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SIMULATIONS FOR INCLUDING THE ENVIRONMENTAL TAX IN MOTOR LIABILITY INSURANCE

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Abstract

Nowadays, all over the world, the car transport sector is one of the main factors responsible for the Greenhouse Gas Emissions. The current systems of emission taxation do not take into consideration the distance travelled by cars; therefore, they are not fully compliant with the "polluter pays" principle. In addition to the produced inequality, these systems do not encourage the reduction of the distances travelled annually (with possible favorable effects on pollution and traffic). Some academic studies have targeted the issue of introducing taxation based on the number of travelled kilometers in the motor insurance in developed countries (USA, Canada, Western European countries). Our study evaluates the feasibility of introducing this system in an emerging market (Romania). Using Monte Carlo simulations, the results show that the total tax, which includes insurance and environmental tax, may have financial sustainable values for the population. The average value of the new tax would be 160 Euros (3.7% of the annual average wage) and 80% of the cars would be taxed between 100 Euros and 239 Euros. We also discuss the obstacles in implementing this tax, respectively, the process of monitoring the distance travelled by cars.

Key words: environmental tax, European emission standards, greenhouse gas, motor liability insurance

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1. Introduction

The international environmental negotiations - Petrescu and Ozunu (2008) - have become very important in a period in which global warming was intensified by the emissions of carbon monoxide (CO), carbon dioxide CO_2 (which is the leading greenhouse gas GHG) and nitrogen oxides (NO). Nordhouse and Boyer (2000) estimated the global consequences of a 2.5^o C warming at almost 2% of world GDP. This awareness of future damages caused by global warming leads to diminishing the consequences of the climate change.

Road transportation represents an important factor responsible for polluting the environment to a significant degree (Mitran et al., 2012). The sector is responsible for approximately 15% of overall GHG emissions (OECD/ITF, 2010).

Concerning road transportation, previous studies (Parry et al., 2007) identified three methods to protect the environment: a) reduction of vehicle miles travelled (VMT), b) improvement of fuel consumption efficiency and c) lower exhaust emissions per gallon of fuel combustion. The last two methods are purely technical, while the first one implies an economic and legal system of right incentives. Parry et al. (2007) argue that a gasoline tax alone is inappropriate, since it does not stimulate the aimed behavioral responses.

At European level, Kunert and Kuhfeld (2007) analyzed the overall structure of the passenger car

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taxation. They emphasized the necessity to simplify the tax systems due to the fact that the transport sector should contribute more to environmental protection. Ryan et al. (2009) showed on a panel of 15 EU countries that national fuel taxes influenced the sales of passenger cars and the intensity of CO_2 emissions.

Proost and Van Dender (2001) have considered other pertinent options for road transportation in order to protect the environment: fuel efficiency regulation and increase of fuel taxes. Crowford and Smith (1995) and Sipes and Mendelsohn (2001) demonstrated that only high taxes have visible effects on GHG emissions. As a consequence, even if gasoline taxes are regressive in relation to consumers' income (Poterba, 1991), those concerned with global warming will make pressures for setting higher fuel taxes. Another solution, which also has low public support, could be to apply an annual tax to higher polluting vehicles (Krupnick et al., 2001).

Hickson (2006) strongly supports the idea of using taxes for reducing the polluting emissions from automobiles. His reasoning considers the emissions as 'external diseconomies' generated by a private consumption. The CO_2 emission is produced by the entire population, thus market regulation by means of an offer-demand mechanism among all participants is not possible. Therefore the solution of state intervention through taxation is preferred.

Hickson (2006) considered the GHG emissions as a risk like any other risk insured either for the property or for the liability of motor vehicles. "The insurer acts as a tax collector for the government, in a manner similar to the current collection of premium taxes. This approach results in higher costs for major risk classes that produce higher GHG emissions" (Hickson, 2006).

