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4 **Economic, Social and Environmental Impacts of Fuel Subsidies:**  
5  
6 **A Revisit of Malaysia**

7  
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15  
16 **Abstract**

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18 Subsidizing energy has been widely used but is economically unfavorable. The Malaysian  
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20 government has shown strong intention to reduce energy subsidies recently, but face challenges to  
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22 prepare policy instruments to manage the impact. This study develops a Computable General  
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24 Equilibrium (CGE) model with breakdown of households by income level to evaluate the potential  
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26 impacts of removing energy subsidies on the Malaysian economy. It is shown that removing  
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28 petroleum and gas subsidy would improve economic efficiency and increase GDP up to 0.65%.  
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30 Budget deficit would be largely reduced after removing the petroleum subsidies, especially when  
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32 the saved subsidy cost is not budgeted for other expenditure. Households would be worse off in  
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34 most scenarios due to higher price level, but some compensation policy could make the lowest  
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36 income group no worse than baseline, without harm the economy. The reduction in carbon  
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38 emissions ranges 1.84-6.63% in different scenarios. The simulation results suggest Malaysia to  
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40 completely remove all fuel subsidies and use the saved funding to cut budget deficit or spend on  
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42 education, health and other service sector. It is also necessary to set a compensation scheme to  
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44 minimize public resistance and make sure such scheme is affordable.  
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53 Key words: CGE model; Fuel subsidy reform; Household; Carbon emissions; Malaysia

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4 **1. Introduction**  
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6       Subsidy has been an important energy policy instrument in many countries due to social and  
7 political concerns, but is widely deemed as economically unfavorable. Although different in form,  
8 energy subsidies generally work by directly or indirectly lowering the net amount paid by energy  
9 consumers or raising the effective price received by energy producers (IEA, 1999). Subsidies to  
10 energy products make consumers lack incentive to conserve energy, as the subsidized energy prices  
11 cannot reflect the true costs of energy supply and disclose adequate information of resource scarcity.  
12 Subsidies to energy producers also hamper their efforts to optimize production and adopt more  
13 advanced technologies. Over-use of energy caused by both types of subsidies would accelerate the  
14 depletion of fossil resources and aggravate environmental degradation (e.g. climate change, acid  
15 rain and air pollution).  
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30       From social perspective, as differentiating customers is costly in practice, energy subsidies to  
31 households are usually applied to all income groups and may even spill over to industries in practice.  
32 Against the original intention of assisting disadvantaged groups, the universal energy subsidy  
33 benefits accrue disproportionately to higher income groups as the poor overall consumes much less  
34 energy. Over-consumption arising from subsidized prices also tends to increase import demand of  
35 net energy importers or reduce exports by net energy exporters, which will deteriorate the country's  
36 balance of payments and raise concerns on energy security. These environmental, economic and  
37 social concerns have motivated governments and international organizations to vote for removing  
38 energy subsidies.  
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52       An evolving trend towards no or less energy subsidies originated in OECD countries during the  
53 1990s, and has spread to developing and transition economies gradually. For developed countries,  
54 environmental problems (especially climate change) and the goal for sustainable development are  
55 their major motivations to phase out energy subsidies. Since the Rio Earth Summit in 1992, the  
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4 wealthy countries have made great efforts to reduce the distortions in energy markets (OECD,  
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6 1997a). On the other hand, economic growth is the primary concern of developing and transmission  
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8 countries. Usually it is pressure from international community or/and financial burden on fiscal  
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10 budget that force them to reform energy subsidies.  
