Pragmatical model for highway tolls pricing management

Emmanouil Papadimitriou, Grigorios Papageorgiou

Abstract: Highways stand for a decisive part of the road network with respect to the economic growth prism. In Europe, as well as in developed and developing countries worldwide, an extended network of highways, serves as one of the interconnection infrastructure cornerstones of touristic, professional and commercial activities. The financing of that road infrastructure investments lays mainly on toll stations at certain points of highway trafficked surface. Thus, toll stations operate as points of fee collection from road users. Tolls pricing methodology with a pragmatical approach is the scope of this paper. While many methods for pricing tolls fee are implemented according to the policy adopted by the road authorities of each country, none of them has up to now manage to calculate fee value with respect to continuously updated historical data of past expenses and revenues, due to construction, maintenance, operational and tolls fee income, accordingly. The development of a pragmatical model that reconsiders costs and revenues yearly, so tolls pricing becomes more realistic along with time, is the subject this paper investigates. A calculation formula for this goal is presented hereafter, distinct characteristics of which are realism, reconsideration and sustainability.

Index Terms": Highway management, highway toll-stations, tolls fee, tolls pricing policy

1 INTRODUCTION

Road infrastructure is of vital importance in order to enhance a country's growth and development. The road network is a critical juncture in the fight against poverty, as it provides broad access to social services, health and education. It thus contributes directly to social and economic development in its neighboring areas. So, it could be said that all the assets that belong to the public are the road infrastructure (Malkoc, 2015). Roads stand for a primary mean of transportation. Various types of roads are constructed to fulfill various needs accordingly. Highways' main scope is to connect two or more cities or countries. As roads are an important asset, it is necessary to maintain it so that it withstands for a long service-life. A highway, throughout its life-cycle, is subject of various costs related to its construction, maintenance, operation, as well as restoration costs resulting from natural disasters (Table 1). The construction cost (C_c) depends on factors such as the type of pavement, the width and number of lanes of the road. Usually, a highway lane is 3.50-3.75 m wide. The cost will depend on the number of lanes constructed. The dimensioning of pavement is also important, depending on the layers below the trafficked surface. The type of layers is determined by the California Bearing Ratio (CBR) value, which directly shows the strength of the soil, as well as the percentage of water contained therein. The final construction cost is also related to the existing costs of selected materials. The maintenance cost (C_m) is directly related to actions that aim to heal condition deficiencies of the roadway and, by extension, other infrastructure elements, such as safety equipment, traffic lights, signs, etc.

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The operation cost (C_o) refers to costs incurred that are directly related to operational needs such as lighting, water supply, power supply to facilities and equipment, pathway cleaning, staff payroll, toll facilities, and maintenance of existing machinery. Finally, the natural disaster cost (C_{nd}) refers to the rehabilitating costs facing the effects of natural disasters, such as tornadoes, hurricanes, volcanic eruptions, floods and earthquakes. Essential resources and revenues to draw from, are, commercial exploitation, financial sponsoring and tolls fee (Fig. 1). It is important to note that the three fundamental toll systems on the highways are: open to central toll stations, closed to access and exits, and open roads, where tolling does not exist. direct, but payment depending on usage is made online, at strategic points or even at entry and exit points in each piece of use. Modern highways with tolls often use a combination of the three: for example, the Pennsylvania Turnpike and Florida's Turnpike implement all three systems in different sections.

A. Tolls Station types

Road network maintenance can be achieved by different types of toll stations to cover the costs of damage caused by natural disasters. Three mechanisms for obtaining revenues are commonly used as presented in Tables 2, 3 and 4.