Bordoff and Noel (2008) estimated that by introducing a pay-as-you-drive – PAYD – insurance system, the number of travelled miles would decrease by 8%, CO_2 emissions, by 2% and fuel consumption by 4%. The pay-as-you-drive insurance assumes that a person's insurance payment varies in direct proportion to annual VMT (vehicle miles travelled) by car owners and the vehicle's relative risk factor – Parry et al. (2007). The Maryland Commission of Climate Change (2008) considers PAYD insurance as one of the most powerful instruments for reducing the GHG emissions associated to road transportation. Litman (2011) analyzed the costs and benefits of distance based vehicle insurance. He concluded that this system is feasible and reduces insurance costs, vehicle crashes, traffic congestion and environmental pollution.

Treating the environmental risk as a component of motor liability insurance has advantages for governments, insurance companies, environment, and car owners (Greenberg, 2009):

- for the governmental budget: the amounts collected to the budget from the environmental tax are more predictable;
- for environment: the amounts paid for the motor insurance depend on the number of driven kilometers, so that the drivers are motivated to travel less, which leads to reducing the emissions of GHG;
- for car owners: decreasing number of accidents and traffic congestions - Bordoff and Noel (2008); the possibility of paying low premiums as a consequence of not using the cars excessively.

Certain studies cited before investigate the matter of introducing the environmental risk as a component of motor insurance. In most cases, we have a theoretical and descriptive approach of this topic. Yet, there are applications for the developed regions or countries: United States of America, Canada and the European countries from the Euro zone. National specificities (such as the legislative framework, the volume and structure of the car fleet and the concern of the authorities for environment protection) entail the separate approach of such an issue.

Our article discusses the advantages and disadvantages of treating the environmental risk as part of the mandatory motor insurance for an emerging market (Romania). After a description of the existing system for protecting the environment against the pollution generated by cars, we accomplish a simulation of the tax level that should be paid by the car owners. We also discuss the current technical and legal obstacles for implementing such a system, as well as the financial affordability of the population for such a cost.

2. Case study

In Romania, the issue of environment protection against polluting emissions from cars came into legislation only in 2007, with the European Union accession. So far, the taxation of cars for polluting emissions has been done in two successive systems.

In the period 2007-2012, the tax had different names and methods of calculation. Initially it was called 'special tax of first registration' and was calculated in accordance with the engine capacity, the emissions standards and the age of the car. The contributions were transferred to the State Budget. In 2008, it was re-named 'tax for pollution from cars' and for clarifying its purpose the collected receipts were transferred to an Environmental Fund for financing several programs for environmental protection. The CO_2 emissions were introduced in the formula. Regardless of the name or formula, the unique tax was imposed at the first registration of the car in the country (the cars being either new or second-hand).

Starting with the year 2013, the compulsoriness of paying an environment stamp was set up. Its value depends on the engine capacity, the age of the car and the European emissions standards. This tax is imposed when purchasing a car, regardless of its being registered or not on the national territory. Apparently, these regulations have

the role of ensuring a better equity of the tax compared to the previous taxation system.

Both systems promote a false environment tax. In reality, none of them incites the decrease of pollution for the car fleet, the 'polluter pays' principle being distorted. According to the two taxation methods, if an automobile covers 2000 km/ year or 30000 km/year the tax is identical.

For the moment, in Romania the tax vehicle system does not offer the motivation to reduce the number of driven kilometers. According to the Ecopolis study (Todor, 2011), Romania is the country with the lowest receipts for environmental taxes at European Union level. The annual budgetary target of 450 million Euros for all types of vehicles (340 million Euros for cars) representing receipts for vehicle first registration taxes and for environmental taxes was never achieved. In the period 2009-2012, the total receipts reached only 1.02 billion Euros. This is the result of a drastic drop in the number of new car registrations when the vehicle tax has grown. Another significant phenomenon is tax evasion. There is an important number of cars registered in other countries in order to avoid the payment of the first registration tax. By including the environmental component in the mandatory motor liability insurance, the payment of the tax could not be avoided through this behavior.

If we consider the European legislation, we ascertain that the motor vehicle registration tax is not harmonized, risking double taxation for citizens and the fragmentation of the Single Market (Terra and Wattel, 2012). This is the reason why the European Commission intends to replace the motor vehicle registration tax with a polluting tax on vehicle use.

In the context of the budgetary crisis and of the European Union recommendations for hardening pollution taxation, the increase in the environmental tax collection represents a priority for Romania (Todor, 2011).