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14       Particularly, subsidies to fossil fuels are prevailing and serious in the Association of Southeast  
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16 Asian Nations (ASEAN), which amounted to \$51 billion in 2011 (IEA, 2013). Even so, Malaysia is  
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18 an outstanding example in the neighborhood. In 2011, the share of after-tax fossil fuel subsidies to  
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20 GDP was roughly 7.2% in Malaysia, only less than 8.4% in Brunei but much higher than the world  
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22 average of 2.7% (Clements *et al.*, 2013). In terms of the ratio of energy subsidies to overall  
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24 government budgets, Malaysia had the highest ratio in ASEAN at about 32.9%, which was much  
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26 higher than the world average of 8.1% (Clements *et al.*, 2013). Estimates show that higher-income  
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28 groups got more than 70% of the fuel subsidies in Malaysia (NEAC, 2009). Table 1 gives an  
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30 overview of Malaysia's subsidy policies for fossil fuels.<sup>1</sup> Generally, budget for petroleum subsidies  
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32 in Malaysia has grown substantially overtime since 2000. Gas subsidies provided indirectly by  
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34 PETRONAS do not explicitly appear on the fiscal budget, but implicitly affects government  
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36 revenue through reduced corporate tax base. The amount of PETRONAS' forgone revenue is much  
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38 larger than petroleum subsidies in size.  
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46       Malaysian government proposed to gradually rationalize commodity subsidies in the "2010-  
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48 2015 Malaysia Plan", motivated by rising budget deficit and national debt, dwindling current  
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50 account surplus and currency depreciation partially due to lacking actions to cut budget deficit  
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52 (IISD, 2014). However, the initial government plans did not succeed, except an ad hoc increase of  
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54 petroleum price in September 2013 (see Table 1). Only the low oil price at the end of 2014 finally  
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58 <sup>1</sup> Electricity consumers may receive monthly rebate and even a discount on bills (e.g. government schools and welfare  
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60 homes). As the amount is small if compared with subsidies to fossil fuels, direct electricity subsidy would not be  
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62 discussed in this study.  
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4 made it possible for Malaysia to overhaul fossil fuel subsidies to some extent (Adam and Pakiam,  
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6 2014). But the fundamentals of petroleum subsidy policy has not been changed, and it is not clear  
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8 whether the fossil fuels subsidies will come back if the oil prices increase again (Shi, 2016).<sup>2</sup>  
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11 However, while the majority of citizens may support the subsidy rationalization policy, the rest  
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13 who are not willing to part with the subsidies may hamper the reform. A poll conducted by the  
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15 government shows that 61% of the Malaysian public supported reducing subsidies (IISD, 2013).  
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17 The 2013 adjustment still incurred fierce oppositions from political parties and the public, and  
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19 triggered several protests across Malaysia due to corruption concerns and doubts on the  
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21 government's promises (IISD, 2014). Therefore, it is timely to investigate the economic, social and  
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23 environmental impacts of different reform schemes, identify the most vulnerable sectors and income  
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25 groups, and evaluate potential compensation to households. A static computable general equilibrium  
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27 (CGE) framework is developed based on Malaysia's input-output (I-O) tables to implement the  
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29 assessment.  
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35 Compared to existing studies on energy subsidies in Malaysia, this paper contributes to the  
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37 literature in the four aspects. First, households are disaggregated into four groups by income so that  
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39 the differential impacts of fuel subsidy reform on different income groups and compensation  
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41 policies targeting the poor could be analyzed. Second, in addition to petroleum subsidies that are the  
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43 major topic in previous studies, natural gas subsidy provided by state-owned gas supplier is also  
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45 analyzed in this study. Third, different settings are simulated for the use of saved budget or  
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47 increased tax revenue stemming from subsidy reform, which could provide policy makers a range of  
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49 potential impacts depending on government behavior. Last, this study uses the recently released  
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51 Malaysia's 2010 I-O tables, while previous CGE studies are based on its 2005 or older I-O tables.  
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60 <sup>2</sup> An Incentive Based Regulation framework for natural gas was scheduled to be introduced in January 2016, but so far  
61 no obvious action has been taken or publicized.  
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4 The paper proceeds as follows: Section 2 briefly reviews literature on energy subsidies and  
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6 studies relevant to Malaysia. Section 3 introduces the CGE model and scenario settings. Simulation  
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8 results and interpretations are reported in Section 4. The last section discusses the policy  
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10 implications and concludes the paper.  
