Journal of Asian Scientific Research
ISSN(e): 2223-1331
ISSN(p): 2226-5724
DOI: 10.18488/journal.2.2018.88.265.276
Vol. 8, No. 8, 265-276

URL: www.aessweb.com

THE OPTIMAL PROGRESSIVE TAX POLICY TO REDUCED VEHICLES EXTERNALITIES

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Article History
Received: 19 June 2018
Revised: 23 August 2018
Accepted: 17 September 2018
Published: 26 October 2018

Keywords
Vehicle externalities
Driving or usage taxes
Ownership taxes
Purchase or acquisition taxes
Progressive emission tax
Optimal tax policy

ABSTRACT

Although much of the emphasis in taxation studies relates to a particular type of tax, the contribution of this paper by try to combine different taxes in one tax, whereby it was widely agreed that a mixture of the different taxes is regarded an ideal to reduced vehicle emissions. The study used existing empirical literature to prove that the taxes on vehicles alone are not sufficient to reduce vehicles externalities or short-term effects of these taxes, therefore there is need to impose a tax on emission source strongly due to the fact that many contemporary scholars proposed to taxation based on the actual emissions test, and car types/engines. The approach of the study was shown in the diagram which used to design a proposed progressive tax system which consists of a mix of different taxes. Therefore, the current study will add to the current literature, by provides background and details on taxes on vehicles and its operations. The aim will be to comment on them in terms of design and effectiveness in reducing emissions.

1. BACKGROUND

The motor vehicle externalities have increased over time and there is more effective measures are required for their reduction [1]. There was increased interest in the world in taxing vehicle characteristics to protect the environment. But, the implementation of these taxes remains also somewhat ambiguous in literature, due to weaknesses such as not considering environmental aspects of transport in their road taxes or the minor elements of such tax role [2]. Therefore, such studies have not considered the taxes on the vehicles to be sufficient to reduce externalities in the long run. For instance, the researchers Beck, et al. [3] and Nel and Nienaber [4] have revealed that "the taxes on passenger vehicles may not be the most effective way of reducing externalities and one instrument alone is not sufficient to achieve the South Africa environmental goals" [4].

On the other hand, regulations of emissions from motor vehicles are mostly reliant on the traditional "command and control" approaches, with a new car tailpipe emissions standards being the majority approach. However, it has been criticized as being inflexible, poorly targeted, incompatible with motorist's incentives, and ultimately too expensive to be effective [5]. Therefore, several economic incentives were proposed as alternatives. One that is particularly promising is to come up with a system where vehicle owners pay fees based on their respective levels of annual emissions [5]. Because this can achieve a reduction in the negative externalities [6] and reduce the pollution at lower cost (see for example Bohm and Russell [7]; Harrington, et al. [8]; West [9]). However, a mix of different taxes can be regarded as an optimal to obtain maximum reduction in exhausts emissions, as per [10].

2. TAXES ON VEHICLES ARE PROGRESSIVE

Generally, the functional mechanism of environmental taxes and charges are similar, which influence the production/consumption behaviour of polluters by altering prices [11]. Taxes are regarded as the best approach to alter prices to match marginal societal costs [12]. In order to realize a higher level of efficiency, the state is expected to internalize externalities into the tax system via tools such as "pollution tax" [13]. Taxing based on the harm brought about by an activity represents an actual instrument for the control as it taxes the people who actually partake in these activities [14]. This however does not translate to zero emission. Decreasing emission has an associated cost, and the aim is to reduce it to levels deemed acceptable to society [15]. A proper emissions tax mechanism can be used to decrease emissions by providing car owners with incentives to change their vehicles or better maintain it. This will also mitigate the number of cars on the road [16].

