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Macroeconomic Evaluation of Projects Regarding the Traffic Constructions and Equipment

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Abstract

This paper deals with the issue of macroeconomic evaluation of projects regarding the construction of traffic infrastructure and equipment. The objective of traffic infrastructure projects is to ensure the improvement of public welfare and decrease the negative impacts on the environment. Individual projects must be developed properly therefore the particular elements need to be analyzed in detail. In the paper, the evaluation of projects is made on the basis of comparing the costs on construction of the traffic infrastructure with benefits which the construction will bring, i.e. the macroeconomic aspects within the decision-making process regarding the investments need to be quantified on the basis of Cost – Benefit analysis.

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Keywords: macroeconomic evaluation; traffic construction; traffic equipment; methodological comparison.

1. Introduction

The evaluation of traffic infrastructure projects is focused on the welfare which will bring the traffic infrastructure; however, it is not the primary purpose of the traffic infrastructure project. Such welfare can be related, for example, to the energy savings as a consequence of quality improvement of infrastructure on which the traffic will be more fluent than within the original infrastructure [1].

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The main deliberation must be aimed at the macroeconomic evaluation of the traffic infrastructure projects which requires the comparison of all variants, which must be evaluated on the basis of the same key. Evaluation, quantification and determination of individual factors are divided consequently in the cases when the project will be and will not be implemented. Afterwards, the difference consists of evaluation of operating costs and costs related to the maintenance of infrastructure. It is impossible to evaluate the infrastructure in the category of highway with the village road with the same procedure, with using the same criteria. Even though the process is methodically the same, the results of the methodology will be biased considerably thanks to the possible range of evaluated criterion.

Generally, the evaluation of the infrastructural projects can be done on the basis of comparison of construction costs with positives which the construction will bring. It means to apply the Cost – Benefit analysis (CBA) [2].

In this analysis, there are not evaluated only the monetary impacts from the point of view of benefits and costs, but also the non-monetary impacts are taken into account. These are evaluated either by the conversion into the financial units (converted on the basis of the specific key), or on the basis of evaluation in set scale which must be used again for all evaluated alternatives in the same process [3].

The comparison and selection of traffic infrastructure projects, made on the basis of the macroeconomic evaluation, differ from the calculations made exclusively on the commercial basis. In macroeconomic evaluation, the externalities, in the positive and negative sense, are taken into consideration as well. If the objective data, found out on the basis of calculations, are not available within the evaluative process, the shadow prices are used. These are used for example for setting the accident costs, costs on medical help, etc. In the case that some payments are done via public budgets, indirect taxes, monopolistic competition, etc., such payments must be also taken into account referring to the form of support [3, 4].

2. Macroeconomic evaluation criteria

In relation to the macroeconomic evaluation of the projects which are under consideration, the following criteria should be evaluated and compared according to the individual variants [4, 5]:
Reduction (limitation) of transport costs

- Savings in fixed costs
- Savings in variable (operational) costs
- Changes in costs according to the modal split

Costs on the maintenance of traffic networks

- Costs on renewal and maintenance
- Periodical costs on the maintenance

Improvement of traffic safety
Improvement of accessibility (traffic infrastructure and access to it)
Space savings

- Regional economic benefits
- Regional structural benefits

Benefits from the perspective of impacts on the environment

- Limitation of traffic noise
- Limitation of emissions
- Limitation of separable costs
- Limitation of housing quality and communications

Evaluation procedure of individual projects and their variants is to be performed in a table for better transparency and for subsequent elaboration (see *Table 1*).

Table 1. Evaluation table of individual projects regarding the traffic infrastructure.

Project	number of project:	
A) Benefits of the project		Annual savings (mil. €)
Reduction (limitation) of transport costs (fixed and variable costs)		
Costs on the maintenance of traffic networks (renewal and maintenance, periodical costs on the maintenance)		
Improvement of traffic safety (limitation of the number of accidents, the number of dead persons)		
Improvement of accessibility (traffic infrastructure and access to it) (savings in travel time, …)		
Space savings (influence on the employment, structure of employment and other potential influences of the project)		
Benefits from the perspective of impacts on environment (limitations of traffic noise, decreasing the amount of emissions, decreasing the negative impacts on the water resources)		
Total benefit which will contribute to the project		
B) Project investment costs (building costs, costs on acquisition of land, insurance, costs on acoustic shielding, costs on lessening the negative impacts…)		
C) Total: difference between costs and benefits (B – A)		

3. Comparison of project impacts in time

The calculation of compared characteristic indexes, which are evaluated in the process, requires unified procedure for the assessment. Assessment must be realized in the same process by meeting the basic criteria. [6].