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## 15 16 **2. Literature Review** 17

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19 Although advocated by economists and environmentalists, not all the interest groups support  
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21 abolishing energy subsidy. Major opponent opinions are that disadvantaged groups would not be  
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23 able to couple with the market prices of fuels and electricity, and firms would face higher  
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25 production costs which would be partially passed on to consumers and partially undertaken by the  
26  
27 firms. In other words, the general public and also the industries would not support such policy. The  
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29 debates have been ongoing for decades, and public protests or even riots took place when some  
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31 countries attempted to revise exiting policies for energy subsidy. For example, when the  
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33 government raised the petroleum prices by 23% on February 2006, the public expressed their  
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35 dissatisfaction and anger through protests (Bacon and Kojima, 2006). Moreover, fuel subsidy  
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37 removal is also often used as a weapon in domestic politics (Shi and Kimura, 2014).  
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43 Along with the years of debates and practices, a large body of research has been conducted to  
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45 investigate energy subsidy related issues. The research was primarily initiated and has been driven  
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47 by international organizations such as the United Nations, World Bank, OECD and IEA. Early  
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49 studies made great efforts in estimating the extent of energy price distortions or the amount of  
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51 subsidies provided (e.g. Kosmo, 1989; Larsen and Shah, 1992; Koplow, 1993; IEA, 1994 and 1995;  
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53 Larsen, 1994; Larsen and Shah, 1995). Several metrics, such as the divergence between actual and  
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55 “undistorted” prices, producer support estimate, consumer support estimate and aggregate measure  
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57 of support, have been developed to measure different types of energy subsidies (Porter, 2002).  
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4 With the implementation of energy subsidy reform over the world, qualitative literature focus  
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6 on lessons learned from past experience, challenges for reform and the design of optimal strategies  
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8 for governments to smooth the reform path based on country-specific conditions (e.g. OECD, 1996,  
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10 1997b, 1998, 2005 and 2013; IEA and UNEP, 2001; UNEP, 2004 and 2008; World Bank, 2010).  
11  
12 Quantitative literature usually uses numerical models to analyze economic, environmental and  
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14 welfare impacts of energy subsidies (e.g. Burniaux *et al.*, 1992; Light, 1999; Anderson and  
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16 McKibbin, 2000; OECD, 2000; Burniaux and Chateau, 2011; Burniaux *et al.*, 2011; Liu and Li,  
17  
18 2011; UNDP, 2012; Acar and Yeldan, 2016; Dennis, 2016; Rentschler, 2016). As the quantitative  
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20 studies differ in scope, methodology and years of reference, the results obtained are quite diverse  
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22 and not directly comparable. Among others, CGE modeling- a macroeconomic framework based on  
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24 general equilibrium theory- is the most common approach adopted to quantify the impacts of  
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26 subsidy reform. Most quantitative studies at global and regional levels by international  
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28 organizations and institutes are based on CGE modelling (e.g. OECD, 2013; UNEP, 2014).  
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35 Studies on energy subsidies relevant to Malaysia also appeared in the recent literature. IISD  
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37 (2013) reviewed Malaysia's energy subsidies by fuel type and identified experiences that could be  
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39 useful to Malaysia from efforts to reform energy subsidies in other countries. IISD (2014) focused  
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41 on Malaysia's fuel subsidy reform in 2013, and discussed lessons learned from the reform. There  
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43 are also some quantitative studies using CGE models and Malaysia's 2005 I-O tables. Solaymani  
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45 and Kari (2014) evaluated the impacts of removing petroleum subsidy and electricity rebate on  
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47 Malaysia, with a focus on the transportation sector. They show that the outputs of land transport,  
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49 water transport and air transport would decrease by 3.5%, 1.2% and 2.1%, respectively. Similarly,  
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51 Solaymani *et al.* (2015) investigated energy subsidy reform and the resulting change in travel  
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53 behaviours of rural, urban and noncitizen households. Solaymani *et al.* (2014) explored the impacts  
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55 of removing all government subsidies, including those on food, energy and education. It is  
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4 discovered that poverty levels among rural households would increase more significantly than urban  
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6 households. Solaymani (2016) focused on the poverty and income inequality impacts of energy  
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8 subsidy reform, and found that urban households would suffer more than rural and noncitizen  
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10 households.

