

## Issues on Measurement the Benefits of Improved Highway Infrastructure

Zilvinas Bazaras, Diana Miceviciene

Kaunas University of Technology Panevezys Institute  
Klaipedos str. 1, LT-37164, Panevezys, Lithuania  
e-mail: zilvinas.bazaras@ktu.lt, diana.miceviciene@ktu.lt

*The paper reviews the theoretical and empirical issues on the measurement of the impacts of the performance of the improved highway infrastructure. It focuses on experience with the notion of the assessment of so called direct benefits associated with the investments rather than the estimation of the indirect ones in context of so popular in practice cost-benefit analysis generating a huge literature in its own right. Raising the issues of validity of the intervention of governments into economics in terms of social justice, the concept of public alternative costs is discussed. Concluding that the inadequate usage of public resources for the formation and development of highway infrastructure may have negative consequences on the dynamics and tendencies of the development of other economic sectors, the question of an adequate, socially and economically reasonable assessment of development is raised. Despite the fact that the cost-benefit analysis is the method by which this concept of efficiency can be applied to publicly supplied good it lacks clarity. In fact, the intangible costs and benefits never enter the analysis. It is suited only for ranking courses of action designed to attain the same ends so the real benefits of decisions will be speculative and uncertain. Taking into account the complexity of the interaction the authors of the article focus on the research of the methodological framework of the evaluation of the benefits of the public in the result highway system modification. The research is based on the improvement of the simplified general equilibrium model which focuses at the price effects of direct changes in transport costs and their measurement. The research results may answer the question if the accomplishment of tasks set for the system or its parts meet the society (which uses or is a neighbor to that infrastructure )needs. Other aspects are going to be excluded from this initial investigation.*

*The logical structure of the article was determined by the aim and the objectives of the scientific research solution sequence which is reflected in three parts. In the Introduction the topic relevance, scientific problem and level of its analysis, object, the aim, and tasks of the scientific research were presented. The methods of the research, results' analysis, scientific novelty and significance of the work are introduced there as well. The second part of the article is dedicated to the analysis of the methodological framework of the application of general equilibrium models in measurement of the performance of improved transport systems. The possible extension of the model and its application issues are presented in the last chapter of the paper introducing the mathematical expression of the consumer and producer surpluses.*

Keywords: *highway, infrastructure, costs, consumer and producer surplus*

### Introduction

**Relevance of the topic.** As far back as the beginning of the 20th century, transport was started to be treated not only as a catalyst of harmonious economic, cultural and social development but as a tool to manage the mentioned processes as well. The establishment and management of the strategic rates and priorities of transport sector development related to the issues of infrastructure upgrowth became the object of scientific and political discussions in many countries. The development of transport infrastructure is considered to be the means to induce economic prosperity and it earns one of the predominant positions in the headlines of scientific periodicals and broadsheets. However, intensive state investment on large-scale objects must be well substantiated for public resources are limited. Thus, a transparent decision-choice funding of projects or programs must be strictly prioritized seeking to allocate the resources optimally. State must intervene into the economy only in case when a market failure can not be removed by other, less competition distortive measures. Public support should be an appropriate policy tool to align the interests of many groups of interest. Recently it is believed that society members taking part in making decisions and motivation is understood as the determination of activity or stimulation to act (Tijunaitiene, Neverauskas, Balciunas, 2009). So assuming complexity decisions to be taken in the fields of transport arteries development, the experts-specialists in different areas of knowledge need to be involved (Hodakovska, Trofimenko, 2008). This context arises very often in the discussion on sustainable development issues. Most authors agree that sustainability assessment currently arises as a comprehensive, integrated and provident decision-making approach (Ciegis, Ramanauskiene, Startiene, 2009). Despite the fact scientists and politicians are often focused on the analysis of interregional and interstate aspects of the interaction, the problem of influence of developed and improved highway infrastructure on separate stockholders and especially measurement of their benefits are still an open ground for the scientific discussion. This problem as one among the most important ones is constantly stressed not only by EU institutions managing the projects of transport corridor development, but highlighted by the Secretariat of international transport program (TRACECA), involving 14 member States of the Eastern European, Caucasian and

Central Asian region, North America (Toronto-Windsor-Detroit-Chicago transport corridor) and others. It is also constantly emerging among policy makers, scientists and practitioners in Intelligent transportation systems society,

**Level of scientific problem investigation.** The beginnings of the analysis into the impact of transport infrastructure on public welfare are considered to be an academic discussion on the quantitative assessment of the impact initiated by USA scientists in 1950s. The pioneers in analyzing the impact are Samuleson (1954), Hirschman (1958) and Mohring (1961); individual aspects of the issue were also investigated by Rosenstein-Rodan (1961). Until the beginning of 1970's the problem under other economic and managerial topics was researched narrowly and in more generalized way. The essential change in this attitude was scientific works published in 1980s, introducing methodological principles to assess wider impact of transport infrastructure in the context of economic growth. The conclusion was drawn examining the studies by Kidokoro (2004), Le Sage, Polasek (2006), Vickerman (2007), Smart (2008), Jacoby, Minten (2009) and others. Kilijotiene, Simanaviciene, Simanavicius (2010), p. 71) also conclude, that "education and trainings, capital, land and *infrastructure* were distinguished often for the identification of regional development level".

