MODEL FOR ASSESSMENT OF EXTERNAL TRANSPORT COSTS

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Abstract

The term "external effect" can be explain as a condition that occurs when production or consumption activities of an entity affect the welfare of other(s) subject(s) without having to pay compensation for that impact. The major difficulty for determining external costs is that they cannot be confirmed through the application of market laws and well-known market analysis with interactive effects of demand and supply. The transport greatly affects the quality of life of people, flora and fauna. The interest of studying transport externalities is objective of several researches and special attention is given to how reduce these negative externalities of transport in practice. This paper considers the external transport costs, their significance and their monetary values estimated in relevant EU studies. The methodology for estimating external transport costs as well as specification of a model for assessment of these costs in Republic of North Macedonia is also shown in this paper. The results obtained by this model are discussed and commented.

Keywords: external transport costs, assessment, passenger and freight transport

1 Introduction

The external costs, or negative externalities, are such type of costs when the economic activities of one social or economic entity affect the welfare of other(s) subject(s) or persons without having to pay compensation for that impact. The estimation of these costs is very difficult that they are not market costs and they cannot be determined through the application of market analyses with interactive effects of demand and supply. Transport activities cause external costs that are not directly assumed and paid by transport users but they have an effect on the immediate environment. These costs are submitted by other persons not directly involved in the transport. However, the external costs of transport need to be estimated and expressed in monetary values as well as other costs and benefits in rank to be included in the cost-benefit analyses. This paper will consider the external costs of transport, their significance and their monetary value. EU recommendations and estimations of these external transport costs are the starting point for their assessment in Republic of North Macedonia.

2 Previous studies and relevant documents

2.1 Previous studies

The International Union of Railways (UIC) is a pioneer in the study and evaluation of external cost of transport in European countries presenting assessments of rail, road, air transport and inland waterways [1]. In 2012, UIC publishes the document Green Transport, Reducing External Costs [2]. The methodology for monetary expression of external cost of transport in this paper uses an approach to determine the value of non-market goods.

The study developed in the HEATCO project under the 6th EU Framework Program 2002-2006 for harmonization of European practices in the estimation of transport costs and project assessment, pays particular attention to estimation of the external cost of transport in the EU countries [3], [4].

Internationalization of External Transport Costs is presented in a study funded by the European Commission, developed by CE Delft and published in the 2008Handbook [5]. This study is a follow-up to the 2006 HEATCO study. The update of this study is carried out in 2011 "to obtain a state-of-art overview of the total, average and marginal external costs of transport in the EU" [6]. The previous Handbook was updated also in 2014 version taking in account new input values [7]. The last edition of the Handbook of the external costs of transport is published in version 2019 by European Commission [8].

2.2 Categories of external cost of transport

The external costs of transport frequently assessed in the previous studies and published Handbooks concern the following five core cost categories: Traffic Accidents, Air pollution, Climate change, Noise and Congestion. External costs of transport are estimated for four modes of transport and they are separated for passenger and freight transport. The four modes of transport are following:
• Railway transport for passenger and freight and for diesel and electric engine of traction.
• Road transport for passenger: cars, buses and coaches and motorbikes/mopeds; Road transport for freight: light vehicles (LDV), heavy vehicles (HDV).
• Air transport for passenger.
• Inland waterways for freight transport.

The most important impact for estimation of external costs of transport has the road transport sector, because it is responsible for the majority of external costs.

2.3 Methodology used for assessment of external transport costs in relevant studies

The estimation of external costs includes several uncertainties, but there is a wide consensus for methodological approach for their assessment. The costs of environmental transport activities cover a wide range of different impacts, including the diverse effects of emissions of a large number of pollutants that have an effect on the human health, materials, ecosystems, flora and fauna. Impacts appear at local, regional, European and global levels. The damages caused by transport activities could be prolonged in future. External costs of transport vary considerably with the characteristics of vehicles, trains, boats or aircraft. HEATCO's scientific research project uses an approach called "Impact Pathway Approach" based on damage cost. Using the concepts of welfare economics, monetary assessment follows the "willingness to pay" approach for valuation of the respective health effects and improving the quality of the environment.

The best practice estimation of congestion costs is based on speed- flow relations, value of time and demand elasticity. For example, the procedure for calculating external costs of transport from air pollution is following:

- Quantification of changes in the emission of pollutants (NOx, SO2, PM2.5/PM10) resulting from the project studied (the project being evaluated) and expressed in tonnes, using the latest national or European emission factors. The future progress of these programs should also be taken into account.
- Classification of emissions according to the amount of emission (near ground surface or high) and local environment (urban - out of urban areas).
- Impact calculation - years of life lost (YOLL) and costs per pollutant.
- Impact Report (YOLL) and Costs.

Parameters to consider for exposure to the population are: emission source size, location - urban and outdoor, location within Europe.