Generally, there are a few studies on progressive emission tax in literature (see e.g., [17-26]). But, the taxes on vehicles have been found to be progressive (see e.g., Barker and Köhler [27]; Klinge, et al. [28]; Dresner and Ekins [29]; Bork [30]; Callan, et al. [31]; Poltimäe [32]) where the researchers found that taxes on vehicles are more likely to be progressive. Sterner, et al. [33] found also in their study in developing countries, that the vehicle taxes are more likely progressive [32]. On the other hand, Ekins, et al. [34] found that the taxation of vehicle is progressive, not regressive because of the wealthier people are more likely to own vehicle, tend to drive it further and tend to have a bigger. The majority of the poorest households do not have access to a vehicle at all. According to Bird and Zolt [35] it is not inconceivable that indirect taxes such as a VAT and especially certain excises in “higher-income” consumption goods such as motor vehicles may be more progressive than a personal income tax that in reality falls largely on a limited group of wage earners. The essence of progressive taxes is to provide a rate that increases as the taxable amount increases. Due to the level of harm caused by the taxed activity/product, the taxpayer is wary of these taxations, fearing that the purchase of more polluting products will lead to more taxes [36]. It also compels the polluters to come up with a way to decrease their respective emissions instead of having the government do so [37]. Therefore, Heinemann and Kocher [25] have confirmed that the level of compliance is higher under a progressive instead of a proportional regime.

3. THE RELATIONSHIP BETWEEN VEHICLE TAXES AND VEHICLE EMISSIONS

The relationship between vehicle taxes and vehicle emissions has been subjected to a somewhat ambiguous picture in literature, where efforts of previous studies revealed mixed results (see e.g., [3, 4, 19, 38-46]). Thus this part tries to discuss vehicle taxes and provides some background and details of how it operates. as well as will be reviewing most of the criticisms related to these taxes which are found in the literature and evaluate the reforms of tax on vehicle emissions and where relevant.

Depending upon the transportation policies adopted by countries or the local jurisdiction, a vehicle tax could be a non-recurrent payment in connection with its purchase and registration (e.g. turnover tax, registration tax, registration fees). Also, it could be periodically charged to the vehicle as a tax on the ownership or tenure (e.g., vehicle tax, insurance tax) In addition to acquisition and ownership taxes, usage dependent taxes, fuel taxes, and value-added taxes are also imposed in many European and Asian countries [43]. There have been several criticisms against taxes on vehicles (e.g., the researchers Beck, et al. [3] and Nel and Nienaber [4]) found that taxes on passenger vehicles may not be the most effective way of reducing emissions), from where they were not been the most effective way of reducing emissions.

In general, taxes on vehicle purchase, ownership and use have different effects, and can be used to pursue different policy goals. For example, taxes on purchase and ownership can incentivize manufacturers to develop low carbon vehicles and people to buy those [45]. Vehicle taxation in its widest definition represents a prime example of the use of the whole spectrum of consumption taxes [47].

Therefore, the stage at which the tax is levied vehicle green taxes can be levied at three different stages [4, 43, 45-48] (i) Driving or Usage Taxes, (ii) Ownership Taxes and, (iii) Purchase or Acquisition Taxes.

3.1. Driving or Usage Taxes

Vehicle taxes such as excise duties include taxes on fuel, tolls, road space, and parking [45]. The manner in which this tax is implemented varies from country to country [49] where it is basically a regulatory instrument that compels customers to choose specific vehicles [46]; [39]. It is also a vital policy tool that can be used to control externalities linked to automobile use and reduce dependency on fuel imports [50].

