The Effect of Tax-Related Emission Factors on Vehicles Exhaust Emissions: Mediating Role of Driver Motivations

by

YASSER AMMAR ABDULHAMEED AL-RAWI
(1442611383)

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LIST OF ABBREVIATIONS

ES	Engine Size
PEST	Progressive Engine Size Tax
VA	Vehicle Age
PVAT	Progressive Vehicle Age Tax
VKT	Vehicle Kilometers Travelled
VMT	Vehicle miles Travelled
PVKTT	Progressive Vehicle Kilometers Travelled Tax
VEE	Vehicle Exhaust Emissions
PEET	Progressive Exhaust Emissions Tax
TREF	Tax-Related Emission Factors
FRE	Factors-Related Emission
DM	Driver Motivations
MDOE	Malaysia's Department Of Environment
MAA	Malaysian Automotive Association
OECD	The Organisation for Economic Co-operation and Development
ppm	Parts Per Million
CO	Carbon Monoxide
NOx	Nitrogen Oxides
CO2	Carbon Dioxide
HC	Hydrocarbons
PM	Particulate Matter
SO2	Sulphur Dioxide
SPM	Suspended Particulate Matter
VOC	Volatile Organic Compounds

Kesan Faktor Pelepasan Berkaitan Cukai ke atas Pelepasan Ekzos: Peranan Pengantara Motivasi Pemandu

ABSTRAK

Pemahaman yang menyeluruh oleh pihak pembuat keputusan mengenai kos yang bersangkutan dengan pelepasan ekzos dan impaknya dapat membantu mengurangkan kesan negatif yang berkaitan, yang merupakan salah satu keutamaan bagi pihak kerajaan di seluruh dunia. Pengetahuan ini membantu mewujudkan dasar yang membolehkan individu membuat keputusan yang selaras dengan kepentingan kerajaan dan masyarakat untuk memaksimumkan faedah keseluruhan dan mengurangkan kesan luaran akibat penggunaan kenderaan. Di seluruh dunia, terdapat satu matlamat pra-tetap berbanding dengan pelepasan purata maksimum. Walau bagaimanapun, matlamat ini hampir mustahil untuk dicapai tanpa campur tangan pasaran. Oleh itu, pihak kerajaan memperkenalkan cukai untuk membimbing individu di pasaran ke arah pengurangan pelepasan.

Tujuan kajian ini adalah untuk meneroka peranan pengantara motivasi pemandu yang mempengaruhi kesan faktor pelepasan berkaitan cukai (cukai saiz enjin progresif, cukai pelepasan progresif, cukai jangka hayat kenderaan progresif, dan cukai perjalanan perkilometer kenderaan progresif) ke atas pelepasan ekzos kenderaan. Kajian ini diterapkan berdasarkan pendekatan kaedah campuran untuk mengumpulkan data primer, yang bertumpu terutama pada soal selidik dan sebahagiannya pada temu bual. Analisis data kuantitatif kemudian dilakukan dengan menggunakan Smart PLS 3.2.7. Bagi peranan pengantara, kajian mendapati bahawa pengenaan cukai progresif pada saiz enjin, jangka hayat kenderaan, dan pelepasan kenderaan, akan meningkatkan motivasi pemandu untuk membeli kenderaan yang mempunyai saiz enjin yang lebih kecil, menukar atau menyelenggarakan kenderaan lama yang mencemarkan atau mengatasi masalah pelepasan. Hasil yang diperoleh daripada temu bual mengesahkan hasil yang diperoleh daripada analisis kuantitatif.

Kajian ini menyumbang kepada kajian lepas dengan menyediakan satu rangka kerja sistematik yang menunjukkan asas teori motivasi Pigovian dan ekstrinsik. Rangka kerja ini juga mencapai matlamat teori dan praktikal dan menyampaikan mesej yang jelas kepada para pengamal dan mana-mana badan yang berkaitan di Malaysia bahawa cukai progresif dapat meningkatkan motivasi pemandu sebagai strategi untuk mengurangkan pelepasan ekzos kenderaan.