Base year - (it means to set a date to which the assessment of project costs and benefits will be performed (for example: assessment will be performed to year 2009)).

Price level - (it means to present a date to which the prices will be recounted (for example: price level of year 2008)).

Predicted period - (the evaluation impacts of traffic infrastructure project must be done for all variants identically (for example: assessment done till year 2015)).

Project lifetime (*see formula 1*) - (economic lifetime means the time when the traffic infrastructure is utilized. Information about expected lifetime is necessary for setting the gross benefit from infrastructural project. Expected project lifetime can be evaluated as an average lifetime of individual components (tunnels, the way itself, green vegetation, etc.)) [7].

$$a_n = \frac{\sum K_g \times a_g}{K} \quad \text{[years]} \tag{1}$$

where: a_n - average lifetime of the project [years], K_g - costs on the particular component to the given year [€], a_g - average lifetime of the component [years], K - total investment costs [€].

Construction time - (time necessary for the infrastructure construction. It is generally true, that the bigger construction project must be more exactly timely defined).

4. The proportion of benefits and costs

The proportion of benefits and costs, which is expressed in the formula 2, represents the rate of all benefits of project investments on all costs which will be required within the particular project implementation [8].

$$NKV = \frac{N_b}{K_b} \tag{2}$$

where: *NKV* - the proportion of benefits and costs, N_b - total value of all components which generate the benefit of the project [€], K_b - total value of all costs on the project [€].

In the case that the evaluated projects do not have the same construction time or the life time, the particular values must be re-calculated on one base. It means to express the benefits of the project to selected year.

If the above mentioned recalculation is not performed, it can be selected such variant that will have the higher benefit in absolute numbers, however, it will take more time. It can be obtained other comparative recalculations (the relative benefits of evaluated project in united period).

The development on the financial markets and development of economics, which determines the gross domestic product, must be taken into consideration as well. Projects investment can take into account the expected inflation rate and set the expected costs of the project implementation on its basis [9]. Forecasts regarding the development are not fulfilled in most of cases. It must be analyzed the situation when the resources are invested in other way than into the traffic infrastructure. Eventually, the individual variants when considering the different interest rates can be analyzed. So, it is necessary to take into account the discount rate.

If we want to obtain the current benefit of the project, we must discount the incoming revenues (*see formula 3*) [10]:

$$N_{b,i} = f \times N_i \text{ [€]}; \; f = (1+p)^{t_b - t_{a,i}} \tag{3}$$

where: $N_{b,I}$ - present value of the investment benefits *i* [€], *f* - discount factor, N_i - original (not discounted) value of the investment benefits [€], *p* - discount rate, t_b - base year for discounting, $t_{a,I}$ - year when the benefit of investment is discounted.

If the constant investment benefits for entire lifetime are expected, the calculation will be performed according to the *formula 4* [10]:

$$N_{b,j} = f \times B \times N_j \text{ [€]}; B = \frac{1-(1+p)^t}{p} \tag{4}$$

where: $N_{b,j}$ - present value of the investment benefits *j* [€], *f* - discount factor which takes into account the time difference between the operation beginning and base year to which the investment is evaluated, *B* - capitalization factor, N_j - value of average benefit of the project in year j [€], *t* - number of years with the constant investment benefits.

We can accomplish the investment costs discounting using the discount factor (*see formula 5)* [4]:

$$K_{b,i} = f \times K_i \text{ [€]}; \; f = (1+p)^{t_b - t_{a,i}} \tag{5}$$

where: $K_{b,I}$ - present value of cost item [€], *f* - discount factor, K_i - evaluation of cost items in current year [€], *p* - discount rate, t_b - base year, $t_{a,I}$ - year when the cost item is discounted.