Fuel taxes are the best-known usage taxes [51]. Traditionally, fuel tax raised public revenue due to its low administrative costs, where it contribute ~20% of total government revenues in certain countries, such as Niger, Nicaragua, South Korea, and Côte d'Ivoire to preserve foreign exchange and finance public works [43]. The two commonly cited advantages of fuel taxes are the fact that they are cheaper and more widely implementable. The structure to do so is already in place. Compared to different policy options for reducing fuel consumption, fuel taxes are deemed to be most efficient [42]. (e.g., [16, 38-40, 52]) showed how fuel taxes decrease both travel demand and fuel consumption. Fullerton, et al. [39] pointed out that the usage of gasoline is indeed linked to emissions. Eltony [52] reported that the price of gasoline per gallon is empirically more successful than the price per mile for the stock of car acquisition. However, in the event that the price of gasoline lagged in the context of time, an increase of 10% in its price would result in 75% of households to decrease travel within a year. 15% of households will use smaller vehicles, while 10% will switch to more fuel-efficient vehicles. Hirota, et al. [40] studied 67 large cities, 49 of them being OECD countries and 19 non-OECD countries in Asia. He posited that VMT and CO2 are inversely proportional with fuel tax, where the former decreases by 0.042% for every 1% increase in fuel tax income. Also, CO2 decreased by 0.238 for every 1% increase in fuel tax. Goodwin [38] proposed that literature seem to imply a short-run elasticity of ~-0.15 between fuel prices and car kilometres, and a long-run elasticity within -0.3 - -0.5 (due to the influence of car ownership and average kilometres travelled per vehicle). Since fuel taxes would directly impact car fuel consumption, they will also impact car carbon dioxide emissions due to the direct link between emissions and fuel consumption Acutt and Dodgson [16]. Nel and Nienaber [51] reported that usage tax is the most effective in reducing emissions, due to the decreased distance travelled, while Knittel and Sandler [53] reported that gasoline consumption and emissions are directly proportional. They also show that gasoline taxes are not suitable as replacements for a true Pigouvian emissions tax.

Conversely, Walls and Hanson [19]; Fullerton, et al. [39]; Timilsina and Dulal [43]; Beck, et al. [3] reported that a fuel tax is insufficient for decreasing vehicular emissions. They believe that gasoline taxes decrease the distance travelled in the short run, but longer, it would lead to the purchase of more fuel-efficient vehicles, which increase the distance travel, and thus pollution. They also did not distinguish between dirty and clean vehicles. Beck, et al. [3] outlined that the objective of fuel taxes in most countries is to raise revenues.

Fullerton, et al. [39] confirmed that fuel tax incentivized decreased emissions via decreased driving, but this does not extend to decreasing emissions per gallon of fuel consumed. Timilsina and Dulal [43] discovered that fuel taxes have not been used to decrease the transport sector's externalities. Finally, Mirrlees and Adam [54] reported that fuel tax varies with the output of harmful emissions.

3.2. Ownership Taxes

Taxing vehicle ownership includes recurring charges [48] on vehicles during period of ownership [47]. These taxes are defined as (annual circulation tax, vehicle tax, or road tax). There are many ways to determine the amount that is to be levied. More often than not, it is based on engine power, cylinder capacity, and weight/fuel consumption [48] and can be charged annually (fixed) without accounting for the distance a vehicle has traveled [46]; [51].

Within the EU, most ownership taxes are based of engine power, CO_2 emissions, fuel consumptions, or cylinder capacity [46]. In France, the ownership tax based on weight, axles and suspension, while in Belgium, the taxes are based on weight and axles. In Spain, it is based on Payload, and in Germany, it's based on weight, exhaust CO_2 emissions, and noise. In the UK, ownership tax is based on weight, axles, and exhausts CO_2 emissions [55].

According to Hirota, et al. [40] VMT and CO_2 are inversely related to fuel and ownership taxes, and the results confirmed that CO_2 emission decreased by 0.285 for every 1% increase in ownership tax.

The principle findings reported by Carroll-Larson and Caplan [41] stipulated that a VMT tax rate of $0.003 per passenger car mile and $0.01 per light-duty truck mile (resulting in a mean annual tax burden of $128 per household in the first year) would reduce annual PM2.s emissions by 7 - 11 %.

Ryan, et al. [44] analyzed the effect of national fiscal measures in the EU15. He reported that taxes are disparate in its effect on CO_2 emission intensity. Ownership taxes are more effective on CO_2 intensity relative to acquisition taxes. The latter became insignificant when country fixed effects were accounted for. Schipper, et al. [56] confirmed a higher diesel share of the vehicle fleet not necessarily translating into lower average CO_2 emissions, while Ryan, et al. [44] showed that when ownership taxes on diesel increased, its share drops, which directly affect the intensity of CO_2. Hirota, et al. [40] reported that CO_2 decreased by 0.285 for every 1% increase in ownership tax.