Cukai-cukai ini boleh dianggap sangat berkesan apabila ia dirancang dengan betul, ditetapkan pada kadar yang memadai dan adil, dan dikenakan sebaik mungkin ke atas bahan pencemar atau aktiviti yang merosakkan alam sekitar. Kajian ini merancang gabungan pelbagai cukai progresif yang menunjukkan teori keadilan (cukai saiz enjin, cukai jangka hayat kenderaan, cukai perjalanan perkilometer kenderaan dan cukai langsung ke atas pelepasan ekzos) dengan menggunakan bahasa visual studio 2010 (C#). Rancangan sistem cukai yang optimum memenuhi tujuan untuk mengubah motivasi ke arah pola yang kurang mencemarkan. Apabila pelepasan dikenakan bayaran, orang ramai akan sedaya upaya mengelakkan cukai dengan mengurangkan

pelepasan, seolah-olah kos yang ditanggung oleh orang lain akibat pelepasan itu ditanggung oleh para pemandu sendiri.

The Effect of Taxes-Related Emission Factors on Vehicles Exhaust Emissions: Mediating Role of Driver Motivations

ABSTRACT

The comprehensive understanding of the costs associated with emissions and understanding their impacts by decision-makers could help to reduce its negative effects, which is one of the main priorities for the governments in the worldwide. This knowledge would aid in establishing the policies that allow the individuals to make decisions consistent with the government and society interests in maximizing overall benefits and reducing externalities resulting from vehicle use. In the worldwide, there is pre-set goals vis-à-vis the maximum average emission. However, these goals are nearly impossible to realize without the intervention of the markets. Therefore many governments introduced the taxes to guide the personals towards reducing emissions.

The purpose of this study is to explore the mediating role of driver motivations in the effect of tax-related emission factors (progressive engine size tax, progressive emissions tax, progressive vehicle age tax, and progressive vehicle kilometres travelled tax) on vehicle exhaust emissions. The study was adopted on the mixed methods approach to collect primary data, where it was focused mainly on the questionnaire and partially on the interviews. An analysis of the quantitative data was then made using Smart PLS 3.2.7. For the mediating role, the study found that the progressive taxes on engine size, vehicle age, and vehicle emissions if imposed, it will increase driver motivations to buy smaller engine size vehicle, change or maintenance old polluting vehicle or fix emission problems. The results from the interviews confirmed the results obtained by the quantitative analysis.

This study contributes to the literature by presenting a systematic framework that demonstrates the underlying the Pigovian and extrinsic motivation theories. as well as achieves the theoretical and practical objectives by a clear message to practitioners and any related body of Malaysia that the progressive taxes can increase driver motivations as a strategy to reduce vehicle emissions.

The taxes may be considered as a very effective when they are designed properly, are set at an adequate and fairness rate, and are levied as close to the environmentally damaging pollutants or activity as possible. This study designed a combination of different progressive taxes that demonstrates the fairness theory (engine size tax, vehicle age tax, vehicle kilometre travelled tax and a direct tax on exhaust emissions) by using a language of visual studio 2010 (C#). The design of an optimal tax system may aim at changing motivations towards less polluting patterns. when emissions were priced, persons try to avoid taxes to the extent they can, by reducing emissions, as if the costs those emissions cause to others have become their own.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Malaysia is one of the most urbanized developing countries in the world (Duflot, 2012). It has a relatively well-developed economy within the ASEAN region (Kurabayashi et al., 2013). Malaysia's rapid urbanization rate surpasses China's urbanization rate. The annual rate of urbanization from 2010 to 2015 was estimated 2.4%, and if this trend continues, over 70% of the Malaysian population will be urban by 2020 (Duflot, 2012). As a result, vast population activities in urban areas exert an unprecedented impact on the environment. Such an impact results in higher demands for transport increased consumption patterns, and energy sources, as well as an increased number of vehicles on the country's cities' roads by 2050 (Okunola, 2012; Cassiani et al., 2013; Mathew, 2014). As analyzed by Kurabayashi et al. (2013), among (Thailand, Indonesia, Vietnam, Myanmar, and Malaysia), the percentage of households owning an "automobile" is the highest in Malaysia at 93.4 percent. This is mainly because private vehicles in Malaysia are more reliable and affordable than other ways of transport. Therefore, they have become one of the major modes of personal transport (Mohammed and Shakir, 2013; Borhan et al., 2014).