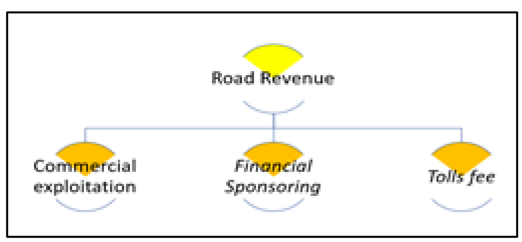

***Fig. 1**. Road revenues.*

TABLE 1
COST TYPES OF HIGHWAY NETWORKS

Cost type	*Cost Analysis*
Construction Cost (C_c)	*a) Depending mainly on the terrain and soil conditions, as well as on the skill of operators and labourers involved; road construction costs may vary; b) Includes road infrastructure and relevant equipment*
Maintenance Cost (C_m)	*a) Maintenance costs may vary according to different factors, such as weather conditions, innovative techniques and road data; b) Includes routine, preventive, corrective maintenance*
Operation Cost (C_o)	*Refers to costs incurred that are directly related to operational needs such as: a) lighting; b) water supply power to facilities and equipment; c) highway cleaning; d) staff payroll; e) toll facilities; f) maintenance of existing machinery*
Natural Disaster Cost (C_{nd})	*Refers to the resulting costs from the effects of natural disasters.*

TABLE 2
ADVANTAGES, DISADVANTAGES, FEATURES OF DIRECT TOLLS (SOURCE: PPP.WORLDBANK.ORG)

Direct tolls	
Advantages	*a) Investments in infrastructure can be augmented; b) Zero cost to the Government; c) Government has fiscal space to fund other projects; d) Optimization of use of the transport network*
Disadvantages	*High capital construction costs mean that project's traffic volumes may be considered as an insufficient revenue stream to meet debt service.*
Features	*a) Road users pay for the road infrastructure use; b) Concessionaire paid for making road available for public use; c) Tolls applied to vehicles are generally differentiated on the basis of number of axles, period of time (day/week) and emissions "Euro standard class".*

TABLE 3
ADVANTAGES, DISADVANTAGES, FEATURES OF SHADOW TOLLS (SOURCE: PPP.WORLDBANK.ORG)

Shadow tolls	
Advantages	*a) The introduction of public-private partnerships (PPPs) can be established when the environment is not promising at all; b) Ensure that traffic emergencies are covered*
Disadvantages	*a) The government may pay higher "fees" when the volume exceeds the thresholds set; b) Users do not receive price signals; c) The total cost of the construction project is solely for the public purse*
Features	*a) Concessionaire is paid by authority on road use – the more the road is used the more the Concessionaire is paid; b) Usually have banding mechanism, which applies different shadow toll payments to different levels of traffic.*

TABLE 4
ADVANTAGES, DISADVANTAGES, FEATURES OF INDIRECT TOLLS (SOURCE: PPP.WORLDBANK.ORG)

Indirect tolls	
Advantages	*a) There is no concept of monitoring traffic flows during operation; b) The project becomes cheaper as the risks for the Concessionaire are minimal; c) The care required is low*
Disadvantages	*a) The concessionaire's interest in the volume of traffic is negligible; b) The total cost of the project relates solely to the public fund; c) Limited price signals (affecting traffic behaviours).*
Features	*Amount of deduction/ non-availability payment usually determined by reference to factors including: i)Duration of unavailability; ii) Time of day of unavailability; iii) Length of project road; iv) Number of lanes affected.*

B. Tolls fee policies

Governments are constantly looking for ways to meet the needs of citizens to develop their road networks and other transport links. Governments are unable or unwilling to often commit budgetary expenditure to new motorways as they are very costly. The lack of public funds has led to the introduction of new models for the financing and management of tolls, from toll collection to private financing through more 'complex' concession models. Each model provides a different linkage between countries (ASECAP, 2014). Worldwide, today such a link may have different profiles:

- Direct control by the state (and by specific organizations).
- Road toll concession system.
- Public-Private Companies.

Road tolls were levied traditionally for a specific access (e.g. city) or for a specific infrastructure (e.g. roads, bridges). These concepts were widely used until the last century. The different charging concepts are designed to suit different requirements regarding purpose of the charge, charging policy, tariff class differentiation etc.:

Time Based Charges and Access Fees: a road user has to pay for a given period of time in which they may use the associated infrastructure.

Distance or Area Charging: In a distance or area charging system concept, vehicles are charged per total distance driven in a defined area (Bernhard, 2004).