Generally the topic of the significance of transport infrastructure in economics was escalated in scientific literature when the European Union started to form the Trans-European Transport Network (TEN-Tr.). However, scientists focused on highly generalized conception of the benefits of transport infrastructure on economics and distinguish various effects such as direct and indirect ones (Berechman, 2001; Rodrigue, 2009), those of short, long and average duration (van Exel *et al.*, 2002; Laksman, Chatterjee, 2005) as well as macroeconomic and microeconomic ones (Button, Henser, 2003). The benefits of transport infrastructure were investigated using the methods of cost-benefit analysis, modified production function approach and correlation-regression analysis as well as general equilibrium, as Laid *et al.* (2007), Vickerman (2007), Rodrigue (2009) state. While the need to justify investments into transport infrastructure developed in Europe, Asia and Africa was increasing, scientific literature started to pay more attention to the impact analysis of exploitable transport infrastructure. Though Kancs (2005), Schade *et al.*, (2006), Zietsman (2006), Vickerman (2007), Smart (2008) and Rodrigue (2009) recognized the impact to be positive and undoubtedly beneficial the society, their opinions diverged in terms of level, factors and the subject of the impact analysis. Nevertheless, in this context *the change in transport costs* was unanimously distinguished as an essential object of the impact investigation of improved transport infrastructure.

In Lithuania the individual aspects of the impact of transport infrastructure in terms of the benefit spread in economics were fragmentally investigated by Palsaitis (2003), Matausek, Sakalys (2003), Steponaviciene (2004), Cibinskiene, Navickas (2004), Maciulis, Vasilis-Vasiliauskas, Baublys (2008), Jakubauskas (2009). The structure of economic effects of highway network

development investigated by. Isoraitė (2004) introduced the methodological principles to assess road investment projects (following the method of Cost-Benefit Analysis), whereas Zavadskas *et al.* (2008) applied the principles of the multicriteria analysis. Vasilis-Vasiliauskas, Barysiene (2008) examined the utility of the integrated multimodal system in the context of international trade relations. Strategic directions in the field were introduced by EBRD (European Bank for the Reconstruction and Development) concerning the railway infrastructure development and management issues (Strategija Lietuvai, 2009). Technical criteria of the benefit evaluation proposed by Beljatsynkij *et al.* (2009). The infrastructure (as the whole) performance measurement issues were investigated by Snieska, Simkunaite (2009), but the principles of the equilibrium modelling were not introduced.

**The problem of scientific research.** It was determined there was no structurally coherent base that would allow to analyze the benefits of highway infrastructure and to assess them in terms of transport cost change.

**The object of scientific research:** benefit measurement of the impact of highway infrastructure .

**The aim of scientific research:** to propose the methodological framework to assess the benefits of highway infrastructure in terms of transport cost change.

**Research objectives** are as follows:

1. To distinguish the peculiarities of the evaluation of the impacts of highway infrastructure development.
2. To develop the methodological framework of the measurement of the benefits of highway infrastructure in terms of the transport cost change.

**Research methods:**

1. In order to conceive the analyzed problem, general methods of scientific literature comparative structural analysis and synthesis as well as those of logic analysis were applied.
2. When determining the benefits of highway infrastructure the area method was applied to determine consumer and producer surplus.

**Scientific novelty and significance of the work are specified by the following results:** a specified methodological framework that enables to determine the change in consumer and producer surplus (total benefit of consumer and producer when effective quantity of a product is produced) due to transport cost change after highway infrastructure improvement has been specified.

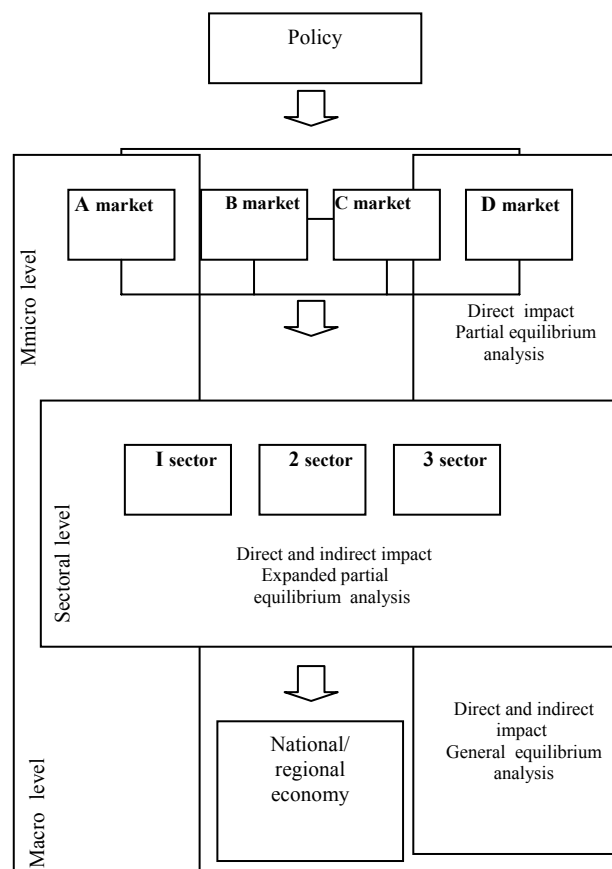
## **The effects of highway infrastructure improvements**

Typical transport infrastructure improvements reduce effective distances between origins and destinations by reducing congestion, thereby lowering travel times (Laksman, Chatterjee, 2005). It is believed that travelers gain directly from travel time savings and lowered vehicle-operating costs, despite the fact that Metz (2008) argues that the evidence of the research is performed in the past is still insufficient. However, the position that companies enjoy direct efficiency gains from cheaper and more reliable freight services and reduced assembly and delivery costs are not under controversy. Despite the fact that

companies compete for customer, revenue, market share with products and services that meet customer's needs (Boguslauskas, Kvedaraviciene, 2009), cheaper and better transportation services provide incentives for firms to reorganize and reduce their inventories, sometimes to just-in-time levels. The advantages of scale economies occur as firms consolidate production and distribution sites, increase outputs (Laksnman, Chaterjee, 2005) as well as obtain the possibility to increase the competitive advantage. As Lydeka, Adomavicius (2007) conclude, in one of two ways – (a) by achieving advantageous position in as an industry; (b) by developing and using core competences to offer products and services. The competitive ability is most efficiently increased upon prompting basic research and knowledge spread obtained as the result of this research (Jasinskis, Simanaviciene, 2008). However, despite large amounts invested on roads, it is still little known about their benefits (Jacoby, Minten, 2008). In fact, the argument that the improvement of transport infrastructure changes travel costs and benefits the stockholders in the commodity market is not neglected. The analysis of scientific literature allows to conclude that in this case benefit consumers and producers in terms of welfare change. The increase of the economy's welfare due to the existence of a market for a particular good is equal to the sum of the consumer's surplus and the producer's surplus (Rothengatter, 1994; Rietveld, Roson, 2002) that are measured using partial general or partial equilibrium models.