Shabadin et al. (2017) stated that the number of registered vehicles in Malaysia has increased by 100% in 2014. The data released by MAA shows that the total

number of Malaysian vehicles on roads standing at 28,181,203 units up to June 2017. That's mean 0.88 vehicles for every person in the country (https://paultan.org). Koonstra (1993) developed an exponential model to describe Malaysia's vehicle ownership in the year 2020. It was estimated that in 2000, a total of ~10 million vehicles were to be registered. This estimate is to some extent accurate because Malaysia has registered ~10.5 million vehicles in 2000. Koonstra (1993) pointed out that Malaysia will be saturated with vehicle ownership. It was found that there is one registered vehicle for every two persons in 2018 (cited in Rohayu et al., 2009). Owing two or three cars by individuals indirectly increases the kilometers traveled and substantially increases vehicle emissions (Keyvanfar et al., 2018). Figure 1.1 provides the statistics that are provided for the growth of passenger vehicles, which are registered in Malaysia until 2018.

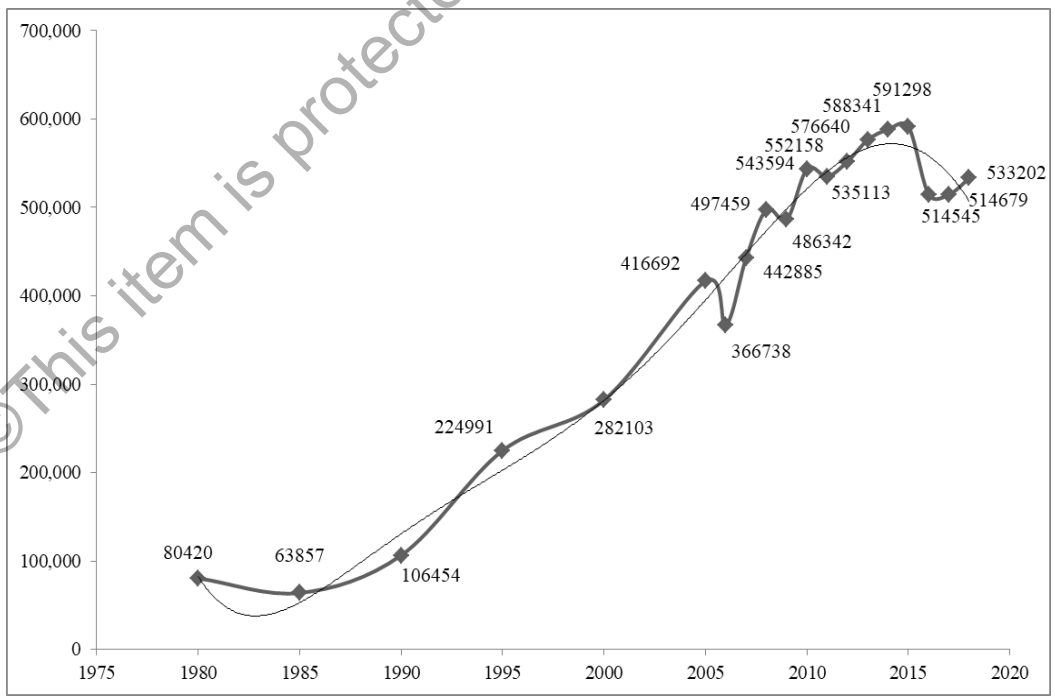

Figure1.1 New passenger vehicles registered in Malaysia for the years from 1980 to 2018 (MAA, 2018)

The steadily increased number of vehicles is shown in Figure 1.0. This increased number of vehicles has led to an increase of the VKT, where the average annual kilometer vehicle traveled in 2013 has increased 4994 kilometers from those traveled in 2007 (Shabadin et al., 2017). Figure 1.2 shows the total kilometers traveled by Malaysian vehicles in 2013 according to Shabadin et al. (2017):