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13 The several quantitative studies discussed above focus on certain industries or differentiated  
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15 impacts on household groups by ethnic or residential area. Since identifying the most vulnerable  
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17 group is essential for targeted policy measures, efforts are made in this paper on disaggregating  
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19 households by income level based on Malaysia's household income and expenditure surveys in  
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21 2009/2010. The disaggregation allows comparing different impacts of fuel subsidy reform on  
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23 different income groups and also assessing the effectiveness and economic feasibility of  
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25 compensation policies targeting disadvantaged groups, which are not seen in existing literature.  
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27 Increased commodity prices due to higher energy prices after subsidy removal were expected to hurt  
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29 the poor more than high income groups (IISD, 2013).  
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35 Indirect natural gas subsidies provided by PETRONAS have different funding from petroleum  
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37 subsidies. And more than half of Malaysia's electricity is generated by natural gas. Given the  
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39 magnitude of gas subsidies, it is worthwhile to investigate its transmission mechanisms of gas  
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41 subsidies individually. Therefore, unlike existing studies that focus on petroleum subsidies or  
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43 analyze government subsidies/energy subsidies as a whole, analysis of gas subsidies is within the  
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45 scope of this paper. The saved budget from subsidy removal in the existing studies is not planned  
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47 for any other use other than cutting budget deficit. This assumption is also considered as the default  
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49 setting in this paper, but spending the saved budget or increased government revenue on  
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51 infrastructure development or/and education, health and other public services is additionally  
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53 evaluated as alternative options for the government to better utilize the extra funding. Last, the latest  
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55 2010 I-O tables used in this paper is supposed to be more appropriate in accessing the subsidy  
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3 reform initiative than the 2005 version of I-O tables used in previous studies. This is because during  
4 the Mahathir's premiership up to 2003, subsidy was mainly in the form of forgone tax revenue-  
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6 little in direct subsidy (Thillainathan 2009; Hamid and Rashid 2012). The amount of fuel subsidies  
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8 was kept at unsustainable level in more recent years.  
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### 11 12 13 14 15 16 **3. Methodology and Data** 17

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19 In this paper, a static Malaysian CGE model is developed to quantify the potential impacts of  
20 energy subsidy reform. In the model, the behaviors of each agent, such as households, firms and the  
21 government, are specified by a system of non-linear functions. When an external shock comes, the  
22 interactions of these agents would lead the economy to a new equilibrium. Comparing equilibriums  
23 obtained under different scenarios can provide policy makers insights into long-run economic  
24 planning and policy-making. Therefore, CGE model has been widely used in analysis of  
25 government regulation, tax reform, trade liberation, regional cooperation and environmental issues  
26 (e.g., Hudson and Jorgenson, 1974; Ballard *et al.*, 1985; Martin *et al.*, 1992; Harrison and  
27 Rutherford, 1999; Dixon, 2006; Hosoe, 2006; Perali *et al.*, 2012; Parrado and De Cian, 2014).  
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40 To be consistent with the classification of I-O tables and household income and expenditure  
41 survey, the Malaysian economy in this study is divided into 15 non-energy sectors<sup>3</sup>, i.e. Agriculture,  
42 Food & Wear, Wood & Paper, Chemicals & Metal, Machinery, Vehicles, Construction, Wholesale &  
43 Retail trade, Hotel & Restaurant, Transport, Communications & Amusement, Housing, Education,  
44 Health, Other services, and 5 energy sectors, i.e. Electricity, Crude Oil, Natural Gas, Other Mining,  
45 Petroleum.<sup>4</sup> The Natural Gas sector in this study is an aggregate of natural gas and gas sectors in the  
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57 <sup>3</sup> For ease of calculation, the data treatment scheme-1 is used to match the I-O classification and energy classification  
58 (Su *et al.*, 2010).