Conversely, Hayashi, et al. [10]; Borger and Mayeres [57]; He and Bandivadekar [58]; Beck, et al. [3]; Nel and Nienaber [51]; David and Křápek [2] all confirmed that the effect of ownership taxes is negligible on reducing emissions. According to Hayashi, et al. [10] increased ownership taxes are negligible on decreasing CO_2 emissions, unless it's set to vary in tandem with the actual fuel efficiency/CO_2 emissions. Furthermore, increasing ownership taxes for specific classes of vehicles can also result in people using other vehicles. Ashiabor, et al. [11] and Nel and Nienaber [51] pointed out that ownership tax is negligible on its influence on fuel efficiency and CO_2 emissions. Borger and Mayeres [57]; OECD [59]; Beck, et al. [3] found that there would be no explicit role for annual ownership taxes in correcting externalities because road user charges are calculated to account for costs of road maintenance instead of internalizing the environmental cost of road transport. OECD [59] revealed that the motor vehicle-related fees and charges can be differentiated by engine size and type of vehicle, but these aspects are not reflective of its potential for environmental damage. He and Bandivadekar [58] discovered that the fiscal charges are proportional to both vehicle price and engine size, and are not precisely related to vehicle emissions performance. David and Křápek [2] found that the annual road tax allows for neither the actual distance travelled nor the specific conditions and state of the vehicle to be accounted for, and has absolutely no information value in terms of actual emissions produced. Including the emissions of the respective car's make and type according to its technical documentation does not address the actual emission volume in the context of vehicle use.

3.3. Purchase or Acquisition Taxes

When buying a new vehicle, it needs to be registered, and non-recurrent taxes need to be paid (It is also called a turnover tax, registration tax, registration fees) [60]. This include payments of excise duties/other fees and charges linked to the registration of a newly acquired vehicle, regardless of the status of the vehicle (new, used, etc) [61]. This process varies from country to country, and call registration taxes by many names, such as registration tax, registration fee, turnover tax or vehicle sales tax [48] value added tax, Interior tax, Surtax, and luxury tax [62].

Klein [48] reported that the acquisition tax has a significant indirect effect via factors such as engine size and power. When taxes are based on CO_2 emissions, car buyers select vehicles with lower engine power on average, ceteris paribus. Smaller power engines emit less CO_2. In tandem with the economic theory, we assume the causality for this effect. This confirms that acquisition tax can shape car buying behavior in the context of engine power and size, which influence CO_2 emissions.

On the contrary, Nel and Nienaber [4] reported that acquisition tax is not particularly effective in reducing CO_2 emissions via influencing consumer decisions. Hayashi, et al. [10] pointed out that registration/acquisition tax is not particularly effective towards decreasing CO_2 emissions. For example, the cylinder capacity or price of a vehicle provides no information pertaining to its external costs Kloess [46]. Ryan, et al. [44] confirmed that registration tax is not influential upon CO_2 intensity of new passenger vehicles in Europe over a decade (period of study).

Despite the size of the engine not being a significant factor, the specific indirect effect of engine power is significant enough for the acquisition tax to have a significant indirect effect on the intensity of CO_2. Thus, basing acquisition taxes directly on CO_2 is expected to decrease the CO_2 emissions of new cars, as it is expected that consumers purchase vehicles that have smaller (weaker) engines [48].

Ferrara and Serret [63] reported that taxes on fixed costs driving (e.g. car purchase tax) decreases fuel consumption and total vehicle use, but this depend on the amount of driving people do. While vehicle ownership will decrease, the average age of the cars will increase, which means increased pollution.

4. PROGRESSIVE EMISSION TAX

This part clarifies progressive taxation on emissions as the most important economic instrument available to efficiently deal with pollution and protect the environment [54].