Generally, the concept of consumer and producer surpluses are defined in microeconomic course. *Consumer surplus* is a measure of consumer welfare gained by consumers being able to purchase a good or service in the market at a price lower than the maximum that they would be prepared to pay for it rather than going without it. *Producer surplus* is the difference between the revenue that the firms would earn from offering a good or service for sale rather than not selling it and the revenue that they are able to achieve by selling it at the market price. The producer surplus arises because the producer can now sell more than before and/ or at a higher price. Both of the effects commonly are determined using general or partial equilibrium models (Wills *et al*, 1997; Streimikiene, Mikalauskiene, 2004; Kidoko, 2005; Zhu *et al*, 2008). The difference between the methods is demonstrated in Figure 1.

As Streimikiene, Mikalauskiene (2004) conclude General equilibrium analysis includes a full range of calculations to determine market prices through a set of supply and demand equations. The principles of market demand estimation formulated in the available economic research publications have mainly to do with different managerial aspects focusing on the peculiarities of various methods used for market investigation as well as their implementation possibilities and pointing out traditional factors that have influence upon demand investigation (Snieska, 2008). Thus, mathematical models of general equilibrium simulate the production factors and goods markets, using supply and demand equation in all markets.



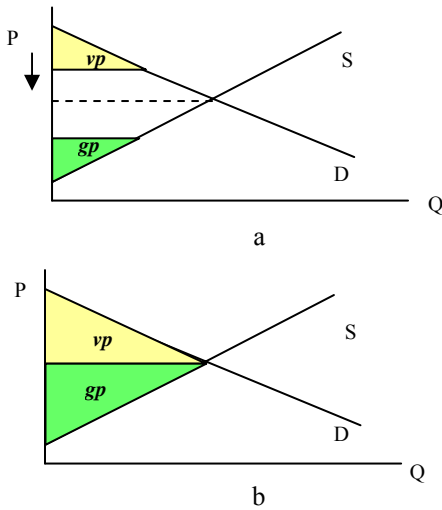
**Figure 1.** Connections and differences between the general, partial and expanded partial equilibrium models

These models are constructed to a particular problem solving and have the following general characteristics:

- description of supply and demand curves and equations determine the equation parameters;
- solves these equations, which are usually linear system.

However, the application of the model is rather complicated and hardly functional in the developing countries that, firstly, lack experience in the model application, secondly, are short of the statistical data.

Partial equilibrium models are an alternative to the presented one above. This option is more suitable for economic modeling in the developing countries, where each of the related goods and factor markets are not so interrelated comparing with the situation demonstrated by the general equilibrium so called "basic" (Kidokoro, 2004) models with several assumptions. Usually the basic model is a representative consumer model with a quasi-linear utility function. This model is simplified in that no income effects exist. It is sufficiently general that the income share of transportation services is usually low (Kidokoro, 2004). The partial equilibrium model can be used to analyze how transport costs affect trade and welfare. Taking into account that transport costs in effect drive a wedge in between the price received by supplier and the price paid by a consumer. As increase or decrease in transport cost reduces increases or reduces the gains from trade for both stockholders (Figure 2).



**Figure 2.** Impact of transport cost change on consumer and producer surpluses

A decrease in transport costs and the price of the commodity (the effect is marked by the arrow, Fig. 2, a) increase the gains from the exchange of the product equal to the areas *vp* (consumer surplus) and *gp* (producer surplus, b).

Mathematically the partial equilibrium model might be delineated referring to Brocker (2000). The author assumes that the commodity transported from the point *R*, where it is produced, to the point *P*, where it is consumed.

The elasticity  $\mu$  and  $\gamma$  of the supply function  $S = S(p)$  and the demand function  $D = D(p)$  and are constant:

$$\frac{S'}{S/p} = \mu, \quad -\frac{D'}{D/p} = \gamma \quad (1)$$

where  $p$  – price of commodity.

Assuming these equations to be differential and solving them, the common form of these functions with free parameters  $\alpha$  and  $\beta$  is obtained:

$$S = \alpha p^\mu \quad D = \beta p^{-\gamma} \quad (2)$$

At a point *P* the transport costs of the commodity may increase to a value where the price factor  $\Delta$  describes the growth of transportation:

$$q = p(1 + \Delta) = p + \Delta p \quad (3)$$

Therefore, at the point *P* the demand for the product is:

$$D = \beta (p(1 + \Delta))^{-\gamma} \quad (4)$$

Applying to the expressions (2), (3) and (4) the supply and demand equilibrium condition, the equality 5 is obtained:

$$\alpha p^\mu = \beta (p(1 + \Delta))^{-\gamma} \quad (5)$$

J. Brocker (2000) solves the equation in respect of the price  $p$ , assigning to the parameters specific numerical

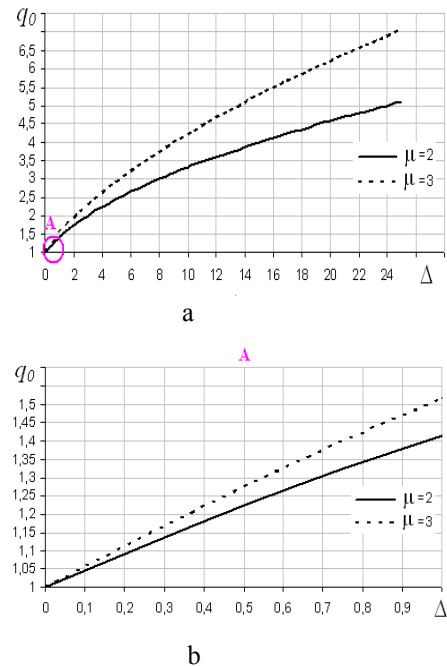
values. However, the solution the equation requires a deeper insight. It is easy to see that:

$$p^{\mu+\gamma} = \frac{\beta}{\alpha} (1 + \Delta)^{-\gamma} \quad (6)$$

Therefore, the producer price, which in this particular case, identified as  $p_0$ , is:

$$p_0 = \left(\frac{\beta}{\alpha}\right)^{\frac{1}{\mu+\gamma}} (1 + \Delta)^{-\frac{\gamma}{\mu+\gamma}} \quad (7)$$

Figure 3 shows the variation of the equilibrium price  $p_0$ , calculated according the equation (5). Using the original price expression (7), from the expression (3) it is possible be obtain the price of transported goods at the point  $q_0$  at the point *P* (equation 8).



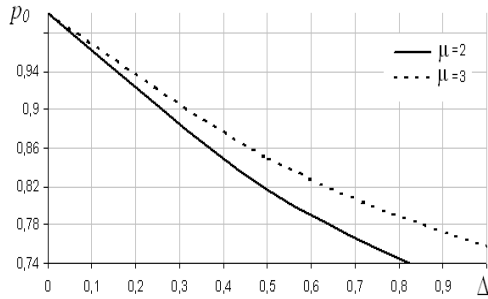
**Figure 3.** The interdependence of the consumer price  $q_0$  and variation of transport costs  $\Delta$ , at given  $\mu$  estimates, when  $\gamma=2$ ,  $\alpha = \beta$

$$q_0 = p(1 + \Delta) = \left(\frac{\beta}{\alpha}\right)^{\frac{1}{\mu+\gamma}} (1 + \Delta)^{\frac{\mu}{\mu+\gamma}} \quad (8)$$

Since in the expression of this price  $q_0$  the exponent  $\mu / (\mu + \gamma)$  is positive, increase in the transport cost  $\Delta$ , makes the final price  $q_0$  growing. And conversely, a decrease in transportation costs, declines the price  $q_0$  at the point *P* (Figure 3 a).

Figure 3 shows that the interdependence between the price of the commodity and the transport costs is not linear. It is unreal to consider that the price of a commodity paid by consumer will increase 24 times. For the reason the variation of the final price in the range from 0 to 1 is presented (Figure 3 b). Meanwhile, the price of the manufacturer  $p_0$  at point *R* has the opposite characteristic, as Figure 4 shows. As the member  $-\mu / (\mu + \gamma)$  in the expression (7) is negative, then, the price  $p_0$  decreases

conversely to the increase of  $\Delta$ . This, at first glance, contradictory character of the producer price is determined by the equilibrium condition. This dependence is also non-linear. Thus, we may conclude that falling transport costs in the range from 0 to 1, decrease the final price of the commodity consumed at the point  $P$  and allows to grow the producer price of at the point  $R$ .



**Figure 4.** The interdependence of the producer price  $p_0$  and variation of transport costs  $\Delta$ , at given  $\mu$  estimates, when  $\gamma=2$ ,  $\alpha = \beta$

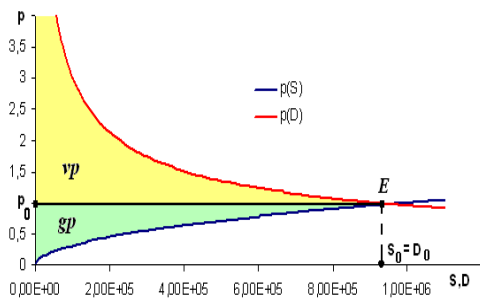
Fixing the impact of decreasing transport costs in the commodity market the further investigation was methodologically expanded. The results of the research are presented below.

The consumer and producer surpluses might be calculated using the reverse demand and supply functions:  $p = p(S)$ ,  $p = p(D)$  obtained resolving the equations (1) in respect of  $p$ :

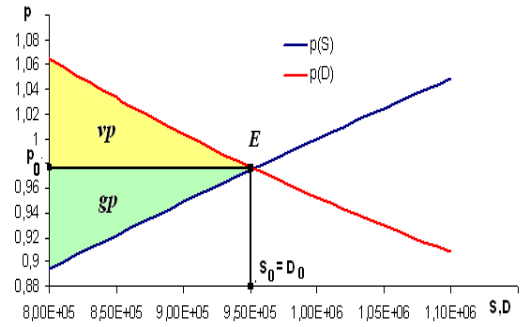
$$p = \left(\frac{S}{\alpha}\right)^{1/\mu}, \quad (9)$$

$$p = \left(\frac{D}{\beta}\right)^{-1/\gamma} \frac{1}{1+\Delta} \quad (10)$$

The graphs of the functions are presented in the Figure 5.



a



b

**Figure 5** Enlarged demand and supply functions when  $\mu = \gamma = 2$ ,  $\alpha = \beta = 10^6$ ,  $\Delta = 0,05$  (a), enlarged equilibrium in zone  $E$  (b)