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60 <sup>4</sup> In Malaysia's I-O tables, coal is not separately listed but included in the Other Mining sector. More than one third of  
61 electricity in Malaysia is generated from coal.  
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3 I-O tables. Each sector is assumed to have one representative producer. The economy has four  
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5 representative households, which represents the lowest 15% (H1), lower-middle 40% (H2), upper-  
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7 middle 30% (H3) and highest 15% (H4) households by income.<sup>5</sup>  
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### 10 11 12 13 **3.1. The model** 14

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16 Figure 1 describes the nested production structure for all sectors, which consists of three broad  
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18 categories of inputs: factor inputs (i.e. labor and capital), energy inputs and non-energy intermediate  
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20 inputs (see Eqs. A1-A6 in the Appendix A). Domestic input and imported input of the same variety  
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22 are treated as imperfect substitute in production, and aggregated using a constant elasticity of  
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24 substitution (CES) function. The fossil fuel bundle, energy bundle, capital-labor bundle and capital-  
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26 labor-energy bundle are all CES aggregations. Following a Leontief function, the capital-labor-  
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28 energy input and non-energy intermediate inputs are then aggregated into the gross output, which is  
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30 either supplied to domestic market or exported. At each level of the production structure, the  
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32 producer is assumed to choose a bundle of inputs that maximizes profit (i.e. revenue minus costs for  
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34 factor inputs/energy inputs/non-energy intermediate inputs and taxes, etc.) subject to its production  
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36 technology. Subsidies to petroleum, gas and other commodities enter profit functions as negative  
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38 costs or effective revenues, and will affect the effective prices of composites at corresponding  
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40 production levels. The influence of subsidies will be transmitted up to the gross output along the  
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42 production structure. For crude oil, natural gas, other mining and petroleum, domestic supply and  
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44 exports are not differentiated. For the remaining sectors, the gross output is further transformed into  
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46 domestic commodity and export commodity using a constant elasticity of transformation function.  
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48 Similar to production, the firm also maximizes profit subject to transformation function.  
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60 <sup>5</sup> The household survey data is used to differentiate the households into four income groups. Similar technique is used in  
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62 Su et al. (2017) on Singapore's household income group disaggregation.  
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4 The representative households receive factor income by supplying capital and labor inputs, and  
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6 receive transfer payments from the government and the rest of the world (ROW). After paying  
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8 income taxes and making non-tax payments to the government, the households consume  
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10 commodities and save. As the Malaysian government has a budget deficit, part of the household  
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12 savings is lent to the government to close its budget deficit. The lending could be interpreted as  
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14 equivalent to purchasing government bond. The total consumption of each representative household  
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16 is subject to its budget constraint. The consumption of each commodity  $j$  and the respective shares  
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18 of domestic commodity  $j$  and imported commodity  $j$  are determined following a nested CES  
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20 structure (see Eqs. A7-A8 in the Appendix A).  
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26 Government revenue is mainly from tax collection. According to the data, taxes in the model  
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28 include (1) labor income tax, (2) capital income tax, (3) production tax on gross output, (4) sale tax  
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30 on final consumption and investment, and (5) sale tax on exports. Tax revenue and non-tax  
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32 payments as well as with borrowings from the households allow the government to spend on goods  
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34 and services such as education, health and national defence, save for development investment,  
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36 provide subsidies, and also make transfer payments to the households and the ROW. In this study,  
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38 government subsidies are provided for products of the Agriculture, Food & Wear, Chemical &  
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40 Metal and Petroleum sectors. The total government consumption is a composition of commodities,  
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42 each of which is a CES combination of domestic and imported products, following a Cobb-Douglas  
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44 function (see Eqs. A9-A10 in the Appendix A). That is, the government is assumed to consume each  
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46 variety of commodity in a fixed proportion of the total government consumption.  