An emission tax is a levy that directly charges based on effluents or on fuel relative to the content of emissions. For example, a NOx (Oxides of Nitrogen) tax is charged based on the amount of NOx released from a vehicle, while a carbon tax is levied on fuels relative to their carbon content. Generally, if the content of a fuel (e.g., carbon, sulfur) is primarily responsible for emissions, then that proportion is taxed. However, if this is not the case, then the emission charge will be directly applied on the emissions instead of the proportion of the effluents in the fuel. For example, the release of NOx is not only caused by oxidation of N_2 in the fuel (i.e., fuel NOx), but it could be a proportion of atmospheric N_2 (i.e., thermal NOx) [43]. A report by the World Bank detailed three types of emission taxes used to decrease transportation emissions: i) taxes on local air pollutants (such as VOCs), as well as ii) regional air pollutants (such as NOx), and iii) GHG emissions, also referred to as carbon tax [64].

Regulation of emissions from motor vehicles is mostly reliant upon the traditional "command and control" approaches, with new car tailpipe emissions standards being the dominant strategy. However, they are not exactly flexible, are inaccurate vis-a-vis actual in-use emissions, incompatible with motorists' incentives, and ultimately expensive [8, 65]. Observers suggested several economic incentive approaches instead, with one proposing to charge vehicle owners based on the estimated annual emissions (see e.g., Walls and Hanson [19]). Both studies accounted for local pollutants, where Walls and Hanson [19] analyzed taxes on hydrocarbons (HC), while Sevigny [66] analyzes taxes on HC, carbon monoxide (CO), and oxides of nitrogen (NOx) [9]. Emission taxes are set based on the amount of emissions and environmental damage, called "Pigouvian taxes" [67].

Theoretically, a similar technology vehicle with similar environmental and fuel characteristics should emit the same level of emission [68]. However, taxing emission runs into the problem of complexity surrounding devising an effective tax instrument, since similar vehicles could emit different levels of pollutants. This extends to even the same vehicle, where the amount of pollutants emitted from a cold engine differs from that of a hot engine. The German Council of Environmental Advisors proposed a system that charges based on the quantities of emitted pollutants: according to the British Royal Commission on Environmental Pollution [16].

The idea of the environmentally progressive tax is that damaging effluents would be subject to additional taxes [24]. This also means that tax rates increase in tandem with marginal damages due to emissions [69]. Instead of charging everybody the same rate regardless of their respective level of emissions, progressive taxes charges people based on their respective emission levels [24]. A consumer who drives a gas guzzler and emit more pollutants would pay more than those who drive environmentally friendly vehicles [70]. The concept of a 'per-unit' is defined as taxing every additional 'unit, e.g. g/km of pollutant at a fixed cost [71] where a 'per-unit' taxation of emissions would include the cheapest forms of vehicle pollution abatement [72].

Wong and Chan [20] examined the effect of carbon tax on contractors' adoption of carbon reduction strategies. They concluded that carbon tax is significantly correlated to the adoption of carbon reduction strategies.

Walls and Hanson [19] stated that the most effective tax would be those that take emission reading in heavily congested areas at specific time of the day. They confirmed that this approach would be ideal in the case of HC (and/or NOx) emissions.

Paul and Wahlberg [18] posited that Global taxes can have significant policy steering effects. A carbon tax reduces carbon dioxide emission, which slows the effect of global warming.

Gregory [17] found that the effects of automobile pollution can be internalized by taxing the cars, gas, or emissions.

Caperton [23] studied progressive carbon tax in the context of preventing problems associated with weather-related effects of climate change, Massive droughts, Devastating tornadoes, and horrific wildfires. He pointed out that unless we begin curbing GHG emissions, things are only going to get worse, and concluded that progressive carbon tax is the correct approach.

Myers [73] considered the possibility of internalizing external costs via specific forms of taxation to correct market failure and charge the social costs of production. This theme is oft-repeated when deciding who pollutes and who does not. Each polluter is given the incentive to pay the full social cost of their action and adjust production. In theory, environmental pollution should decrease and the taxes paid by the consumer increase.