Consumer surplus  $vp$  – are under the lines  $p_0$  and  $p(D)$ , when:

$$D \leq D_0 = D(p_0) = \beta (p_0(1+\Delta))^{-\gamma}. \quad (11)$$

Entering into the formula the expression  $p_0$  we get:

$$D_0 = \beta (p_0(1+\Delta))^{-\gamma} = \beta \left(\frac{\beta}{\alpha}\right)^{\frac{-\gamma}{\mu+\gamma}} (1+\Delta)^{\frac{-\mu\gamma}{\mu+\gamma}} \quad (12)$$

Taking into account that the area under the curve is calculated integrally, the consumer surplus then:

$$vp = \int_0^{D_0} (p(D) - p_0) dD_0. \quad (13)$$

Inserting the reverse demand function  $D_0$  instead  $p(D)$  (12) and  $p_0$  from equation (7) consumer surplus then gets the expression:

$$vp = \frac{\beta \left(\frac{\beta}{\alpha}\right)^{\frac{1-\gamma}{\mu+\gamma}} (1+\Delta)^{\frac{-\gamma(1+\mu)}{\mu+\gamma}}}{\gamma-1} \quad (14)$$

Analogically,  $S_0$  applying formula (2):

$$S_0 = \alpha p_0^\mu. \quad (15)$$

Producer surplus  $gp$  then:

$$gp = \int_0^{S_0} (p_0 - p(S)) dS_0. \quad (16)$$

Inserting reverse function  $p(S)$  into the equation (16) as well as the supply function (12),  $S_0$  (15) and finally  $p_0$  (7) the producer surplus then:

$$gp = \frac{\alpha \left(\frac{\alpha}{\beta}\right)^{\frac{-\mu+1}{\mu+\gamma}} (1+\Delta)^{\frac{-\gamma(1+\mu)}{\mu+\gamma}}}{\mu+1}. \quad (17)$$

Thus, according to Brocker (2000) the study of the methodology of consumer and producer surpluses was improved. Using this methodology, we can determine the changes in producer and consumer surpluses in the case of disposition of the information sufficient to determine supply, demand functions and transportation costs.

## Conclusions

1. In modern economics transport is considered to be one of the determinants of economic development so the strategic solutions in the sphere of transport investments, based on clear understanding of the needs of the stockholders generated by the infrastructure must be clearly understood. The research showed that in the scientific literature discussions confine in respect of generalized assessment of the effects and benefits of improved highway transport infrastructure.
2. The investigation of the peculiarities of the relationship between transport infrastructure and economic impacts in terms of the change in transportation costs, allows to state:
  - taking into account typical attributes of highway infrastructure, it was determined that at present not only the objectives as serving different economic branches, to guarantee flexibility, expedition and quality of supply and distribution system are raised;
  - guarantee of continuous mobility of society members when satisfying their socio-economic needs as well as the decrease in expenses of the infrastructure users benefiting them are also often emphasized but poorly quantified;
  - the subjects of the change, so called beneficiaries,
3. The research into the methods used to assess the benefits of highway infrastructure, it was determined that:
  - modified production function, general equilibrium and land use models as well as the methods of correlation-regression analysis in the change of real estate and hedonic prices are often applied to establish the impact under the investigation;
  - research has shown that the experience of modelling the impact of highway infrastructure on benefit change of the stockholders is limited. Shortcoming of the practice – consideration of demand and supply curves are to be exclusively linear. Seeking to eliminate the shortage, the authors of the article improved the method of the partial equilibrium model, proposed by Brocker;
  - it was determined that consumer and producer surpluses might be determined more precisely considering the demand and supply curves to be non-linear. Assuming that the elasticity of the demand and supply curves are constant, the parameter  $\Delta$  (transport costs) is incorporated into the demand and supply expressions, and applying the equilibrium conditions the received equation is solved.

## References

- Baublys, A. (2009). Models of transport system development. *Transport* (24), 283-287.
- Baum, H., & Korte, J. (2001). Influence of economic growth on transport infrastructure. *Transport and economic development*. Report of the hundred and ninth round table of transport economics held in Paris, 5-50.
- Beljatynskij, A., Kuzhel, N., Prentkovskis, O., Bakulich, O., & Klimenko, I. (2009). The criteria describing the need for highway reconstructions based on the theory of traffic flows and repay time. *Transport* (24), 308-317.
- Berechman, J. (2001). Transport, investment and the economic development. Is there a link? *Transport and economic development*. Report of the hundred and ninth round table of transport economics. Paris, 103-132.
- Blum, I., & Dudley, L. (2001) Transportation, location and growth. In *Transport and economic development*. Report of the hundred and ninth round table of transport economics. Paris, 51-85.
- Boguslauskas, V., & Kvedaraviciene, G. (2009). Difficulties in identifying company's core competences and core processes. *Inzinerine Ekonomika-Engineering Economics*(2), 75-81.
- Brocker, J. (2000). Assessing spatial economic effects on transport by CGE analysis: state of the art and possible extensions. *First international ITEM workshop*, 19.
- Christauskas, J., & Skerys, K. (2005). Transport infrastructure. Vilnius. Technika, 172.
- Cibinskiene, A., & Navickas, V. (2004). Socialinės ekonominės infrastruktūros valstybinio reguliavimo algoritmas. *Organizacijų vadyba: sisteminiai tyrimai*, 31, 46-52.
- Ciegis, R., Ramanauskienė, J., & Startienė, G. (2009). Theoretical Reasoning of the use of indicators and indices for sustainable development assessment. *Inzinerine Ekonomika-Engineering Economics*(3), 33-40.
- Forkenbroack, D. J., & Weisborg, G. E. (2001). Guidebook for Assessing the Social and Economic Effects of Transportation Projects. NCITRP report 456.: National academy press, 141.
- Hodakovska, T., & Trofimenko, J. (2008). Reliability of Experts' Group Evaluation at Making Decisions. *Mašīnzinātne un transports-Transport and Engineering* (26), 72-76.
- Isoraite, M. (2004). Analysis of transport performance indicators. *Transport*, (XX.), 111-116.
- Jacoby, H. G., & Minten, B. (2009). On measuring the benefits of lower transportation costs. *Journal of the Development Economics* (89), 25-38.
- Jasinskas, E., & Simanaviciene, Z. (2008). Government's support for farmer's knowledge dissemination and its improvement. *Inzinerine Ekonomika-Engineering Economics*(3), 67-72.