A fair and efficient system must comply with the following requirements:

- to fairly respect the "polluter pays" principle, respectively taxation proportional or progressive to the quantity of produced polluting emissions;
- to be bearable by the population (economic feasibility);
- to ensure a better collection to the State Budget, with fewer possibilities of tax evasion.

Such a system can be built up by introducing this tax into the motor insurances. Particularly, in Romania there exist two types of motor insurances: *the Liability Motor Insurance*, which compensates the losses caused to a third party (automobile) and *the Property Motor Insurance*, which compensates for the losses of the owned automobile. Since only the liability motor insurance is mandatory, it is best suited to embed the environmental risk. In addition, collection can be outsourced through insurance agencies.

In order to perform our research, we have relied on data from various governmental and non-governmental sources. Data needed for the estimations in our study were collected from:

- RAR – Romanian Automobile Register;
- Ministry of Administration and Interior – Directorate for Driving Licenses and Vehicle Registration Certificates (http://www.mai.gov.ro);
- ISC – Insurance Supervision Commission;
- Capital Journal (2012) – estimations of the number of driven kilometers (http://www.capital.ro);
- Mobile.ro (2012) - website regarding car selling advertisements (http://www.mobile.ro).

Based on this data and using the Monte Carlo simulations, we estimate a sample of 10000 cars. The Monte Carlo method is widely applied in many problems arising in economy, biology, environment, where the decisions are based on random or stochastic processes. In order to generate a sample of a certain distribution *X*, we follow the steps:

1. Based on the experimental samples we determine the parameters of each distribution:

- LogNormal (1704, 550) for the engine capacity of gasoline cars. *A priori*, the values of the distribution vary from $-\infty$ to ∞, eliminating 10% of the values (the extreme ones).
- LogNormal (2026, 632) for the engine capacity of diesel cars. We also eliminate the extreme values.
- LogNormal (1000, 4600) for the number of kilometres driven annually for an automobile. We eliminate here the extreme values.
- A discrete, empirical distribution for the European emission standards of the engine (see fig. 1) for the distribution frequencies.

2. We generate a uniformly distributed random number *u* on the interval (0, 1) in Matlab.

3. We generate a random number having the distribution function *F* using the uniformly distributed random number *u*. We can do this by using the inversion method, i.e. $x = F^{-1}(u)$ is a random number having the *X* distribution. Thus, we achieve the volume of the Monte Carlo samples needed from the *X* distribution.

Considering the characteristics of each simulated car, we calculate the tax included in the Motor Liability insurances.

The general principle for constructing the new proposed cost is that it contains both the insurance premium and the environment tax. Therefore, we estimate the value of those two components based on the existing statistics for the national car fleet and the budgetary collection policy.

Consequently, for simulating the final distribution of the tax values compared to the existing cars, we use the distributions of some variables which characterize the registered cars: the European emission standards, the number of driven kilometers, the type of the engine and the engine capacity. The study limits to cars, but it can be generalized for other vehicle categories: motor-cycles, minibus, bus, trucks etc. According to RAR, the number of registered cars in Romania is 4.3

million. The following information has been retrieved from the mentioned data sources:

- The aggregate volume of annual gross written premiums for the motor liability insurance (only cars): approx. 340 million Euros;
- The budgetary target concerning the receipts for the first registration tax and for the environmental tax: 340 million Euros for cars;
- The distribution of the cars considering the engine type: 69.3% gasoline engine, 30.7% diesel engine;
- Estimations indicate a log-normal distribution of the number of kilometers driven annually, with a mean of approximately 10000 kilometers and a standard deviation of approximately 4600 kilometers;
- The distribution of the cars considering the European emission standard of the engine (Fig. 1);
- The distribution of the cars considering the engine capacity (Fig. 2). Estimations indicate a log-normal distribution for the gasoline engines with a mean of 1704cc and a standard deviation of 550 cc, while for the diesel engines they show a log-normal distribution with a mean of 2026cc and a standard deviation of 632cc.