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53 Domestic savings by government and households as well as foreign savings arising from trade  
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55 balance are assumed to be entirely used on investment. Similar to the government consumption, the  
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57 total investment is also based on a Cobb-Douglas function and the substitution between domestic  
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59 and imported products follows a CES function (see Eqs. A11-A12 in the Appendix A). In addition to  
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3 market-clear conditions for commodities, labor and capital, several other assumptions are made to  
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5 close the model: (a) household saving rates are exogenous, (b) government saving rate is exogenous  
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7 or government savings are exogenous depending on scenarios, (c) prices of exports and imports are  
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9 exogenous, and (d) foreign savings are fixed while the exchange rate is floating.  
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### 15 **3.2. Data**

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17 The SAM is constructed according to the framework presented in Section 3.1. Economic data  
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19 used are mainly from Malaysia's I-O Table 2010 (DOS, 2014) and Malaysia's Statistics Handbook  
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21 (DOS, 2011b). According to the data, GDP and total exports of Malaysia in the base year 2010 were  
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23 around RM 825.4 billion and 643.6 billion, respectively. The Malaysian government had RM 121.5  
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25 billion of tax revenue and RM 50.1 billion of non-tax revenue, and spent RM 106.5 billion on  
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27 commodities (mainly education, health, public administration, defence and public order, and other  
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29 public services), RM 52.8 billion on infrastructure development (i.e. government savings), RM 32.6  
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31 billion on transfer payments and RM 12.4 billion on commodity subsidies. As a result, the  
32  
33 government had a budget deficit of approximately RM 32.6 billion in 2010. Most parameter values  
34  
35 used in the simulation such as tax rates and saving rates are calibrated on a basis of the SAM, but  
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37 elasticities of substitution/transformation in production, consumption and investment functions are  
38  
39 set in line with those used in the MIT EPPA model (e.g. Paltsev *et al.*, 2005), the GTAP model (e.g.  
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41 Huff *et al.*, 1997) and Solaymani and Kari (2014).  
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50 The household disaggregation is based on information from the Malaysia Household Income  
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52 and Basic Amenities Survey Report 2009 and Malaysia Report on Household Expenditure Survey  
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54 2009 (DOS, 2011a and 2012). The figures show that income inequality is quite serious in Malaysia-  
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56 the bottom 15% of households (H1) receive around 4% of total income while the top 15% of  
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58 households (H4) receive more than 40% of total income. Energy related data such as energy supply,  
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4 sectoral consumption of fossil fuels, retail fuel prices in Malaysia, etc., are obtained from the  
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6 Malaysia National Energy Balance and Malaysia Energy Statistics Handbook (EC, 2012 and 2015).  
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8 These data are utilized to disaggregate crude oil & natural gas sector and electricity & gas sector in  
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10 the I-O tables and calculate CO<sub>2</sub> emissions from fossil fuel combustion. Using emissions factors  
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12 suggested in IPCC (2006), Malaysia's total carbon emissions are found to be around 188.5 million  
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14 ton in 2010.<sup>6</sup>  
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## 20 **4. Simulation and Results**

23 Three broad categories of scenarios are designed for the assessment, which are (1) no  
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25 petroleum subsidies, (2) no gas subsidy and (3) no petroleum and gas subsidies. For gas subsidy,  
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27 removal in power sector only and complete removal (i.e. in power, industries and commercial  
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29 sectors) are simulated separately as sub-scenarios. As cutting budget deficit is the primary incentive  
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31 for the government to abandon subsidy policy, fiscal expenditure is by default set to be fixed at the  
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33 level in 2010. But another extreme situation, to relocate the saved budget or increased government  
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35 revenue on consumption of education, health and other public services, etc. and infrastructure  
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37 development as in 2010 (i.e. floating setting), is also considered as an alternative. While the  
38  
39 sustainability of fiscal system discourages the floating expenditure setting, providing better  
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41 infrastructure and more public services can explicitly show the public that the government is  
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43 utilizing the freed budget or increased revenue in a more beneficial way.<sup>7</sup>  
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50 In this study, direct government transfer is chosen as the compensation option for the most  
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55 <sup>6</sup> Emissions from gas flaring reinjection & use (specified in the National Energy Balance table) is not considered here.