Field and Olewiler [37] pointed out that there is a concerted global effort at reforming fiscal systems in order to better address major externality problems, encompassing local air quality, road congestion, and climate change. They provided a template for thinking about tax reform. They stated that tax design become more complex if governments care only about revenue and environmental objectives. The cost-effective solution in this context involves two separate tax instruments for each objective. They illustrated an overall progressivity of alternate tax systems using a database of all (new/used) vehicle purchases in Mauritius in 2010. The vehicles are grouped by CO_2 per kilometer, although the average pre-tax vehicle price increases steadily per km.

van Meerkerk, et al. [74] reported that since 2008, passenger car taxation has become increasingly dependent on its CO_2-emissions. They analyzed recent changes in vehicle taxes in the Netherlands, encompassing the implementation of a surcharge for fuel inefficient vehicles (gas guzzler tax) and a progressive CO_2 registration tax. They concluded that small fuel-efficient cars are cheaper while its inefficient counterpart becomes more expensive.

Yang, et al. [75] discussed progressive carbon taxation in their work. They proposed an integrated inventory model with progressive carbon taxation, which minimizes both the total cost and carbon emissions. They went on to conclude that the excess progressive cost of the second gap and transport significantly impact the integrated inventory policy.

In summary, when vehicle emissions exceed the established standards, its owner is expected to pay for the emission cost, which necessitates fixing the price for a single unit of emission [76].

5. THE OPTIMAL PROGRESSIVE TAX POLICY

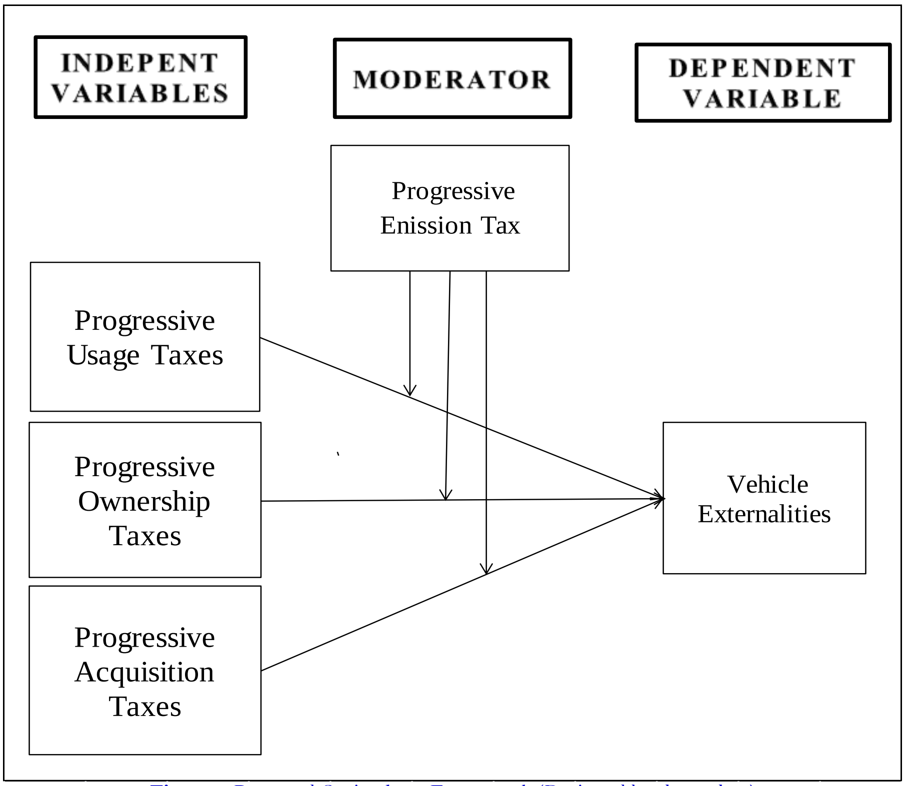
The optimal taxes system reported in the early 1970s resulted in many new areas of research; however, it also widens the gap between theorists and practitioners. To the latter, these new theories are an abstraction. Even now, it is known that the optimal tax theory reported minimal robust results that can be used to formulate policies [77]. A phrase 'optimal taxation' sets a high bar for research. Has somebody discovered the optimal tax system? The answer to this is a resounding no. Optimality always hinges on values. For example, income redistribution, which is always used to justify taxes, is a hot button issue with multiple purported solutions. Via positive economics, an optimal tax policy cannot be explicitly determined [78]. The standard theory of optimal taxation states that a tax system is to be selected to maximize social welfare, subject to preset constraints. The literature on optimal taxation typically treats a social planner as utilitarian, where, social welfare is based on the utilities of individuals in a society [79].