If the information about the distribution of costs during the construction process is not available, it is expected their unified distribution. Subsequently, the calculation of current costs is performed according to the next *formula 6* [4]:

$$K_b = f \times B \times K_j \text{ [€]}; B = \frac{1-(1+p)^t}{p} \tag{6}$$

where: K_b - current value of investment costs [€], *f* - discount factor (between the time point of the investment beginning and base year), *B* - capitalization factor, K_j - the value of average investment costs during the construction process [€], *t* - construction time.

Realized analysis expresses the way of handling with the resources on the construction process. The current value of investment benefits and current value of costs on the project are obtained for the evaluation.

5. Difference between the cost and revenues

Next evaluative criterion is the difference between the costs and revenues. The criterion compares the total discounted revenues resulting from the project with the total discounted costs which must be expended within the project realization. The criterion is relative to the base year and is expressed by *formula 7* [6]:

$$NKD = N_b - K_b \text{ [€]} \tag{7}$$

where: N_b - total current revenues of the project [€], K_b - total current costs on the project [€].

In the case that the costs and revenues are expressed in particular years, the criterion value for each year using the capitalization coefficient is calculated according to the *formula 8* [6]:

$$NKD_j = N_b \times \frac{1}{B} - K_b \times \frac{1}{B} \text{ [€]} \tag{8}$$

where: NKD_j - annual difference between the costs and revenues [€], B - capitalization factor.

6. Supplementary Evaluative criteria

Among the supplementary evaluative criteria, the following criteria within the evaluation of the traffic infrastructure projects are to be considered [11]: ecological evaluation (evaluation of the risks on the environment impact) - CBA, evaluation of urban development - CBA, additional (specific) evaluative criteria.

The factors, which are not moneywise expressible, but represent the important foundation for development of infrastructure and consequently the development of economy, play the significant role within the issues regarding the landscape planning. These factors include: approach to the systems of combined transport, connection to the neighbouring countries in Europe, approach to other important traffic junctions (airports, harbours, etc.).

7. Evaluation of variants of road traffic infrastructure construction

The following table (Table 2) is generally utilized for projects evaluation including all kinds of road infrastructure buildings. The specific type of construction needs to be specified in part X of the *Table 2*. In general, the road traffic infrastructure development is divided within the methodology into [12 - 14]:

- construction of the new road traffic infrastructure (A)
- reconstruction of existing road traffic infrastructure (2 traffic lanes) (B)
- reconstruction of existing road (4 traffic lanes) (C)
- reconstruction - increasing the capacity (from 2 to 4 traffic lanes) (D).

8. Conclusion

From the foregoing, it is necessary to transform all the project impacts on the financial expression which are not related directly to the economic categories (for example: improvements in social field which originates from the infrastructure construction).

Decision-making process about the investment including the macroeconomic aspects must be realized on the basis of the Cost – Benefit analysis. Obtained results (values) need to be summarized in the following way [16-17]:

- evaluation is performed for all investment projects,
- especially, it should be pointed out to the insufficiency in budgets,
- it must be stated the choice of rationalization.

Simple list of obtained values does not have appropriate predictive ability. It is not possible to obtain the objective overview of compared variants by comparison of absolute numbers. That is the reason, why it is necessary to evaluate the variants using the coefficients which express the relative relations of individual indicators. Subsequently, it is possible to determine the sequence of the variants [18-22].

Table 2. Methodical comparison of variants of road traffic infrastructure construction.

Kind of work		Flat terrain	Hilly terrain	Mountainous terrain	Flat terrain	Hilly terrain
		Outside urban (residential) area			Urban area	
X) A; B; C; D	**Unit**	**€**	**€**	**€**	**€**	**€**
Land occupation	km^2					
Roadway (own surface)	km					
Road materials	Type *					
Earthwork (landscaping, retaining walls, grooved walls, ...)	km					
Median strip of the road	km					
Level crossing (+ Roundabouts)	buildings					
Interchanges	buildings					
Crossings (+ flyovers, underpasses)	buildings					
Traffic signs (horizontal)	km					
Traffic signs (light)	pcs					
Traffic signs (vertical)	pcs					
Bridges	km					
Tunnels	km					
Safety measures (sounds...)	pcs					
Safety measures (barriers)	km					
Lighting	pcs/km					
Modification of water flows	buildings					
Technical background	buildings					
Design and supervision	%					

*/ Road materials: bitumen, asphalt concrete, concrete.

CBA - costs (infrastructure construction)	km
CBA - benefits (infrastructure construction)	km
construction time	months

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