3 Model for assessment of external costs of transport in Republic of North Macedonia

The model for calculating external costs of transport in Republic of North Macedonia is specified according to the methodology and recommendations in previous EU studies and can be presented as follows:

1. Estimation of unit value for external costs of transport by type of externality in a given year:

$$ET_{MYi} = ET_{FUY0} \cdot PPP_{MY0} \cdot A_{GDPRZi} \qquad (1)$$

ET_{MYi} – unit value of external cost of transport for a given externality in Republic of North Macedonia in year Y_i

ET_{EUY0} – unit value of external cost of transport for a given externality estimated as EU average in year Y_0

PPP_{MY0} – purchasing power parity indicator in Republic of North Macedonia in relation to the EU in year Y_0 (that indicator is 100 % for the EU)

A_{GDPRYi} – average annual growth of gross domestic product in Republic of North Macedonia between years Y_0 and Y

$$A_{GDPRYi} = (1 + p)^i \qquad (2)$$

p – average GDP growth rate between years Y_i and Y_0
i – number of years between Y_i and Y_0

2. Estimation of emission quantities of externalities that depend on the transport operation, type of vehicles and their engines, the location of the infrastructure, other geographical and time factors. These estimated quantities can be expressed by the following equation:

$$QE_{MYi} = \sum Q \cdot E_{MYi,v,s} \qquad (3)$$

QE_{MYi} – quantities for a given externality of transport in Republic of North Macedonia in year Y_i

$QE_{MYi,v,s}$ – quantities for a given externality of transport in Republic of North Macedonia in year Y_i obtained from different transport activities, different vehicles and in specific spatial conditions.

3. Estimation of the total external cost of transport for a given externality can be expressed by the following equation:

$$CE_{MYi} = ET_{MYi} \cdot QE_{MYi} \qquad (4)$$

CE_{MYi} – total external cost of transport for a given externality in Republic of North Macedonia for year Y_i

ET_{MYi} – unit value of external cost of transport for a given externality in Republic of North Macedonia in year Y_i

QE_{MYi} – quantities for a given externality of transport in Republic of North Macedonia in year Y_i.

4 Estimation of external cost of road transport

4.1 Specific data used in the model

The model presented above needs data concerning the unit values of external costs of transport expressed as average values for EU countries. These data areextracted from the RICARDO-AEA study [7] on specific vehicle types and on urban, suburban and rural environments and refer to year 2010. The unit values of external costs of transport are estimated in €ct/v. km for the following types of vehicles:
• Diesel and petrol cars in European emission standards Euro 0 to Euro 6,
• Buses in European emission standards from Euro 0 to Euro 6,
• Trucks in European emission standards from Euro 0 to Euro 6.

The unit values of external transport costs are adjusted for Republic of North Macedonia using the purchasing power indicator published by Eurostat. According to this indicator (Purchasing Power Standards) Republic of North Macedonia in 2010 was 34 % of the EU-28 average.

To estimate the unit values of external transport costs in a given year different of 2010 they should be weighted also by the average growth rate of GDP from year 2010 to the year of analysis. The assessments in this paper are made for 2015. The average GDP growth in the period 2010-2015 in Republic of North Macedonia is 2.54 %, according to the official data published by State Statistical Office (SSO).

The estimation of quantities of harmful emissions can be made using SSO data for the type of vehicle registered in the country. In addition to these data, it is also necessary to have data on average annual kilometres travelled by type of vehicle and the area of impact separated of urban, suburban or rural places. Some of these data have been estimated from their own studies, and some have been obtained by processing data from SSO.

Data of average annual kilometres travelled by cars on urban, suburban and rural roads and highways do not exist. Since such data are not available, we made assumption that cars travel an average 10000 km/year, of which 70 % are on urban roads and 30 % on suburban, rural roads and highways.

The SSO [9] Publication Transport and Other Services shows that in 2015 on average one bus travelled 79000 km. It is assumed that 70 % of them are made in urban areas, 20 % in suburban areas, and 10 % in highways and rural areas.

The same SSO publication states that trucks in total in 2015 had 860 million kilometres. Assuming that in the same year there were 33237 registered trucks and on average in 2015 one truck travels 25875 km. It is assumed that 30 % of trucks travel distances in urban areas, 20 % in suburban areas, and 50 % in rural areas and highways.

The number of registered vehicles in 2015 in the country is 451724 vehicles. The vehicle flat is very old and the average age of cars is 18.7 years, for buses 18.1 years and for trucks 15.5 years. In 2015 half of the passenger cars and buses have European emission standards with high emissions of harmful substances Euro 0, Euro 1 and Euro 2 (figure 1).

