Energy xxx (2015) 1–10

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

The impacts of climate change policies on the transportation sector

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ARTICLE INFO

Article history:
Received 26 April 2014
Received in revised form
5 January 2015
Accepted 6 January 2015
Available online xxx

Keywords:
Climate change policies
Carbon tax
Energy tax
Transport
CGE (Computable General Equilibrium)
Rebound effect

ABSTRACT

This study examines the impact of carbon tax and its alternative, energy tax, on both the Malaysian economy and the transport sector, using a CGE (Computable General Equilibrium) framework. In order to achieve government revenue neutrality, two schemes for revenue recycling, namely lump-sum transfer and labour tax recycling, are employed. The simulation's results show that the carbon tax policy is more effective than the energy tax policy in reducing carbon emissions; because it is less expensive. The negative impact of the carbon tax, on real GDP (Gross Domestic Product) and investment, is less than the energy tax in both recycling schemes. Through lump-sum transfer, both taxes lead to an increase in the consumption and welfare of households, because the tax interaction effect is less than the tax recycling effect; however, through labour tax recycling, they decrease the consumption and welfare of all household groups. These tax policies are not beneficial for the transportation sector, because they lead to decreases in domestic output, domestic demand, exports and imports of all transport sectors. The climate change policies would lead to mitigation of rebound effect in whole of the economy and the transport sector.

1. Introduction

The primary concern of the consumption of fossil fuels is its environmental impact; especially the emission of carbon dioxide. As a developing country, to maintain economic growth, Malaysia is still very much dependent on fossil fuels; mainly natural gas, coal, and oil, for its commercial energy demands and electricity generation. The total final energy demand in Malaysia in 2012 was estimated at 46.7 mtoe (million tonnes of oil equivalent); which is a 732% increase on that of the year 1980 (6.49 mtoe). According to the ITF (International Transport Forum), Malaysia is one of the top 10 CO_2 emitting non-ITF economies. North America and the top-ten CO_2-emitting non-ITF/OECD countries, namely Brazil, China (including Hong Kong), Islamic Republic of Iran, Indonesia, Kazakhstan, Malaysia, South Africa, Saudi Arabia, Chinese Taipei, and Thailand, dominate representing 55% of world emissions [26]. With an increase in energy demand to sustain the country's growth, it is inevitable that CO_2 emissions will continue to climb; as long as fossil fuels remain the main contributor in the energy mix. In 2009, the total CO_2 emissions from fuel combustion in Malaysia was 164.2 Mtc (million tonnes), of which the electricity and heat production sectors, with 68.2 Mtc, was the main CO_2 pollutant, followed by the transport sector with 41.2 Mtc, and manufacturing with 32.9 Mtc [25].

The main energy users in the transportation sector are motor vehicles [3]. In 2010, according to the Malaysia Environmental Quality Report, 95% CO, 29% NO_2, 17% PM (Particulate Matter), 8% SO_2, and significant quantities of hydrocarbons (VOC), were emitted by the transport sector [16]. Although passenger cars are the major contributors of CO_2, N_2O, and CO pollution emissions, motorcycles are the main source of HC (hydrocarbon) emissions [43]. Further results indicate that a CO_2 emission of 71% of the total CO_2 equivalent is the primary source of greenhouse gas pollution. In light of these statistics, the transport sector is the primary source (or the precursor) of air pollution in Malaysia.

By decomposing several indicators of the 1980–2005 period, Timilsina and Shrestha [61] found that the main factors for increased CO_2 emissions in the transport sector of Malaysia, and other Asian countries, are per capita gross domestic product,

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http://dx.doi.org/10.1016/j.energy.2015.01.017
0360-5442/

transportation energy intensity and population growth. In contrast, Wee et al. [67] showed that Malaysia as a developing county needs the most important development plans with minimum energy consumption and CO_2 emission to achieve its development targets. Therefore, in this country, reducing CO_2 emissions by reducing per capita activity is not feasible. However, reducing CO_2 emissions is possible by reducing energy intensity and carbon intensity. This finding was supported by Ong et al. [42], who analysed the trends of energy patterns and emissions from road transport in Malaysia, and Al-Mofleh et al. [3], who analysed the factors influencing the pattern and emission level of energy consumption in the Malaysian transport sector.

The analytical findings of the aforementioned studies show that adopting suitable energy policies is necessary to decrease energy demand and emissions. Furthermore, Almselati et al. [4], using an analytical approach, concluded that a shift towards public transportation can reduce CO_2 emissions through a decrease in fuel consumption. However, this is not possible unless the quality of public transport improves. Although Almselati et al. [4] studied GHG (greenhouse gas) emissions in the Malaysian transport sector, they failed to address the effects of policy instrument on the reduction of carbon emissions. From the above literature, it can be concluded that, not only is the adoption of suitable energy policies necessary for reducing carbon emissions, but efficient public transport is essential.

