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Estimating Global Warming External Costs Due to Road Transportation in Iran (Case study: Expressways)

Mahmoud Ameri[1], Fatemeh Zahed[*2]

1- Associate professor of Iran university of science and technology and head of transportation research institute
2- Instructor of transportation research institute and manager of research affairs, TRI

Abstract

After power stations, transportation section, especially road traffic, is known as the most important cause of climate change. In the transportation literature these costs, known as the external costs, are not paid by people who cause them. Conversely, based on the economic welfare theory, any cost that takes place in society must be paid by people who cause it. So these costs must be recognized to be converted into the monetary value. The values, then, must be taken by charges or other ways taxes.

In Iran, there is no research that relates to the issue of external cost of climate change. Therefore, there is no monetary value of climate change costs due to road transportation in Iran yet. In this paper, this research gap is considered and a mathematical model is used to estimate the mentioned costs. The results are obtained for different vehicles in road transportation including car, mini bus, bus, truck and other vehicles. The model is run for freeways in Iran. The results of the model indicate that external costs of global warming are 10.3, 31.3, 94, 94 and 135.8 Rials for 1 Km mileage of each passenger car & pickup, mini bus & light truck, two and three axle trucks, bus and heavy trucks, respectively. Annual external cost of CO_2 emission in freeways is also approximately 360 billion Rials, 30% of which is the contribution of heavy trucks, passenger cars & pickup take the second place with the share of 25%. The results of this paper can certainly help the policymakers to make good, precise and fair decisions related to the charges of road transportation.

Introduction

Road transportation, primarily, due to its unique characteristics have a special position among various transportation modes. Road transportation is the most available and easy to use mode of transport in Iran. But the transportation has negative impacts too. Road transportation activity imposes external costs such as air pollution costs, noise costs, climate change costs and etc. What should be considered in external costs is that the contribution of the road transport, as international studies show, is around 92% of total external costs of the transport sector. Climate change or global warming is one of the major threats to humanity in the 21th century. After energy section, transportation section especially road transportation, is known as the most important cause of climate change. In the transportation literature these costs, known as the external costs, are not paid by people who cause them. Conversely, based on the economic welfare theory, any cost that takes place in society must be paid by people who cause it. These costs cause loss of a considerable amount of public resources. For example, the external costs for 17 European countries for year 1995 have been around 975 billion dollars. This costs has been estimated around 600 billion dollars for US in 1989. So, these costs must be recognized to be converted into monetary value and then these costs must be taken by charges or other ways of road pricing. This paper is based on a theoretical-practical research which deals with one of the major challenges of the present transportation by employing quantitative techniques and statistical and econometrics models.

Methods

In Iran, there is no research that relates to an issue of external cost of climate change. Therefore, there is no monetary value of climate change costs in Iran yet. Unfortunately, the government is not attentive to external costs; although the topic has been highlighted in recent years and some studies have been conducted regarding the subject. Yet, these costs are not considered in economical transactions. In this paper, this research gap is considered and a mathematical model is used to estimate the costs of climate change. The results are obtained for

different vehicles in road transportation including passenger car and pickup, mini bus, bus, two and three axles truck and heavy truck. The model is run for Expressways in Iran and results are demonstrated. Estimation of some of the parameters existing in the model would take a long time and require a much budget. So, these parameters were extracted from the literature. To estimate the global warming costs, a simple model from GRACE project has been adopted. Table 1 shows more details of the mentioned model.

Table 1. The model for Estimating costs of global warming

Model Name	Estimating costs of global warming		
Model	$C_{GW} = \sum (EF_{dir}(m,v,g,l) \times DF_{dir}(m,g) + FC(m,v,f,l) \times DF_{FP}(m,f))$		
	Variable	Description	Unit/Comment
Variables	C_{GW}	Cost of global warming due to greenhouse gases	Monetary unit per vehicle
	EF_{dir}	factor-Direct emission	Gram per 1 KM-Vehicle
	DF_{dir}	Damage factor-Direct emission	Monetary unit/gram
	FC	Fuel consumption factor	gram per 1 KM-Vehicle
	DF_{FP}	Damage factor-fuel production	monetary unit/gram
	m	Transportation mode	Road, Rail, …
	v	Technology of Vehicles	Fuel type, environmental standards
	g	Greenhouse gas	CO_2
	l	Place	Urban/Rural
	f	Fuel type	Gasoline, Gasoil, …

The required data for this model has been prepared. These data items include price of 1 tone of Co_2, amount of Co_2 released by each vehicle type and amount of Co_2 released from fuel production.

External costs of global warming are estimated for expressway network of Iran based on the model presented in previous paragraph and in Table 1. The first step of this phase is to select a representative sample of Iran's expressways. Totally 13 expressways were selected. It was tried to select a sample representative of Iran's expressway network to facilitate generalization of the results. In the next step, a lot of information regarding the selected roads (including length of road, daily traffic volume, statistics of vehicle types, and etc.) from different data sources has been collected, aiming at using this information in appropriately in the model. In addition, vehicles have been classified in five main classes. After gathering the required information, the model was employed and the external costs of global warming have been estimated corresponding to different types of vehicles.

Discussion and Conclusions

Table 2 shows the average global warming external cost of 1 KM mileage of each vehicle type.

Table 2. Average global warming external costs of 1 KM mileage of each vehicle type(RIAL)

	Vehicle types				
	Passenger car and Pickups	Minibus and light trucks	Two and three axle trucks	Bus	Heavy trucks (>3 axle)
Expressway	10.3	31.3	94	94	135.8

The values in above table have a straightforward interpretation. As an example, a user of passenger car or a pickup must pay 10.3 Rials passing 1 KM of expressway as a compensation of global warming external costs. This value is 135.8 and 94 for heavy trucks and buses, respectively.

The results indicate that annual external cost of co2 emission in Expressways is approximately 360 billion Rials, 30% of which is the contribution of heavy trucks with more than 3 axles followed by passenger cars and pickups with the share of 25%.

The considerable amount of these external costs is a good index to realize the importance of external costs of Iran's road transport. It should be noted that these costs are different from many non-monetary effects which external costs impose to society. This involves careful attention of governors and macro-level decision makers to external costs and their issues to provide appropriate solutions to reduce or internalize these costs. *www.SID.ir*

It should be noted that the main and most important solution to reduce and manage external costs is road

pricing and charging road users. The experience of this solution in the world has shown that besides reducing external costs, a considerable financial resources is gathered from user charging, which can be used in more transportation infrastructure developments.

The results of this paper can certainly help the policymakers to make good, precise and fair decisions related to the charges of road transportation.

Keywords: climate change, CO_2, external cost, greenhouse gas, road transportation.