Concerning fuel consumption of motor vehicles, according to SSO data,the 53 % of passenger cars use petrol and 47 % of cars use diesel (table 1).
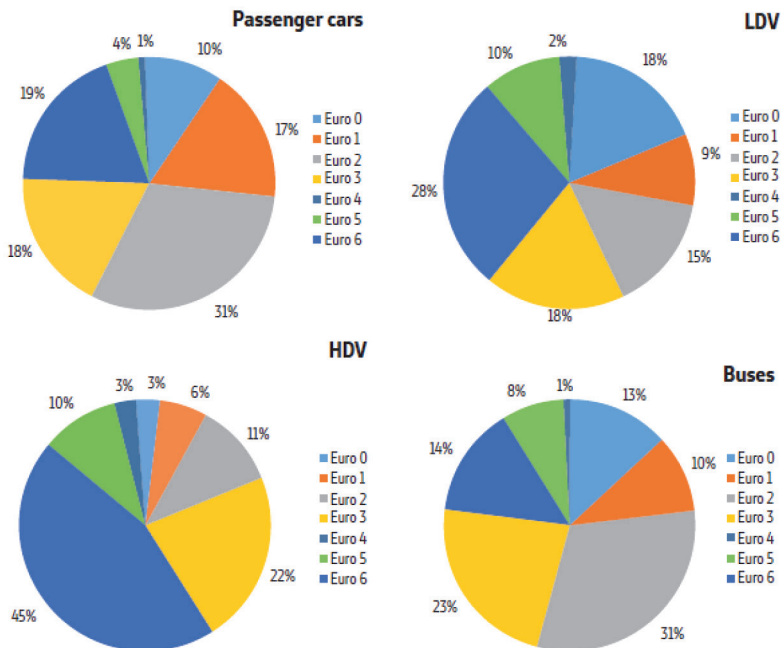

Figure 1   Share of types of vehicles in Euro 0 to Euro 6 emission standards in 2015 in Republic of North Macedonia

Table 1   Number of registred motor vehicles in road transport per type of vehicle and Euro class of motor engines in 2015 in Republic of North Macedonia

Euro Class	Number of cars petrol	Number of cars diesel	Number of trucks	Number of buses
Euro 0	20 150	18 127	997	422
Euro 1	34 256	30 817	1 994	324
Euro 2	62 466	56 195	3 656	1 005
Euro 3	36 271	32 629	7 312	746
Euro 4	38 286	34 442	14 957	454
Euro 5	8 060	7 251	3 324	259
Euro 6	2 015	1 813	997	32
TOTAL	201 504	181 274	33 237	3 242

4.2 Estimations achieved by the model

According to the above assumptions and described model, the estimations of the external transport costs of road transport from air pollution are as follows (table 2):

Table 2   Estimated external costs of road transport from air pollution in Republic of North Macedonia in 2015 in millions of euros

Euro Class	Cars		Buses			Trucks		
	Petrol	Diesel	Urban	Suburban	Rural + highway	Urban	Suburban	Rural + highway
Euro 0	2.70	5.39	3.16	0.54	0.17	1.07	0.45	0.72
Euro 1	1.17	3.45	1.57	0.28	0.09	1.54	0.62	0.99
Euro 2	1.34	5.82	3.95	0.82	0.28	2.23	1.06	1.80
Euro 3	0.45	2.66	2.57	0.51	0.16	3.66	1.71	2.83
Euro 4	0.48	1.94	0.88	0.20	0.07	4.23	2.25	3.95
Euro 5	0.10	0.22	0.44	0.10	0.02	0.65	0.30	0.38
Euro 6	0.02	0.04	0.02	0.00	0.00	0.06	0.01	0.02
Total	6.3	19.5	12.6	2.4	0.8	13.4	6.4	10.7

The estimated external costs of road transport only from air pollution are 72.2 million EUR in 2015.
The external costs of road transport from noise pollution are assessed of 48.7 million EUR in 2015.
The estimated external cost of road transport for climate change in the country is 59.1 million EUR for 2015.
Other external cost of road transport as costs of traffic accidents and traffic congestion are not assessed.

4.3 Comments of estimated results

External costs of road transport from air pollution in urban areas are predominant. Particularly high are external transport costs produced by diesel cars that are in European emission standards Euro 0, Euro 1, Euro 2 or manufactured until 2004. About 50 % of passenger cars and buses have EU standards with high emissions of harmful substances.
About 64 % of external transport costs of road transport from noise pollution are appeared in urban area from car traffic.
Estimations of external costs of transport in EU countries plus Norway and Switzerland in 2008, account about 4 % of these countries' GDP. If we apply the same percentage to Republic of North Macedonia with a GDP of 9072 million EUR in 2015, then the total external costs after this calculation is about EUR 363 million EUR.

5 Conclusion

The official data for transport collected by SSO are not appropriated for estimation of external costs of transport. The new methodology of data collection should be involved in the future to produce solid data for estimation of external transport costs.

The external costs of road transport are predominant in urban areas comparing with rural regions and highways. The very old vehicle fleet in the country and large presence of vehicles in Euro 0, Euro 1 and Euro 2 classes contribute significantly to air pollution. The transport policies have to provide state aid to citizens and transport operators for renewal of vehicles and usage of more environmental friendly cars, buses and trucks.

The external costs of rail transport are not assessed in this paper, but the UIC estimation for 2008 [2] in the 27 EU countries notes that these cost are only 2 % of total external costs of transport. Development of inter modality and favour of rail transport can also contribute to decrease external costs of transport.

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