Empirical studies on climate change policies have shown that a carbon tax can help the environment by reducing emissions from GHGs, all be it with an initial negative impact on economic growth [6,11,14,36]. Studies on the Malaysian economy regarding this policy instrument showed that a carbon tax is effective in reducing carbon emissions. Nurdianto and Resosudarmo [41] explored the impact of coordinated and non-coordinated carbon tax policies on the economy and the environmental performance of each ASEAN country. The findings for Malaysia showed that, in the symmetric carbon tax policies, the level of carbon emissions decreased and these policies had negative effects on real GDP (Gross Domestic Product), household income, and sectoral output. However, the effects of the asymmetric carbon tax policies on carbon emissions were positive; but on other economic indicators were negative.

In the international literature, many studies have investigated emissions from the transport sector such as [22,46,70]. Michaelis and Davidson [39] argued that, due to the high pollution of CO_2 from this sector, the first priority is the energy intensity (energy use per passenger km or tonne km) reductions, and the renewable energy sources can reduce GHG emissions per unit of energy. In contrast, Creutzig et al. [15] concluded that standards and regulations regarding low carbon fuel emissions are more effective than renewable fuel standards in controlling the amount of greenhouse gases from transportation fuels. These studies concluded that policies that lead to a decrease in the consumption of energy in the transport sector are more effective than using renewable energy sources to reduce GHG emissions.

Almselati et al. [4] mentioned that in order to reduce CO_2 emissions, it is suitable to expand public transport and improve the quality of vehicles. Under the VIBAT London study, Hickman et al. [23] found that the techno-optimist user role is only likely to achieve reductions of 6.2% in CO_2 reduction relative to the business as usual scenario in 2025.

Pongthanaisawan and Sorapipatana [47] developed an econometric model based on two mitigation scenarios, namely fuel switching and energy efficiency options, to investigate the prospective trends of energy demands and GHG emissions in the Thai transport sector. They found that the fuel-switching option could significantly reduce the amount of GHG emissions in a relatively short period; whereas, the energy efficiency option was more effective for reducing GHG emissions in the long-term.

Van Dender [63] suggested that the high levels of fuel taxes, used to create conditions for low-carbon emissions in private road transport, are no more effective than a stable environment program for investment, research, and development. Similarly, Yan and Crookes [69] showed that private vehicle control, fuel economy regulation, and fuel tax, were the most effective instruments at reducing total energy demand, petroleum demand, and greenhouse gas emissions in China's road transport during the 2000–2005 period. However, the promotion of diesel and gas and biofuel promotion measures was not effective. That said, the biofuel promotion measure was more effective in reducing petroleum demand than total energy demand.

By employing an econometric method, Kim et al. [30] showed that a carbon tax on gasoline is an effective policy to reduce GHG emissions in the Korean transport sector, and that it is cost-effective. In short, an effective plan to reduce GHG emissions is the implementation of both renewable or environmental programs, and carbon or energy tax policies. Relevant studies in the transport sector that employed a CGE (Computable General Equilibrium) model to analyse CO_2 emissions and GHGs (Greenhouse Gases), showed that in countries with pre-existing taxes, such as the US and Europe, exemption of transport from a carbon tax increases the level of carbon emissions and the welfare of households [1,2,45].

Similar to Yan and Crookes [69], He et al. [21] showed that fuel economy was useful in reducing energy consumption and CO_2 emissions in China's road transport sector. Their findings indicated that China requires an immediate improvement of vehicle quality, in order to decrease the high consumption of oil and CO_2 emissions in transport.

The above CGE studies investigated the policy instruments for a specific area within the transport sector. They concluded that environmental and carbon tax policies are required for the effective reduction of GHG emissions in the transport sector. These findings emphasise the importance of analysing the effects of climate change policies, such as carbon and energy tax policies in all transport sectors.

The Malaysian government is committed to carbon emissions reduction according to the Copenhagen agreement. It wants to achieve a 40% carbon intensity reduction by 2020, compared to 2005. One of the proposed measures is carbon taxation. Carbon taxation will have a significant impact on all economic sectors; especially the transport sector.

The contribution of this study, in comparison to previous studies in Malaysia, is that it employs a CGE framework and analyses the impact of climate change policies on the transport sector. In the context of carbon emissions, studying the transport sector is essential; given that in Malaysia, 68.2% of air pollution is attributable to the transport sector, compared to 29.5% from stationary sources (i.e., industries, including power plants) [17]. In addition, the transport sector is also the main energy user in Malaysia. In 2010, it used over 40% of total final energy, and over 60% of petroleum products [40]. This paper, using a CGE (Computable General Equilibrium) framework, attempts to explore the impact of the carbon tax policy, compared to an energy tax policy, on the Malaysian economy, welfare, and emissions, and on the main Malaysian transport sector indicators, such as output, value added, employment, household consumption, and demand for fossil fuels. This study also aims to answer to this question that how climate change policies affect rebound effect in transport sectors. Computable general equilibrium models assist in tracing the effects of these policies on a specific sector. In this study, the transportation sector includes four sub-sectors, namely land, water, air, and other transport.

Please cite this article in press as: Solaymani S, et al., The impacts of climate change policies on the transportation sector, Energy (2015), http://dx.doi.org/10.1016/j.energy.2015.01.017