For each car, the proposed cost is computed by the Eqs. (1-3):

$$TCV_i = MLcomp_i + ENVcomp_i \quad (1)$$

$$MLcomp_i = FixedVal + k_1(ENGcap_i) \quad (2)$$

$$ENVcomp_i = k_2 ENGcap_i \cdot NBKm_i \cdot EESPCcoef_i \quad (3)$$

where: i – indexes the cars; TCV_i = total cost value for the car i; $MLcomp_i$ = the insurance component (premium for compulsory motor liability insurance); $ENVcomp_i$ = environmental tax component; $FixedVal$ = component of the insurance premium which does not depend on the number of driven kilometers. This is not necessarily a constant. The law allows and the insurance companies use risk classifications for different criteria: number of years since the driver has a license, regional differences (urban and rural areas), crash history (*bonus-malus* system), etc. The introduction of those factors in our study would only cause insignificant fluctuations around the mean, without affecting the environmental tax component. The fixed value used in this analysis represents half of the average value of a Motor Liability Insurance policy (50% from annual gross written premiums in motor liability insurance divided by the number of insured cars); k_1 = constant value which determines that $\sum_i MLComp_i$ equals the total annual receipts from the Motor Liability Insurance. $ENGcap_i$ = Engine Capacity in cubic centimeters (cc); $ENVcomp_i = k_2\ ENGcap_i[NBKm_i(EESPCcoef_i)]$; k_2 = coefficient which allows adjusting the tax in such a way that the total sum collected equals the one fixed as a target; $NBKm_i$ = number of driven kilometers; $EESPC$ = European emission standards for passenger cars.

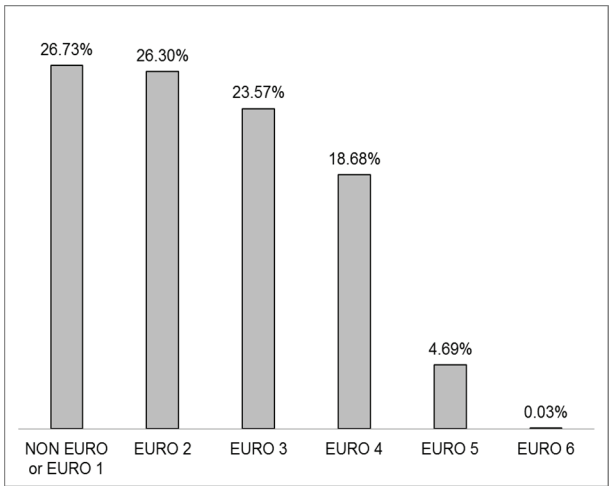

Fig. 1. Distribution of Romanian cars considering the European emission standards of the engine

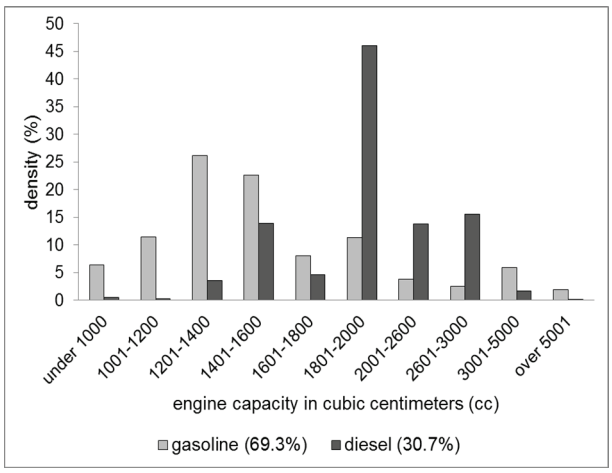

Fig. 2. Distribution of Romanian cars considering the engine capacity

The present classification goes from non-EURO to EURO 6; $EESPCcoef_i$ = multiplication coefficients corresponding to the European emission standards. It can be modified by Governmental authorities according to the environmental policy, more or less restrictive (Table 1).

3. Results and discussion

Based on the previously mentioned data and estimations, we generated though the Monte Carlo method a sample of 10000 cars, considering the distributions of the variables. The distribution of the proposed tax values TCV_i is characterized both in Fig. 3 and in Table 2. The achieved simulation shows that the statistic distribution of the TCV_i values does not differ significantly based on the proposed scenario. The average sum paid annually is of approximately 160 Euros (704 RON).