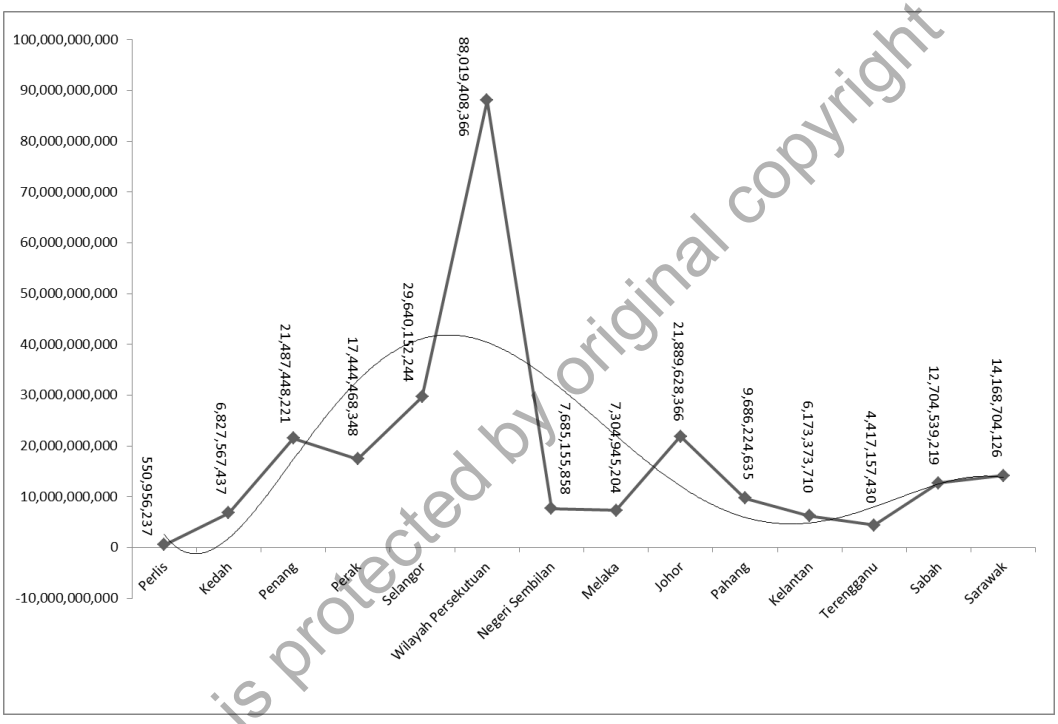

Figure1.2 VKT in Malaysia by states (Shabadin, et al., 2017)

Figure 1.2 shows and confirms that Penang, Selangor, Wilayah Persekutuan, and Johor have the highest percentages of VKT in comparison with other states in Malaysia. The annually increased number of vehicles indicates that the number of old vehicles on the road is increasing. Old vehicles have obsolete engines with high levels of emissions (Ong et al., 2011). Studies showed that the average emissions are increased when vehicles are older, where CO emission is higher for vehicles that are older than 12 years. Also, HC emissions are higher in the case of vehicles that are older than 10 years (Filipczyk and

Kutrzyk-Nykiel, 2010). Borken-Kleefeld (2013) suggested that an emission is directly correlated to the vehicle's age, especially if it is over a decade. Figure 1.3 shows a comparison between the statistics of passenger vehicles that exceed 10 years with those that are less than 10 years in Malaysia until March 2019.

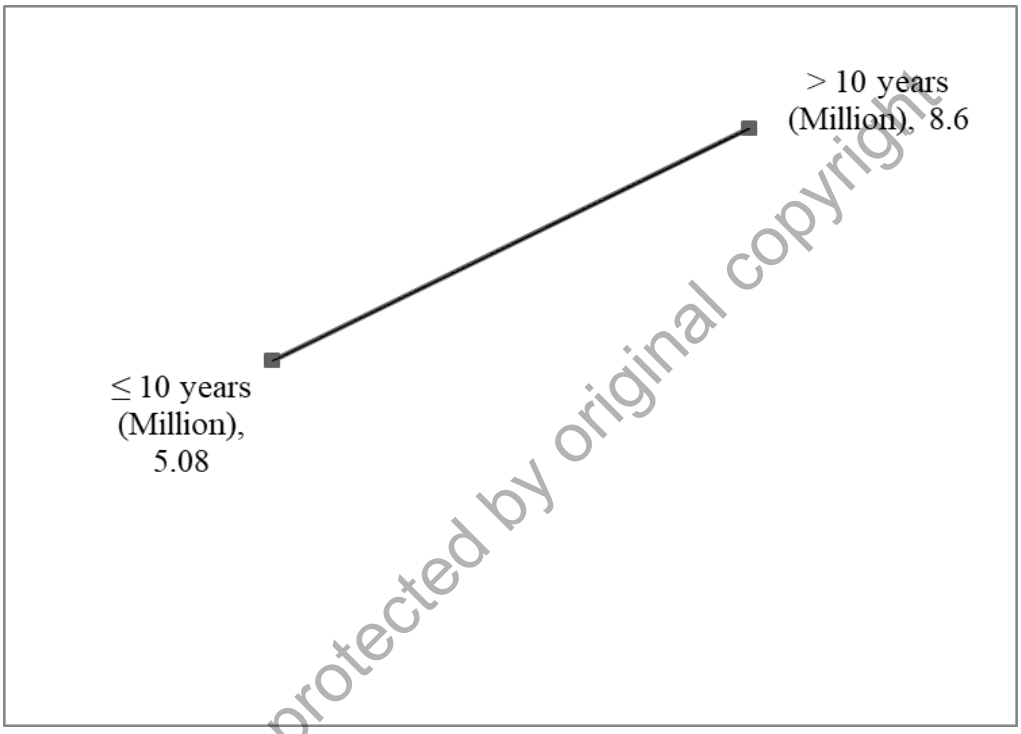

Figure1.3 Number of passenger vehicles registered in Malaysia according to the vehicles age until March 219 (https://www.statista.com; MAA, 2019)