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57 <sup>7</sup> In-between options could be using the money entirely on (i) consumption of commodities, or (ii) savings for  
58  
59 infrastructure development, respectively. Simulated macro impacts are close to those under the floating setting in  
60  
61 scenario (i), and almost the same to those under the fixed setting in scenario (ii). Considering the length of the paper, the  
62  
63 simulated results are not included but available upon request.  
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3 disadvantaged group.<sup>8</sup> It is argued in the literature that targeted cash transfer tends to outperform  
4 universal subsidies and other types of transfers for advantages such as low leakage, less distortion to  
5 markets and incentives, low administrative cost (World Bank, 2010). In the context of Malaysia, the  
6 recipients can be easily identified through the individual income tax collection system or the  
7 existing framework used for transfer payments of the BR1M program. The compensation is  
8 provided to the point that the bottom 15% households (H1) are no worse than the baseline status.  
9  
10 Table 2 summarizes the major scenario assumptions. In all the simulations, the gross outputs of  
11 Crude oil, Natural Gas, Other Mining and Petroleum sectors are fixed at their 2010 capacities based  
12 on these sectors' production features in the short run. Outputs that cannot be absorbed in domestic  
13 markets are assumed to be entirely exported.  
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#### 30 **4.1. Impacts of subsidy removal with fixed fiscal expenditure**

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32 Table 3 displays the simulated macro impacts of petroleum and gas subsidy removal, with fiscal  
33 expenditure fixed and no compensation provided to the most disadvantaged groups. Theoretically,  
34 removing fuel subsidies would induce more efficient distribution of resources among different  
35 sectors and improve economic efficiency. But higher price also means higher production cost and a  
36 subsequent increase in overall price level. This is one of the potential reasons for diverse evaluation  
37 results obtained in the literature.  
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46  
47 In the case of Malaysia, GDP would increase by 0.07% (or RM 0.60 billion) when petroleum  
48 subsidies are completely removed. Total exports increase by 1.01% (or RM 6.5 billion), which is  
49 dominated by the Machinery and Petroleum. According to the I-O data, the Machinery sector  
50 accounts for more than one third of Malaysia's total exports, and is not petroleum intensive. As a  
51 result, the sector benefits from resource relocation from more intensive sectors and expands. And  
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59 <sup>8</sup> Labor income tax rebate to H1 have almost identical impacts as direct government transfer payment. The simulation  
60 results are not reported due to space limit, but are available upon request.  
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4 higher price lowers the country's consumption of petroleum, so that more petroleum products are  
5  
6 available for exports. The petroleum sector contributes to 7% of Malaysia's total exports. As  
7  
8 expected, budget deficit declines significantly by 28.2% (or RM 9.2 billion), and total carbon  
9  
10 emissions reduce by 1.84% (or 3.5 million ton CO<sub>2</sub>). For households, lower-income groups tend to  
11  
12 be slightly less affected than higher-income groups, which is mainly because petroleum products  
13  
14 account for a larger proportion in the consumption baskets of higher income groups. Intuitively,  
15  
16 automobiles and even motorbikes are not affordable to the poor, so the price shock to diesel and  
17  
18 gasoline has smaller direct impacts on them.  