We mention that the average annual wage in Romania is of 4320 Euros. On average, a car owner has to pay 3.7% of his or her annual income for the new tax which includes both the insurance and the environmental component.

Table 1. Multiplication coefficients corresponding to the European emission standards according to the environmental policy

	EURO 6	***EURO 5***	***EURO 4***	***EURO 3***	***EURO 2***	***non-EURO or EURO 1***
Scenario 1	1	1.2	1.4	1.6	1.8	2.0
Scenario 2	1	1.4	1.8	2.2	2.6	3.0
Scenario 3	1	1.6	2.2	2.8	3.4	4.0

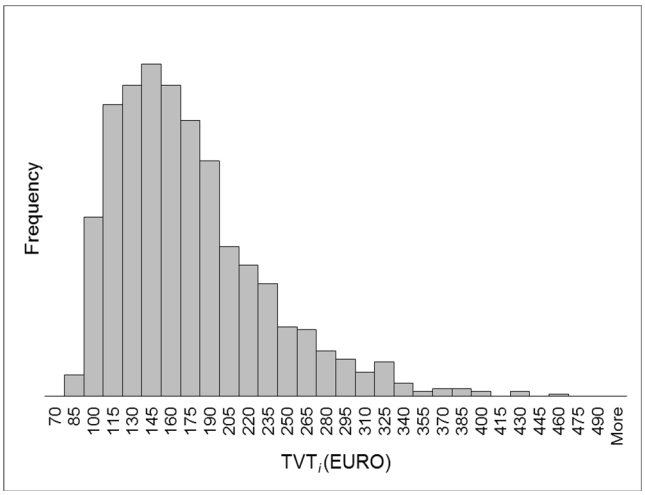

Fig. 3. The distribution of TVT_i for scenario 1

Table 2. Descriptive statistics of the TVT_i variable (Euro)

	Mean	***St. dev.***	***1st decile***	***9th decile***
Scenario 1	160	56.4	100.2	236.0
Scenario 2	160	57.7	99.3	239.0
Scenario 3	160	58.9	98.6	240.2

The calculation of the deciles for the distribution of the total cost value TCV_i shows that 80% of the car owners would have to pay an amount between 100 Euros (440 RON) and 239 Euro (1050 RON).

By comparing the annual average income with the values of the tax, we conclude that this new tax can be supported by the population. This is due to the distribution of the total sum over all the car owners, unlike the current system, where the sum is supported only by a population segment when buying a car.

Our approach encourages less driving for older vehicles owned by lower income individuals and more driving for newest vehicles from low emission classes. Similar results were obtained by Hickson (2006).

Fundamentally, the implementation of such a system does not have economic impediments; it has rather technical and juridical obstacles. One of the obstacles in implementing this tax is the process of monitoring the distance travelled by cars. The monitoring costs include the employment of licensed professionals in odometer checks and the installation of fitted devices in each vehicle. Nevertheless, the cost of automated data collection is declining since the newest cars have odometer data recorded in the engine computer. Many cars also have a global positioning system (GPS) which provides a system of wireless transmission. Another important obstacle is represented by the lack of legal framework.

There is a strong need for state insurance regulation in supporting this system. As governments realize that durable development means corporate social responsibility (Dinu, 2011), they will adopt national regulations regarding the inclusion of the environmental tax in the mandatory Motor Liability Insurance.

4. Conclusions

Worldwide, the GHG emissions coming from cars are continuously increasing. This phenomenon is closely linked to the increase in the distances travelled by cars. Government environmental policies in the car transportation sector have not proved to be very efficient so far. The current systems of emission taxation do not consider the distance travelled by cars, therefore, they are not fully compliant with the "polluter pays" principle. In addition to the inequality produced, these systems do not encourage the reduction of the distances travelled annually because of the lack of right incentive systems.

More and more views are favorable to the idea of introducing the environmental risk in the mandatory motor insurances. Yet, there are certain legal and technical obstacles. At present, the most important problem seems to be the process of monitoring the distance travelled by cars. From an economic point of view, our study shows that such a system is sustainable even in an emerging market such as Romania.

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