Figure 1.3 shows that around 8.6 million old vehicles on roads are aged more than 10 years comparison with 5.08 million are less than 10 years; thus, the increasing number of old vehicles will lead to increased vehicle emissions as mentioned earlier.

Consequently, the emissions from motor vehicles represent the most significant sources of air pollution in many Malaysian urban areas. It has become a major environmental issue due to the increasing number of vehicles (mobile sources) (Teng and Tzeng, 1994; Innes, 1996; Shuhaili et al., 2013; Azid et al., 2015).

Therefore, the Malaysian Department of Environment (MDOE) stated, in its special report on air pollution, those industries, including power stations, motor vehicles, and open burning are the main contributors to the country's emissions, and emissions from mobile sources constitute a major source of air pollution (Innes, 1996; Mukhopadhyay and Thomassin, 2009; Salahudin et al., 2013; Mustafa and Rusli, 2016). For example, in 2015, motor vehicles were the main source of pollution, whereby the emissions from motor vehicles increased by 14.3 percent compared with those in 2010 (www.dosm.gov.my). Figure 1.4 provides the statistics of air pollution sources in Malaysia in 2016.

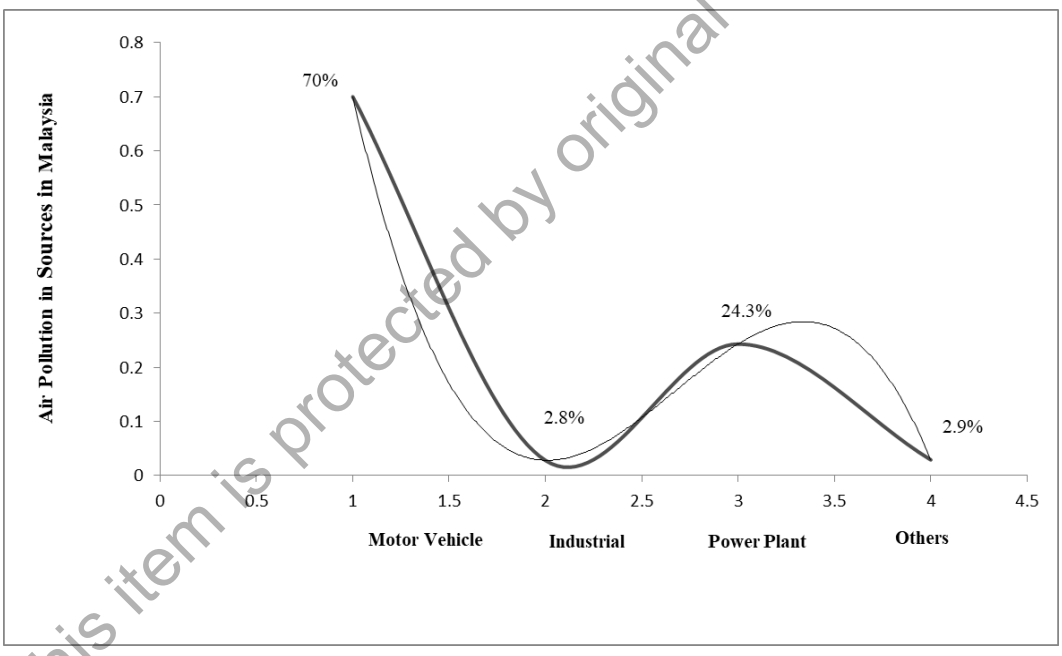

Figure1.4 Air pollution sources in Malaysia (www.dosm.gov.my 2016)

Figure 1.4 shows that air pollution, which is caused by motor vehicles is high compared with other sectors. However, due to the social pressures to reduce environmental degradation, environmentalism has emerged in this country to a certain degree in the early 1970s, and more so in the 1990s (Hong, 2013). Moreover, the growth of urban population, numbers of vehicles, and distance traveled are some of the trends confirming that exposure to traffic-related air