- Kancs, D. (2005). Efficiency of European funds in the accession countries: The case of transport infrastructure investment in Latvia. *Transportation planning and technology* (28), 293-313.
- Kidokoro, Y. (2005). Benefit estimation of transport projects – a representative consumer approach. *Transportation research* (40), 521-542.
- Kilijotiene, A., Simanaviciene, Z. & Simanavicius, A. (2010). The evaluation of social and Economic Development of the region. *Inzinerine Ekonomika-Engineering Economics*, 21(1), 68-79.
- Laird, J., Nellthorp, J., & Mackie, P. (2005). Network effects and total economic impacts in transport appraisal. *Transport policy*, (6), 537-544.
- Laksnman, T. R., & Chaterjee, L. R. (2005). Economic consequences of transport improvements. <http://www.uctc.net/access/26/Access%2026%20-%2006%20-20Economic%20Consequences%20of%20Transport%0Improvements.pdf>
- Le Sage, J. P., & Polasek, W. (2006). Incorporating transportation network structure in spatial econometric models of commodity flows. *Economic series* (188), 45.
- Lydeka, Z., & Adomavicius, B. (2007). Cooperation among the Competitors in international cargo transportation sector: key factors to success. *Inzinerine Ekonomika-Engineering Economics*(1), 80-90.
- Maciulis, A., Vasilis Vasiliauskas, A., & Jakubauskas, G. (2009). The impact of transport on the competitiveness of national economy. *Transport*, 24 (2), 93-99.
- Matousek, K., & Sakalys, A. (2003). Kai kurios priemonės rengiant integruotus intermodalinio transporto sprendimus Europos Sąjungos pletros kontekste. *Transbaltica*, (03), 20-28.
- Metz, D. (2008). The myth of travel time saving. *Transport reviews* (28), 321-336.
- Palsaitis, A. (2003). Tranzitinis transportas: itaka eismo intensyvumui ir šalies ekonomikos augimui. Transportas, technologija, aplinka. Vilnius, 152-201.
- Rietveld, P., & Roson, R. (2002) Direction dependent in public transport: A good idea? The back haul pricing problem for a monopolistic public transport firm. *Transportation*, (29), 397-417.
- Rodrigue, P. (2009). The Geography of Transport Systems. New York, 352.
- Rothengatter, W. (1994). Do external benefits compensate for external costs of transport? *Transportation Research Part A: Policy and Practice* (28), 321-328.
- Smart, M. (2008). Transport demand and spatial equilibrium. *Journal of Transport Economics and Policy* (42), 323-348.
- Snieska, V., & Simkunaite, I. (2009). Socio-Economic Impact of infrastructure investment. *Inzinerine Ekonomika-Engineering Economics*(3), 16-25.
- Snieska, V. (2008). Research into International Competitiveness in 2000-2008. *Inzinerine Ekonomika-Engineering Economics*(4), 29-41.
- Steponaviciene, G. (2005). Europos Sąjungos sausumos transporto politika: ekonominis pagritumas ir poveikis Lietuvai. Daktaro disertacija, 155.
- Strategija Lietuvai. (2009). Europos rekonstrukcijos ir pletros banko dukomentas. Patvirtinta direktoriu tarybos 2009 m. rugsejo 22 d. susirinkime, 42.
- Streimikiene, D., & Mikalauskiene, A. (2004). Bendruju ir dalines pusiausvyros modelių taikymas vertinant aplinkosaugos politikos itaka energetikai ir ekonomikai. *Energetika*, (1), 69-77.
- Tijunaitiene R., Neverauskas, B., & Balciunas, S. (2009). Motivation expression of citizen participation in organizations of citizen society. *Inzinerine Ekonomika-Engineering Economics*(1), 65-74.
- Van Exel, J., Rienstra, S., Gommers, M., Pearman, A., & Tsamboulas, D. (2002). EU involvement in TEN development: network effects and European value Added. *Transport policy* (9), 299-311.
- Vasilis-Vaisliauskas, A., & Barysiene, J. (2008). Analysis of Lithuanian transport sector possibilities in teh context of European-Asian trade relations. *Transport* (23), 21-25.
- Vickerman, R. (2007). Recent Evolution of Research into the Wider Economic Benefits of Transport Infrastructure Investments. *OECD/ITF Joint Transport Research Centre Discussion Papers* (9). OECD, International Transport Forum, 15-28.
- Wills, K., Garrod, G., & Harvey, D. (1997). A review of cost-benefit analysis as applied to the evaluation of new road proposals in the UK. *Transportation Research Part D: Transport and Environment*, (3), 141-156.
- Zavadskas, E., Brauers, W., Peldschus, F., & Turskis, Z. Multi-objective Decision Making for Road Design. *Transport* (23), 221-229.
- Zhu, X., Van Ommerin, J., & Rietveld, P. (2009). Indirect benefits of infrastructure improvement in the case of an imperfect market. *Transportation Research Part B: Methodological* (43), 57-72.
- Zietsman, J. (2006). Transportation corridor decision-making with multi-attribute utility theory. *International Journal of Management and decision making* (7), 254-266.