The policy gives direction to three options:

1. Tolling based on computation of cost recovery. The Concessionaire shall manage the road infrastructure for a period stated in the Public and Private Partnership (PPP) agreement to recoup the construction, maintenance and operation costs. Thereafter, the concessionaire shall return the infrastructure to the responsible road authority in the condition specified in the agreement.
2. Tolling based on the proportion of the benefit accrued from the use of the road infrastructure. The Concessionaire shall manage the road infrastructure for a period stated in the PPP agreement to recoup the construction, operation and maintenance costs.
3. Tolling based on projects that are not self-funding. This option considers projects that after a cash flow forecast, toll revenues will not be sufficient to cover costs of construction, operation and maintenance yet they are strategic (MnTU, 2017).

2 LITERATURE REVIEW

Tolls are often put on the roads to raise funds to repay the bonds. Road development cannot be achieved solely with budget support or even with the support of private investment. Motorway infrastructure has traditionally been funded through general government budgets and special taxes and fees rather than tolls. 90% or more of motorways are publicly funded, in most industrialized countries, while in developing countries the total cost is borne by governments. Because of the limited resources available to governments, they favor the creation of private tolls, aiming at alternative forms of meeting the needs of the road network (Fisher, 1996). In Austria since 2004, a distance-based charging system known as Go-Maut has been implemented for all cars over 3.5 tonnes. These are less than 3.5 tonnes, are required to purchase a sticker or sticker for access on the Austrian motorway network, which is owned and operated by a state-owned company called ASFINAG. However, for selected routes, such as large tunnels and expensive routes through the Alps, there is an additional toll charge (Wilson, 2012). Singapore's electronic road pricing system uses prices determined by optimization of traffic flow. The pricing formula was developed using a traffic flow model developed by the Land Transport Authority. When speeds fall below the target levels prices are increased. When speeds rise above the target range, prices are reduced. The benefit of this rule-based methodology is transparency. This aid understanding for both the public and decision makers and underpins public support for the system (OECD, 2018). In June 2005, Transport Secretary Alistair Darling announced a proposal for a national scheme of UK (Tempest, 2005), in which every vehicle would be fitted with a satellite receiver that would calculate charges, with prices (including fuel duty) ranging from £2 per mile on uncongested roads to £1.34 on the most congested roads at peak times (European Commission, 2004). In 2006, San Francisco authorities began a feasibility study to evaluate congestion pricing in the city and finally in July 2010 congestion tolls were implemented at the San Francisco-Oakland Bay Bridge (Cabanatuan, 2010).

3 CONCEPT OF PROPOSED APPROACH

The proposed methodology combines a multitude of features that are initially directly intertwined with modern highway demands and then directly links, through the use of the present value concept, the revenue that is incurred on a highway to the costs incurred throughout their life cycle. The following Fig. 2 is a graphical representation of the proposed methodology.

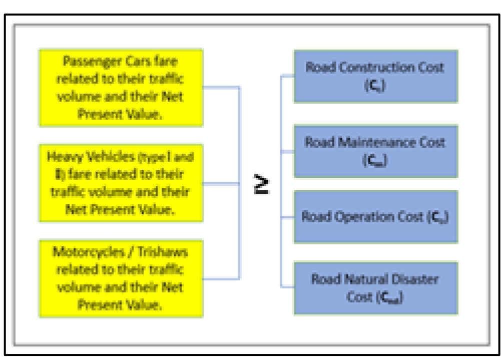

***Fig. 2**. Tolls Road Methodology Flow Chart*

The proposed methodology lies on three fundamental features that shape its innovation, namely sustainability, reconsideration and realism (Table 5). "Sustainability" implies that resources are being exploited at a rate lower than that which is currently being renewed by existing systems. Otherwise the concept of degradation occurs. Theoretically, the long-term effect of downgrading is the system's inability to support the key emerging issues. "Reconsideration" lies in the fact of immediate and holistic, potentially modifying data and possible solutions through the use of net present value. With regard to the concept of reconsideration, it is tempting to note that in common practice the costs of tolls are often revised, without taking into account the actual data of the existing traffic. In Greece, tolls are being revised in line with the policies pursued by the government. With regard to the concept of reconsideration, it is tempting to note that in ordinary practice the costs of tolls are often revised, without taking into account the actual data of the existing traffic. In Greece, tolls are being revised in line with the policies pursued by the government. Proper and at the same time artificially viable rates are set by the revenue and potential costs that occur throughout the life of a major motorway, so that the most appropriate and efficient financing can be sought, closer to the realistic needs, so that this innovative methodology is based on up-to-date data. Finally, an important feature of this methodology is the "Realism", that is, the ability of the responsible manager to grasp the reality and the constraints that it poses and adapts to the demands of modern technology development and optimal requirements as far as sustainable development is concerned of motorways. These three features constitute a dynamic and yet accessible set of support for those who manage the highways, in appropriate and necessary situations, to act in an artificially optimized and most promising way.