Mirrlees [80] began the modern debate on progressive taxation. He posited that the government needs to maximize the utilitarian social welfare function and select an income tax schedule that can increase revenue. A progressive tax on ability, which does not cost efficiency, was excluded due to the fact that ability is impossible for governments to quantify (cited in Slemrod [81]). Mirrlees [80] proposed another set of optimal tax models by formalizing planner's problem that explicitly addressed the unobserved heterogeneity in taxpayers. In the most basic models, individuals earn income differently. Income is an observable construct, defined by ability and effort (not directly quantifiable). If the planner tax high earning individuals, the higher taxes will discourage high earners from continuing to earn at that level. By recognizing unobserved heterogeneity, diminishing the marginal utility of consumption, and incentive effects, the Mirrlees approach formalizes the classic tradeoff between equality and efficiency faced by governments, which has dominated the approach of tax theorists (cited in Mankiw, et al. [79]).

In the context of externalities, a carbon price should be equal to the external social cost of emissions. However, there are no consensuses on the size of the external social costs. Discussions on the optimal carbon tax rates are rife in literature, with multiple viewpoints. Stern (2006) proposed an external cost exceeding $300/ton, while Nordhaus (2007) proposed a carbon tax of $30/ton of carbon, which is one-tenth that of Sterns. The difference comes from how the future should be discounted (cited in Zhi and Ma [82]). Mirrlees and Adam [54] found that only taxing fuel and fuel consumption and car ownership while not accounting for emissions and engine sizes will not result in optimal taxes.

We provide an all-encompassing review on the development of the concept over 75 years and outlined the current practices on road pricing, such as equity, the transition from theory to policy, and public acceptance (Button and Verhoef 1998; cited in Yang, et al. [75]). Huhtala and Samakovlis [83] proposed a scheme that can execute empirical comprehensive accounting and estimate emissions tax. The theoretical model accounts for the welfare effect of emissions on human capital. The model also included a production externality via the flow of air pollutants, resulting in direct disutility and indirect welfare effects due to the negatively affected productivity of labor. They also demonstrated that the defensive medical expenditures/healthcare costs that were allocated towards mitigating the disutility of air pollution should not be removed from the conventional net national product. Thus, they derived a marginal cost-benefit rule for an optimal level of pollution from the negative health effects by coming up with an optimal tax on harmful emissions.

Generally, individual views on the design of the tax structure potentially depend on multiple factors [84]. For example, Hayashi, et al. [10] revealed that in order to design an optimal tax scheme, a combination of different taxes could be regarded as 'optimal'. Therefore, this paper intends to design a structure of optimal progressive tax as shown in the diagram detailed below, because of the fact that many contemporary scholars proposed to imposed taxation based on the actual emissions test, in addition, car types/engines (see e.g., Klein [48]).



Figue-1. Proposed Optimal tax Framework (Designed by the author)

6. SUMMARY

Progressive environmental taxation is regarded as an important economic instrument that can effectively deal with pollution and protect the environment since the increase in per unit price of emissions helps to decrease environmental damage via the imposition of a high tax burden on polluters. This paper showed that the present tax policies for vehicles and other fiscal policies may not be adequate to reduce externalities, and there is need to apply a tax on emission sources. This means that the direct emission tax will increase the efficiency of vehicle taxes in reducing externalities. Therefore, this paper tried to design a proposed optimal tax system which is consists of a combination of progressive taxes in order to support policies reducing vehicles externalities.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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