Zilvinas Bazaras, Diana Micevičienė

**Automobilių kelių infrastruktūros gerinimo poveikio vertinimas**

Santrauka

*Temos aktualumas ir naujumas.* Dar XX a. pradžioje transportą imta traktuoti ne tik kaip harmoningo ekonominės, kultūrinės, socialinės raidos katalizatorių, bet ir kaip įvadytų procesų valdymo priemonę. Strateginių transporto sektoriaus plėtojimo tempų ir prioritetų, sietinų su infrastruktūros plėtotės problematika, nustatymas ir valdymas daugelyje šalių tampa mokslinių ir politinių diskusijų objektu. Transporto infrastruktūros plėtotė laikoma ūkio klestėjimą skatinančia priemone ir užima vieną iš dominuojančių pozicijų mokslinės periodikos ir populiariosios spaudos antraštėse. Nors pastaraisiais metais mokslininkų dėmesys nukreiptas į transporto infrastruktūros kaip ekonomikos augimo veiksnio paradigmą, Lietuvoje ji ypač mažai nagrinėta. Lieka neaišku, ar šiuo metu šalies investicijos į kelių infrastruktūrą spartina ekonominės raidos procesus, ar pasiteisina socialinio teisingumo požiūriu. Nesuiformavusi vientisa efektų vertinimo koncepcija, neaiški jo struktūra ir skirtingų suinteresuotų grupių interesai apsunkina racionalaus sprendimų priėmimą infrastruktūros plėtotės srityje. Mokslinės literatūros tyrimas parodė, jog daugumoje studijų automobilių kelių infrastruktūros poveikis socialiniu-ekonominiu požiūriu atskleidžiamas apibendriniai. Reiškinių analizė siaura, fragmentiška, orientuota į autorių atliekamų specializuotų tyrimų tikslus. Nesant bendresnių nagrinėjimo poveikio analizės ir vertinimo kriterijų, nukenčia tyrimų sistemiškumas. Pasigendama, kaip nustatyta, metodologiškai pagrįstų automobilių kelių infrastruktūros poveikio vertinimo ekonominiu aspektu transporto sąnaudų pasikeitimo požiūriu. Esamas ekspertų įdirbis traktuotinas kaip užuomazgos automobilių kelių infrastruktūros poveikio vidaus ekonomikos augimui tyrimo srityje. Atlikus nagrinėjamų transporto infrastruktūros ekonominių poveikių vertinimo metodų tyrimą, nustatyta, jog dažnai vertinant šiuos poveikius taikomi modifikuotos gamybos funkcijos, bendrosios pusiausvyros ir žemėnaudos modeliai, koreliacinės-regresinės, nekilnojamojo turto ir žemės kainų pokyčių analizės metodai. Šiuo požiūriu parengtas straipsnis pasižymi naujumu, kadangi jame susisteminius mokslinius tyrimus, kuriuose nagrinėta transporto infrastruktūros plėtotės efektų ekonomikoje raiška ir jų fiksavimo alternatyvos, autorių išskirti automobilių kelių infrastruktūros plėtotėi būdingi ekonominiai poveikiai, pasiūlant patikslintą matematinį modelį, leidžiantį nustatyti gamintojo ir vartotojo perviršių pokytį dėl kelionės sąnaudų pasikeitimo išplėtojus automobilių kelių infrastruktūrą.

*Mokslinio tyrimo problema.* Mokslinėje literatūroje nėra struktūriškai nuoseklios metodikos, leidžiančios vertinti automobilių kelių infrastruktūros gerinimo poveikį sąnaudų pasikeitimo požiūriu.

*Mokslinio tyrimo tikslas* – parengti metodologinius automobilių kelių infrastruktūros poveikio vertinimo pagrindus transporto sąnaudų pasikeitimo požiūriu. Tyrimas paremtas dalinės pusiausvyros modelio korekcija siekiant išgryninti metodologinius principus vartotojo ir gamintojo perviršiams vertinti, atsižvelgiant į paklausos ir pasiūlos kreivių netiesiškumą.

*Mokslinio tyrimo metodai:* siekiant suvokti nagrinėjamą problemą, taikomi bendrieji mokslinės literatūros lyginamosios struktūrinės analizės ir sintezės bei loginės analizės metodai. Nustatant automobilių kelių infrastruktūros poveikį prekių ir paslaugų rinkai, taikytas plotų metodas vartotojo ir gamintojo perviršiams nustatyti.

*Straipsnio struktūrą* lėmė suformuluotas tikslas ir jam pasiekti iškelti uždaviniai, kurių sprendimo seka atsispindi trijuose poskyriuose. Pirmasis „Įvadas“ – skirtas išryškinti atlikto tyrimo aktualumą ir naujumą, atskleisti tyrimo tikslą, uždavinius ir metodus. Antrajame – „Automobilių kelių infrastruktūros efektai“ – nagrinėjami automobilių kelių infrastruktūros poveikiai ir jų vertinimo galimybės, tiesioginio automobilių kelių infrastruktūros efektų sklaidos analizės pozicija – dėl pagerėjusių susisiekimo sąlygų mažėjantys kelionės kaštai. Toliau pateikiama įvadytų procesų loginė seka. Gerėjant susisiekimo sąlygoms, gauta kelionės sąnaudų kaip vieno iš bendrųjų sąnaudų elemento ekonomija mažina įmonių bendrąsias sąnaudas, taigi turi įtakos įmonių gamybos apimtims pokyčiams. Pripažįstant, jog skirtingose valstybėse pateikti duomenys gali skirtis, svarbu pabrėžti, jog įmonių sąnaudų mažėjimas kitiems veiksniams nekintant lemia gamybos apimtį didėjimą – sutauptos lėšos panaudojamos papildomai pridėtinei vertei kurti. Tokią nuostatą patvirtina ekonomikos teorija: vienas iš pasiūlos pokyčio veiksnių – gamybos kaštai. V. Pukelienė, I. Maksvytienė (2008) pažymi, kad kiekviena įmonė, naudodamasi savo konkurenciniais pranašumais, siekia gaminti ir parduoti daugiau, geresnės ir mažesnėmis sąnaudomis sukurtos produkcijos ir gauti pelną. Vienas iš šio tikslo pasiekimo būdų yra gamybos plėtra, kuri reiškiasi gamybos masto didinimu. Atitinkamas gamybos masto dydis yra susijęs su tam tikra gamybos sąnaudų apimtimi ir jų struktūra, konkrečiu atveju koreguojamu kelionės sąnaudų pokyčio. Apibendrinus tai, kas aptarta, teigtina, kad mažėjanti kelionės kaina leidžia firmoms pasiekti geografiškai nutolusias rinkas ir joms pateikti naujų produktų. Pažymėtina, jog šis procesas stebimas tol, kol, kaip nurodo P. Rodrigue (2009), įmonės turi naudos iš mažėjančių kelionės sąnaudų.

