID=13008](http://www.mintrans.ru/documents/detail.php?ELEMENT_ID=13008). Ссылка  
активна на 20.06.2019.
5. Лapidус Б.М., Лapidус Л.В. Железнодорожный транспорт: философия будущего. – М: Прометей, 2015. – 232 с. [Lapidus BM, Lapidus LV. *Zeleznodoroznyi transport: filosofia buduchego*. Moscow: Prometei; 2015. 232 p. (In Russ.)].
6. Журавлева Н.А., Панычев А.Ю. Проблемы экономической оценки скорости в транспортно-логистических системах в новом технологическом укладе // Транспортные системы и технологии. – 2017. – Т. 3. – № 4. – С. 150–178. [Zhuravleva NA, Panychev AY. Problems of economic assessment of speed in transport and logistical systems in the new technological paradigm. *Economics of transport*, 2017;3(4):150-178. (In Russ., Engl.)]. doi: 10.17816/transsyst201734150-178
7. Терешина Н.П., Галабурда В.Г., Трихунков М.Ф. и др. Экономика железнодорожного транспорта / под ред. Н.П. Терешиной, Б.М. Лapidуса, М.Ф. Трихункова. – М: Учебно-методический центр по образованию на железнодорожном транспорте, 2006. – 801 с. [Tereshina NP, Galaburda VG, Trikhunkov MF. *Economika jeleznodorojnogo transporta*. Tereshina NP, Galaburda VG, Trikhunkov MF, editors. Moscow: Uchebno-metodicheskii centr po obrazovaniyu na jeleznodorojnom transporte, 2006. 801 p. (In Russ.)].
8. Витте С.Ю. Принципы железнодорожных тарифов по перевозке грузов. – СПб: ПГУПС, 1999. – 364 с. [Vitte SYu. *Principi jeleznodorojnikh tarifov po perevozke грузов*. St. Petersburg: PGUPS, 1999. 364 p. (In Russ.)].
9. Антонов Ю.Ф., Зайцев А.А. Магнитолевитационный транспорт: научные проблемы и технические решения. – М: Физматлит; 2015. – 612 с. [Antonov YuF, Zaitsev AA. *Magnitolevitatsionnyy transport: nauchnyye problem i tekhnicheskiye resheniya*. Moscow: Fizmatlit; 2015. 612 p. (In Russ.)].
10. Зайцев А.А. Технология «Магтрансита» в проекте «Санкт-Петербургский Маглев» // Известия ПГУПС. – 2013. – № 4. – С. 5–17. [Zaitsev AA. *Technology*

- “Magtranscity” in the project “St. Petersburg Maglev”. *Izvestia PGUPS*. 2013;(4):5-17. (In Russ.).
11. Лapidус Б.М., Мачерет Д.А. Методология оценки и обеспечения эффективности инновационных транспортных систем // Экономика железных дорог. – 2016. – № 7. – С. 16–25. [Lapidus BM, Macheret DA. Metodologiya otsenki i obespecheniya effektivnosti innovatsionnikh transportnikh sistem. *Railway Economy*. 2016;(7):16-25. (In Russ.)].
  12. Зайцев А.А. О современной стадии развития магнитолевитационного транспорта // Железнодорожный транспорт. – 2016. – № 12. – С. 62–65. [Zaitsev AA. O sovremennoy stadii razvitiya magnitolevitatsionnogo transporta. *Zheleznodorozhnyy transport*. 2016;(12):62-65. (In Russ.)].
  13. Вакуумно-левитационные транспортные системы: научная основа, технологии и перспективы для железнодорожного транспорта: коллективная монография членов и научных партнёров Объединённого учёного совета ОАО «РЖД» / под ред. Б.М. Лapidуса, С.Б. Нестерова. – М: РАС, 2017. – 192 с. [Lapidus BM, Nesterov SB, editors. *Vakuumno-levitacionnye transportnye sistemy: nauchnaya osnova, tekhnologii i perspektivy dlya zheleznodorozhnogo transporta: collective monograph of members and scientific partners of the Joint Scientific Council of Russian Railways*. Moscow: RAS, 2017. 192 p. (In Russ.)].
  14. Городской транспорт и энергоэффективность. Модуль 5h. Экологически устойчивый транспорт: сборник материалов для политических деятелей в развивающихся городах. [Электронный ресурс] GIZ, Берлин, 2013. Режим доступа: <http://greenlogic.by/content/files/dad357e3aec74d42c89c14e4d4fb872.pdf> Ссылка активна на 10.03.2019. [Gorodskoj transport i energoeffektivnost'. Modul 5h. Ekologicheski ustojchivyy transport: sbornik materialov dlya politicheskikh deyatelej v razvivayushchihsya gorodah. [Internet]. [cited 2019 March 10]. Available from: <http://greenlogic.by/content/files/dad357e3aec74d42c89c14e4d4fb872.pdf> (In Russ.)].
  15. Смирнов С.А., Смирнова О.Ю. Экономические аспекты грузового магнитолевитационного транспорта // Транспортные системы и технологии. – 2017. – Т. 3. – № 1. – С. 108–118. [Smirnov SA, Smirnova OYu. Economic features of freight Maglev transport. *Transportation Systems and Technology*. 2017;3(1):108-118. (In Russ.)]. doi: 10.17816/transsyst201731108-118

#### Information about the authors:

**Sergey A. Smirnov**, Lead Researcher Officer;

Address: 9 Moskovsky Ave., 190031 Saint Petersburg;

eLibrary SPIN: 3042-2910; ORCID: 0000-0002-2096-6967;

E-mail: noc-pgups@yandex.ru

**Olga Yu. Smirnova**, Senior Research Officer;

eLibrary SPIN: 9083-2984; ORCID: 0000-0002-2239-4384;

E-mail: noc-pgups@yandex.ru

#### Сведения об авторах:

**Смирнов Сергей Александрович**, ведущий научный сотрудник;

адрес: 190031, Санкт-Петербург, Московский пр., д. 9;

eLibrary SPIN: 3042-2910; ORCID: 0000-0002-2096-6967;

E-mail: noc-pgups@yandex.ru

**Смирнова Ольга Юрьевна**, старший научный сотрудник;

eLibrary SPIN: 9083-2984; ORCID: 0000-0002-2239-4384;

E-mail: noc-pgups@yandex.ru

**To cite this article:**

Smirnov SA, Smirnova OYu. Magnetic Levitation Cargo Ransport Role in World Economy. *Transportation Systems and Technology*. 2019;5(2):106-117. doi: 10.17816/transsyst201952106-117

**Цитировать:**

Смирнов С.А., Смирнова О.Ю. Роль грузового магнитолевитационного транспорта в мировой экономике // Транспортные системы и технологии. – 2019. – Т. 5. – № 2. – С. 106–117. doi: 10.17816/transsyst201952106-117