TABLE 5
NECESSARY HIGHWAY TOLLS PRICING CONCEPT FEATURES FROM A PRAGMATICAL PRISM

Necessary Highway Tolls Pricing Concept Features from a Pragmatical Prism	
Sustainability	*a) Best financial result for road users and project owners;* *b) A balance between the provision of services and the initial cost spent on the existing project.*
Reconsideration	*a) Cost-accounting approach and Change;* *b) Amendment and Review;* *e) Recall of previous methods.*
Realism	*Representation of real and specific data*

A. Proposed methodology

The categories studied for the implementation of this methodology are:

1. Passenger cars (pc)
2. Heavy vehicles with or without a trailer with 2 or 3 axles and a height of more than 2.20 meters (HVI)
3. Heavy vehicles with or without a trailer with 4 or more axles and a height of more than 2.20 meters (HVII)
4. Bikes/Tricycles (pv, mot) / (motorcycle, trishaw (or pedal vehicle)

Studies have shown that the rates (A) of the different vehicle groups associated with those of passenger cars (using an average) are (http://diodia.com.):

$$\mathrm{A_{iTHVI}} = 2.5 * \mathrm{A_{iTpc}}, \quad \mathrm{A_{iTHVII}} = 3.5 * \mathrm{A_{iTpc}}, \quad \mathrm{A_{iTpv,mot}} = 0.7 * \mathrm{A_{iTpc}}$$

Taking into account the present value (PV), that is, the amount of money required to be found today so that some of it will cover the cost of the original construction and the remainder, together with its performance, to cover the costs of future operations (Nikolaidis, 2005). We also consider as a percentage increase or decrease of the traffic load as λ for each vehicle category. In order to develop the proposed calculation formula, costs are as follows.

$\boldsymbol{C_c} \rightarrow$ Construction cost.

$\sum_i^T \boldsymbol{C_{m_i}} \rightarrow$ refers to any form of maintenance that occurs at regular intervals t_1, t_2, etc. years, depending on the lifespan of each infrastructure to be maintained, after the initial stage of the road.

$\sum_i^T \boldsymbol{C_{o_i}} \rightarrow$ resulting operating costs across the entire road infrastructure.

$\boldsymbol{C_{nd}} \rightarrow$ is expressed in specific percentage values.

The domain of variables is:

$\mathrm{it} \in (1, \mathrm{t}), \quad \mathrm{iT} \in (1, \mathrm{T}), \quad \mathrm{i} \in (\mathrm{t}, \mathrm{T})$

At the same time, the application of the criterion requires the reduction of all costs, including investment on an annual basis. The conversion of investment costs into annual costs is achieved by the following formula:

$$\sum_{\mathbf{1}}^{\boldsymbol{T}} \boldsymbol{PV_{Ccit}} = C_{c0} * (1+\omega)^{it},$$

$where\ C_{c0} = initial\ cost\ value,$
$t = today\ and$
$\omega = interest\ rate\ on\ deposits$

$$UEAC = (investment\ cost) * \frac{\varepsilon * (1+\varepsilon)^t}{(1+\varepsilon)^t - 1},$$

$where\ \ UEAC = Uniform\ Annual\ Equivalent\ Cost,$

$$\boldsymbol{PV} = \sum_{1}^{T} \left[\frac{FV_t}{(1+r)^t}\right]\ where\ \ PV = Present\ Value, r = return\ rate\ and\ t = number\ of\ periods$$

$\boldsymbol{V_{itx}} = real\ traffic\ volume\ from\ year\ 1\ to\ year\ t, with\ x = vehicle\ type$

$\boldsymbol{A_{itx}} = real\ pricing\ cost\ from\ year\ 1\ to\ year\ t, with\ x = vehicle\ type$