Mažėjanti kelionės kaina, kaip įrodyta, leidžia prekių gamintojams ir (ar) pardavėjams prekes nugabenti toliau, taigi ir konkuruoti su tam tikro regiono gamintojais ar paslaugų teikėjais. Vartotojai taip pat turi naudos dviem požiūriais: dėl konkurencijos mažėja prekių kainos, rinkai siūlomas didesnis kiekis įvairesnių produktų. Ištyrus nagrinėjamo poveikio vertinimo metodus, nustatyta, jog dažnai poveikiui taikomi modifikuotos gamybos funkcijos, bendrosios pusiausvyros ir žemėnaudos modeliai, koreliacinės-regresinės, nekilnojamojo turto ir žemės kainų pokyčių analizės metodai. Atskirais atvejais taikomi kokybiniai daugiakriterinės analizės, interviu metodai. Kiekvienas iš jų leidžia vertinti gana siaurus nagrinėjamo poveikio aspektus. Konstatuota, kad vartotojų ir gamintojų laimėjimų išplėtojimą automobilių kelių infrastruktūrą diagnostika – vienas iš tikslesnių metodų, plačiau ir išsamiau nagrinėtų bei aprašytų J. Brocker (2000). Metodologiškai dalinės pusiausvyros modelį autorius pristato tokiu nuoseklumu. Išėities pozicija – prielaida, jog prekė transportuojama iš taško  $R$ , kur ji gaminama, į tašką  $P$ , kur ji vartojama. Šiuo tikslu užrašomos diferencialinės paklausos ir pasiūlos lygtys, kai jų elastingumai yra pastovūs. Esmė ta, kad taške  $P$  dėl transporto sąnaudų prekės kaina  $p$  gali padidėti iki dydžio, kuris žymimas, kur daugiklis  $\Delta$  aprašo kainos dėl transportavimo prieaugio dalį: pasiūlos ir paklausos pusiausvyros sąlyga gauta lygtis sprendžiama kainos  $p$  atžvilgiu, priskyrus jos parametrus konkrečias skaitines vertes. Nustačius, kad prekės kainos priklausomybė nuo transporto sąnaudų yra netiesinė, bet atlikus tam tikrus matematinius veiksmus, padaryta išvada, jog mažėjant transporto sąnaudoms, pirkėjo taške  $P$  kaina  $q$  mažėja, kas leidžia gamintojo taške  $R$  kainai  $p$  didėti. Tai naudinga ir gamintojui, ir pirkėjui. Todėl įvertinus realius kelionės sąnaudų pakitimus dėl automobilių kelių išplėtojimo, įmanoma empiriškai vertinti pastarosios funkcionalumą vartotojų ir gamintojų situacijos gerinimo prasme. Fiksuojant mažėjančių kelionės sąnaudų poveikį prekių ir paslaugų rinkos kainoms, vartotojo ir gamintojo naudą indikuojančio dalinės pusiausvyros modelio pagrindu atlikti tyrinėjimai metodologiškai išplėsti ir gauti toliau pateikiami rezultatai. Perviršiams rasti naudojamos atvirkštinės paklausos ir pasiūlos funkcijos, nustatant tokias vartotojo  $vp$  ir gamintojo  $gp$  perviršių funkcijas:

$$vp = \frac{\beta \left(\frac{\beta}{\alpha}\right)^{\frac{1-\gamma}{\mu+\gamma}} (1+\Delta)^{\frac{-\gamma(1+\mu)}{\mu+\gamma}}}{\gamma-1}; \quad gp = \frac{\alpha \left(\frac{\alpha}{\beta}\right)^{\frac{\mu+1}{\mu+\gamma}} (1+\Delta)^{\frac{-\gamma(1+\mu)}{\mu+\gamma}}}{\mu+1}$$

Straipsnio pabaigoje pateikiami tyrimo apibendrinimai, sukonkretinti skyruije „Išvados“. Tyrimo rezultatas: remiantis J. Brocker (2000) studija buvo sudaryta vartotojo ir gamintojo perviršių skaičiavimo metodika. Taikant šią metodiką, galima nustatyti, kaip keičiasi vartotojo ir gamintojo perviršiai keičiantis pasiūlai, paklausai ir transportavimo sąnaudoms, kai šia informacija yra disponuojama konkrečios prekės rinkoje.

Raktažodžiai: *automobilių kelias, infrastruktūra, sąnaudos, vartotojo ir gamintojo perteklius.*

The article has been reviewed.

Received in April, 2010; accepted in October, 2010.