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Economics and environmental implications of fuel efficiency improvement in Malaysia: A computable general equilibrium approach

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ABSTRACT

The continued increase in urbanization and vehicle ownership poses an increasing challenge in curbing the rising energy consumption and CO_2 emissions in Malaysia. For more than a decade, road vehicles have been the leading contributor in the country, due mainly to their heavy reliance on petroleum products, particularly gasoline and diesel. The efficient utilization of petroleum products becomes paramount in reducing Malaysia's overall CO_2 emissions in the land transportation sector. The timely abolition of petroleum product subsidies in 2014 may provide a financial source to support the improvement of petroleum product efficiency. The primary purpose of this paper is to examine the impact on economic growth and sectoral performance with fuel subsidy savings being reallocated to the biofuel industry for research and development purposes. The study then investigates whether an environmental tax on petroleum products could induce more energy saving and emission control. This research applies the computable general equilibrium modeling for the simulation, as it takes into account the interaction between petroleum products and the economy as a whole. The *Malaysia Input-Output Tables 2010* is the main database used in the simulation. The simulation results found that fuel efficiency improvement could produce a double dividend effect with simultaneous benefits on the economy and environmental quality. A simultaneous implementation with fuel tax policy appears to be one suitable complementary measure for a further emission cut. However, sufficient compensation schemes might be necessary to stimulate economic activities over time. Based on the simulation results, policymakers should emphasize fuel efficiency improvement as a crucial strategy to control the rising energy consumption and emissions in Malaysia.

1. Introduction

Energy is an indispensable factor in ensuring rapid economic growth, especially in developing countries. The efficient use of energy commodities would be paramount for countries to achieve continued economic development while adopting a greener approach. However, as a consequence of the heavy reliance on fossil energy use in production and consumption processes, it appears inevitable that developing countries will experience rising emissions levels over time as economic growth continues (Ministry of Finance Malaysia, 2015).

In Malaysia, the *National Energy Balance 2014* (Energy Commission, 2016) reports that energy intensity (million tonnes CO_2/USD billion GDP) is relatively high compared to neighboring countries. Table 1 shows that Malaysia is more energy intensive than Singapore, which has an income per capita three times higher than Malaysia. For Indonesia, despite her energy intensity being higher than Malaysia, it has fallen more than 30% between 2000 and 2013. Myanmar had a similar experience; its energy intensity was 58% lower in 2013 than 2000. By contrast, Malaysia has shown a relatively static energy intensity, with energy efficiency improving rather slowly compared to other ASEAN countries.

Malaysia's high energy intensity is attributed mainly to heavy energy use by the transportation sector. The Malaysian *National Energy Balance 2014* reports that the transportation sector alone consumed more than 40% of the total energy used in 2014. Petroleum products make up the largest energy type used in that sector.

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Table 1
Final energy intensity in ASEAN countries (mtoe/USD billion GDP).

Countries	2000	2005	2009	2011	2012	2013
Brunei	0.07	0.07	0.11	0.17	0.18	0.11
Indonesia	0.53	0.47	0.41	0.39	0.37	0.36
Malaysia	**0.26**	**0.26**	**0.26**	**0.24**	**0.24**	**0.26**
Myanmar	1.75	1.08	0.76	0.71	0.63	0.73
Philippines	0.29	0.22	0.19	0.17	0.17	0.17
Singapore	0.10	0.13	0.14	0.14	0.09	0.10
Thailand	0.37	0.40	0.40	0.42	0.44	0.42
Vietnam	0.68	0.67	0.65	0.65	0.24	0.55

MTOE (million tonnes of oil equivalent).
Source: Energy Commission (2016)

Among the most commonly used petroleum products in Malaysia are gasoline (RON95 and RON97) and diesel. The steady rise in consumption in the past, as shown in Energy Commission (2016), shows the tendency towards inefficient use among local economic agents, especially vehicle owners, even though fuel is no longer subsidized by the government. The high-energy consumption in the land transportation sector especially has also raised the energy security issue in the country. The *Economic Report 2015/2016* reports that the existing crude oil reserves in Malaysia are sufficient only for another 27 years of production, if no new oil fields are found (Ministry of Finance Malaysia, 2015). In addition, the International Energy Agency has long stated land transportation as a large and emission-intensive sector in Malaysia. The same source reports that more than 95% of total transportation emissions in Malaysia came from land transportation.

These challenges raise the necessity for cleaner technologies or products that employ lesser energy inputs or produce fewer emissions. To address such concerns, the country might need to improve the technical efficiency of energy use including advancing its current technological standards in processing petroleum products. This paper is relevant as it analyzes empirically the economics and environmental impacts of increases in energy efficiency within the land transportation sector in Malaysia.