$\boldsymbol{V_{iTx}} = estimated\ traffic\ volume\ from\ year\ (t+1) to\ year\ T, with\ x = vehicle\ type$

$\boldsymbol{A_{iTx}} = estimated\ pricing\ cost\ from\ year\ (t+1)\ to\ year\ T, with\ x = vehicle\ type$

$\boldsymbol{T} = design\ periods\ (years)$

$\boldsymbol{t} = current\ year$

$\boldsymbol{R} = represents\ revenue$

$\boldsymbol{\omega} = interest\ rate\ on\ deposits$

$$\boldsymbol{PV_{Ritpc}} = V_{itpc} * A_{itpc} * (1+\omega)^{it},\ \boldsymbol{PV_{RitHVI}} = V_{itHVI} * A_{itHVI} * (1+\omega)^{it},\ \boldsymbol{PV_{RitHVII}} = V_{itHVII} * A_{itHVII} * (1+\omega)^{it},\ \boldsymbol{PV_{Ritpv,mot}} = V_{itpv,mot} * A_{itpv,mot} * (1+\omega)^{it}$$

$$\boldsymbol{FV_{Ritpc}} = V_{iTpc} * A_{iTpc},\ \ \boldsymbol{FV_{RitHVI}} = V_{iTHVI} * A_{iTHVI},\ \ \boldsymbol{FV_{RitHVII}} = V_{iTHVII} * A_{iTHVII},\ \ \boldsymbol{FV_{Ripv,mot}} = V_{iTpv,mot} * A_{iTpv,mot}$$

$$\boldsymbol{V_{iTpc}} = V_{itpc} * \left(1+\lambda_{iTpc}\right)^{iT} \xLeftrightarrow{\lambda_{iTpc}=\lambda} V_{iTpc} = V_{itpc} * (1+\lambda)^{iT}$$

$$\boldsymbol{V_{iTHVI}} = V_{itHVI} * (1+\lambda_{iTHVI})^{iT} \xLeftrightarrow{\lambda_{iTHVI}=\lambda} V_{iTHVI} = V_{itHVI} * (1+\lambda)^{iT}$$

$$\boldsymbol{V_{iTHVII}} = V_{itHVII} * (1+\lambda_{iTHVII})^{iT} \xLeftrightarrow{\lambda_{iTHVII}=\lambda} V_{iTHVII} = V_{itHVII} * (1+\lambda)^{iT}$$

$$\boldsymbol{V_{iTpv,mot}} = V_{itpv,mot} * \left(1+\lambda_{iTpv,mot}\right)^{iT} \xLeftrightarrow{\lambda_{iTpv,mot}=\lambda} V_{iTpv,mot} = V_{itpv,mot} * (1+\lambda)^{iT}$$

$$\sum_{\mathbf{1}}^{\boldsymbol{T}} \boldsymbol{PV_{Ccit}} = C_{c0} * (1+\omega)^{it},$$

$where\ C_{c0} = initial\ cost\ value,$
$t = today\ and$
$\omega = interest\ rate\ on\ deposits$

$$\sum_{\mathbf{1}}^{\boldsymbol{T}} \boldsymbol{PV_{Cmi}} = \sum_{1}^{t} PV_{Cmit} + \sum_{t+1}^{T} \frac{FV_{CmiT}}{(1+k)^{iT}},$$

$where\ C_{mit} = last\ year\ maintenance\ cost\ from\ 1\ to\ t\ and\ k = inflation\ rate$

$$UEAC = (investment\ cost) * \frac{\varepsilon * (1+\varepsilon)^t}{(1+\varepsilon)^t - 1},$$

$where\ \ UEAC = Uniform\ Annual\ Equivalent\ Cost,$
$\varepsilon = discount\ rate\ per\ period\ and$
$t = estimated\ duration\ in\ years$

$\boldsymbol{C_{miT}} = d_1 * C_{m0} - C_{mit},$

$where\ C_{m0} = initial\ estimate\ of\ maintenance\ costs,$
$C_{mit} = actual\ cost\ estimate\ of\ maintenance\ and$

$$\sum_{\mathbf{1}}^{\boldsymbol{T}} \boldsymbol{PV_{Coi}} = \sum_{1}^{t} PV_{Coit} + \sum_{t+1}^{T} \frac{FV_{CoiT}}{(1+k)^{iT}},$$