Technological progress is one solution to addressing high energy use and emissions issues and moving toward sustainable economic development. Energy efficiency improvement is often used synonymously with reduced energy use, with output and utility levels being constant throughout a given time frame (Broberg et al., 2015). This study focuses on the fuel efficiency of petroleum products, as they remain the primary fuel for land transportation in Malaysia. In this paper's context, technological change relates to greater use of eco-friendly transportation mode and/or technological advancements in manufacturing petroleum products that contribute to declining energy and/or emissions intensity in the land transportation sector.

Practically, the land transportation and petroleum refining industries may undertake the initiative of improving vehicle engines and gasoline and diesel on the technical front. So that, the same amount of fuel burned would result in greater travel distances, reduced emissions, or both. In another way of saying, the vehicles consume lesser fuel to reach the certain distance. The term "fuel efficiency" will be used in this paper to refer to these technological improvements. The primary objective of this study is to examine the effectiveness of greater fuel efficiency improvements in controlling emissions while preserving economic performance.

This study investigates both autonomous and endogenous change in fuel efficiency improvement in order to determine which is more effective for controlling emissions in Malaysia. Technical progress can be exogenously induced, but can also be endogenous to some degree, based on policy interventions or economic pressures. The study first addresses autonomous energy efficiency improvement (AEEI) to recognize the impact of fuel efficiency improvement on its own. The Malaysian government has established a target of improving energy efficiency by 40% by 2020 through its Green Procurement Long-Term Action Plan 2016–2020 (GreenTech Malaysia, 2016). So far, specific quantitative targets for fuel efficiency improvement in petroleum products are vague. For justification, this study estimates fuel intensity by dividing petroleum product use into GDP over the years 2001–2013. Table 2 shows that the country experienced an average of 5.19% fuel efficiency improvement in that period. For empirical investigation purposes, this study investigates the effectiveness in creating emissions controls while preserving economic performance, assuming a five percent fuel efficiency improvement that results from a one-off improvement in fuel efficiency.

In Malaysia, technological change is more likely to be induced by policy initiatives, because the principal-agent and free rider problems among domestic firms have always discouraged spontaneous technological advancement in Malaysia (Popp et al., 2010). This raises the question of whether endogenous fuel efficiency improvement is more effective in generating energy saving and better at controlling emissions than simply imposing a certain rate of technical improvement through command and control. For fiscal restraint purposes, the government may need to find a new financial source to support research and development (R&D), and the December 2014 fuel subsidy abolition may just provide such a source. The government could reallocate the fuel subsidy savings as a research fund to be invested in renewable energy, such as biofuel production.

Price mechanisms could be implemented as a complement to fuel efficiency improvement in order to reinforce the latter's effectiveness in encouraging energy savings and better emissions controls. Establishing a fuel price that reflects market realities by eliminating the fuel subsidy is a fundamental step in reducing fuel wastage, but ensuring sustainable economic growth may require smarter use of petroleum products. To this end, an environmental tax may become necessary as a complementary policy to encourage even more efficient use of petroleum products. This increasing complexity calls for empirical research into fuel efficiency improvement combined with the environmental tax. The empirical investigation in this study considers the economic impact of the fuel efficiency if implemented together with a fuel tax and the fuel subsidy abolition that is already in place. The term "fuel tax" is used interchangeable with "environmental tax" in this paper.

The significance of this study arises from three perspectives. Firstly, while there is an extensive literature encouraging fuel efficiency improvement in Malaysia as one solution to reduce emissions, many of these studies have used descriptive analysis (Silitonga et al., 2012) or partial equilibrium analysis (Hasanuzzaman et al., 2011). Relatively few have empirically studied the economy-wide impact of energy efficiency improvement. So far, Raitzer et al. (2015) is the closest literature discussing the impact of global climate stabilization in Southeast Asia including Malaysia using a computable general equilibrium (CGE) model. The present paper covers the impact of energy efficiency on emission control in general, without focusing on a specific energy input type. This paper will enrich the current literature by analyzing the impact of petroleum product's efficiency improvement on economic growth and controlling emissions by employing a CGE model.

Secondly, most local literature have not stressed much on the impact of rebound effect of energy efficiency improvement, despite acknowledging that its existence may diminish the energy savings generated by the efficiency gains. Rebound effect is the increase in energy use at a later period after the fuel efficiency improvement had generated some energy savings initially (Turner and Hanley,