$where\ C_{oit} = last\ year\ maintenance\ cost\ from\ 1\ to\ t\ \ and\ \ k = inflation\ rate$

$d_1 = \ indicates\ the\ difference\ between\ the\ two\ sizes = \dfrac{UEACC_{mit}}{UEACC_{m0}}$

$\boldsymbol{C_{oiT}} = d_2 * C_{o0} - C_{oit},$

$where\ C_{o0} = initial\ estimate\ of\ maintenance\ costs,$
$C_{oit} = actual\ cost\ estimate\ of\ maintenance\ and$
$d_2 = \ indicates\ the\ difference\ between\ the\ two\ sizes = \dfrac{UEACC_{oit}}{UEACC_{o0}}$

So, the formula is formatted as follows:

$$\left[\sum_{1}^{t} PV_{Ritpc} + \sum_{t+1}^{T} \frac{FV_{RiTpc}}{(1+r)^{iT}}\right] + \left[\sum_{1}^{t} PV_{RitHVI} + \sum_{t+1}^{T} \frac{FV_{RiTHVI}}{(1+r)^{iT}}\right] + \left[\sum_{1}^{t} PV_{RitHVII} + \sum_{t+1}^{T} \frac{FV_{RiTHVII}}{(1+r)^{iT}}\right] + \left[\sum_{1}^{t} PV_{Ritpv,mot} + \sum_{t+1}^{T} \frac{FV_{RiTpv,mot}}{(1+r)^{iT}}\right] \geq$$

$$\geq \sum_{1}^{T} PV_{Ccit} + \left[\sum_{1}^{t} PV_{Cmit} + \sum_{t+1}^{T} \frac{FV_{CmiT}}{(1+k)^{iT}}\right] + \left[\sum_{1}^{t} PV_{Coit} + \sum_{t+1}^{T} \frac{FV_{CoiT}}{(1+k)^{iT}}\right] + C_{nd} \Rightarrow$$

$$\Rightarrow \left[\sum_{1}^{t} [V_{itpc} * A_{itpc} * (1+\omega)^{it}] + \sum_{t+1}^{T} \frac{FV_{RiTpc}}{(1+r)^{iT}}\right] + \left[\sum_{1}^{t} [V_{itHVI} * A_{itHVI} * (1+\omega)^{it}] + \sum_{t+1}^{T} \frac{FV_{RiTHVI}}{(1+r)^{iT}}\right]$$

$$+ \left[\sum_{1}^{t} [V_{itHVII} * A_{itHVII} * (1+\omega)^{it}] + \sum_{t+1}^{T} \frac{FV_{RiTHVII}}{(1+r)^{iT}}\right] + \left[\sum_{1}^{t} [V_{itpv,mot} * A_{itpv,mot} * (1+\omega)^{it}] + \sum_{t+1}^{T} \frac{FV_{RiTpv,mot}}{(1+r)^{iT}}\right] \geq$$

$$\geq C_{c0} * (1+\omega)^{it} + \left[\sum_{1}^{t} PV_{Cmit} + \sum_{t+1}^{T} \frac{FV_{CmiT}}{(1+k)^{iT}}\right] + \left[\sum_{1}^{t} PV_{Coit} + \sum_{t+1}^{T} \frac{FV_{CoiT}}{(1+k)^{iT}}\right] + C_{nd}$$

$$A = \sum_{1}^{t} [V_{itpc} * A_{itpc} * (1+\omega)^{it}] + \sum_{1}^{t} [V_{itHVI} * A_{itHVI} * (1+\omega)^{it}] + \sum_{1}^{t} [V_{itHVII} * A_{itHVII} * (1+\omega)^{it}] + \sum_{1}^{t} [V_{itpv,mot} * A_{itpv,mot} * (1+\omega)^{it}]$$

$$B = \sum_{1}^{t} PV_{Cmit} + \sum_{1}^{t} PV_{Coit}$$

Consequently, the reconsiderable toll fee can be expressed as follows:

$$\sum_{t+1}^{T} A_{iTpc} * \left[\frac{V_{iTpc}}{(1+r)^{iT}} + 2.5 * \frac{V_{iTHVI}}{(1+r)^{iT}} + 3.5 * \frac{V_{iTHVII}}{(1+r)^{iT}} + 0.7 * \frac{V_{iTpv,mot}}{(1+r)^{iT}}\right]$$

$$\geq (B-A) + C_{c0} * (1+\omega)^{it} + \sum_{t+1}^{T} \frac{FV_{CmiT}}{(1+k)^{iT}} + \sum_{t+1}^{T} \frac{FV_{CoiT}}{(1+k)^{iT}} + C_{nd} \Rightarrow$$

$$\Rightarrow \sum_{t+1}^{T} A_{iTpc} = \frac{(B-A) + C_{c0} * (1+\omega)^{it} + \sum_{t+1}^{T} \frac{FV_{CmiT}}{(1+k)^{iT}} + \sum_{t+1}^{T} \frac{FV_{CoiT}}{(1+k)^{iT}} + C_{nd}}{\left[\frac{V_{iTpc}}{(1+r)^{iT}} + 2.5 * \frac{V_{iTHVI}}{(1+r)^{iT}} + 3.5 * \frac{V_{iTHVII}}{(1+r)^{iT}} + 0.7 * \frac{V_{iTpv,mot}}{(1+r)^{iT}}\right]}$$

So, finally:

$$\sum_{t+1}^{T} \boldsymbol{A_{iTpc}}(€) = \frac{(B-A) + C_{c0} * (1+\omega)^{it} + \sum_{t+1}^{T} \frac{(d_1 * C_{m0} - C_{mit})}{(1+k)^{iT}} + \sum_{t+1}^{T} \frac{(d_2 * C_{o0} - C_{oit})}{(1+k)^{iT}} + C_{nd}}{\sum_{t+1}^{T} \left[\frac{V_{itpc} * (1+\lambda)^{iT}}{(1+r)^{iT}} + 2.5 * \frac{V_{itHVI} * (1+\lambda)^{iT}}{(1+r)^{iT}} + 3.5 * \frac{V_{itHVII} * (1+\lambda)^{iT}}{(1+r)^{iT}} + 0.7 * \frac{V_{itpv,mot} * (1+\lambda)^{iT}}{(1+r)^{iT}}\right]}$$

B. Key features of proposed methodology

A key feature of the proposed methodology is its reconsideration. This methodology also includes the concept of cost due to natural disasters. If implemented correctly, tolls can have a positive impact on improving the logistics efficiency of freight. In addition, tolls can be a major source of revenue for a country's public budget. Because there is freedom in the countries in how the rates of the different categories of vehicles are determined, this methodology studies the precise determination of the prices of the respective categories of vehicles, using a range of costs and benefits resulting from a policy or investment. It is important that this methodology also takes into account and is automatically transformed based on local climatic conditions (natural disasters).

4 CONCLUSIONS

Road tolls take part to making transport more efficient in many different countries, can help to decrease the negative impacts of road transport while incentivizing the smart use of clean vehicles and can generate revenue for national budgets without adversely impacting the movement or price of goods (OECD, 2017). Also, tolls are a financial mechanism that can promote zero emission vehicles and smart transport behavior; all while raising money for the public budget. There exists now the potential to build upon the proposed methodology by the right policy and make all of road transport more clean, sustainable, innovative and more efficient on user requirements. Users of highways after researching models we create in London and Stockholm, once the system is established, begin to accept road pricing. Better use of space in the city is directly consistent with the pricing of road infrastructure. As a result of optimizing the use of space on the road infrastructure, there is a reduction in pollutant emissions and travel time. This increases productivity, opening up an optimistic future for jobs in the existing region. (OECD, 2018). Following the proposed methodology for highway pricing, the calculation of tolls fee value comes closer to real expenses and minimizes unnecessary extra costs for road users. Moreover, continuous reconsideration of fee value, decreases divergence of real and theoretical costs and revenues, mitigating the gap between actual and estimated values. Thus, a realistic approach for highway tolls pricing stands for a useful tool for road authorities to implement at their highway infrastructures.

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