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23 Economic gain tends to be much larger when the subsidy reform is on gas, but the impact on  
24  
25 exports and households are different from the petroleum case. GDP is simulated to increase by  
26  
27 0.28% (or RM 2.3 billion) when natural gas sold to power generators are no longer subsidized and  
28  
29 0.53% (or RM 4.4 billion) when gas subsidy is completely removed in power, industries and  
30  
31 commercial sectors. However, exports would decline in these two sub-scenarios. And again, the  
32  
33 trend is mainly driven by the sinking exports of machinery and petroleum products. The Machinery  
34  
35 sector is electricity intensive and thus suffers from higher electricity price as a result of  
36  
37 unsubsidized power generation form natural gas. Producers and households would more or less  
38  
39 switch from more expensive natural gas and electricity towards domestic petroleum, since  
40  
41 substitution exists across different fuels as well as between fossil fuel and electricity. Therefore, the  
42  
43 amount of petroleum products available for exports reduces. The saved gas subsidy does not  
44  
45 directly go to the government, but becomes the producer's operating surplus or capital income.  
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47 Budget deficit reduction here mainly arises from higher tax revenue, and is thus much smaller than  
48  
49 in the case of removing petroleum subsidies.  
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54 Quite the contrary, carbon emissions reduction is more than doubled than in Scenario 1a. The  
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56 results are consistent with Malaysia's power generation mix- more than 50% of electricity is  
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4 generated by natural gas while less than 5% by petroleum products. Relatively, the emission  
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6 reduction is smaller in the complete removal scenario as more energy is needed for the higher  
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8 economic/GDP growth. For households, the lower-income groups are moderately or negligibly  
9  
10 affected by the gas subsidy removal, and higher-income households are even better off in both sub-  
11  
12 scenarios. The explanation is that: first, natural gas used by households are not initially subsidized  
13  
14 so that all the households are only indirectly affected by the increase in the price of electricity and  
15  
16 other commodities; second, every income group can benefit from the economic growth to some  
17  
18 degree; third, the previously forgone revenue turns into capital income, which is then distributed to  
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20 households following the patterns in the household income survey. Obviously, the higher-income  
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22 groups would receive much higher proportions of the redistributed benefits than the lower-income  
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24 groups.  
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31 When the reform proceeds to both petroleum and gas subsidies, the macro impacts are close to,  
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33 but not equal to, the accumulated impacts of individual cases. The figures show that GDP would  
34  
35 grow more than the sum in separate reforms. When all the fuel subsidies are removed, GDP could  
36  
37 increase by 0.65% (or RM 5.4 billion), which is a significant change in any country. While  
38  
39 removing the two types of fuels subsidies has opposite impacts on exports, the net impacts of  
40  
41 removing both turn to be positive. The thorough reform in Scenario 3a could also reduce around 1/3  
42  
43 of the budget deficit (or RM 11.4 billion) and 6% of total carbon emissions (or 11.1 million ton  
44  
45 CO<sub>2</sub>), which in principle achieves the primary target of the government and meanwhile implies that  
46  
47 fuel subsidy reform could be an important policy instrument for Malaysia to mitigate climate  
48  
49 change and achieve its INDC target. As the impacts of removing petroleum subsidies dominate, all  
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51 household groups would be affected by the complete reform. But the net impacts tend to be slightly  
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53 better than the sum in separate reforms.  
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4 Table 4 shows how sectoral outputs are affected by fuel subsidy reforms. The general  
5  
6 observation is that petroleum intensive sectors are more affected by petroleum subsidy removal and  
7  
8 electricity intensive sectors are more affected by gas subsidy removal. For example, the agriculture  
9  
10 sector and transport sector are petroleum intensive, so their outputs decrease due to higher  
11  
12 production costs when petroleum subsidies are removed but increase due to relocation of labor and  
13  
14 capital from more affected sectors when gas subsidy is removed. On the other hand, the machinery  
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16 sector is electricity intensive, so its output increases in petroleum subsidy removal scenario but  
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18 decreases in gas subsidy removal scenario.  
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#### 26 **4.2. Impacts of subsidy removal with floating fiscal expenditure**

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28 Table 5 displays the macro impacts of fuel subsidy removals for the floating fiscal expenditure  
29  
30 setting. The saved budget is set to be invested in infrastructure and spent on education, health and  
31  
32 other public services as in the base year. Again, no compensation is provided to the lowest income  
33  
34 households yet.  
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38 When only petroleum subsidies are removed, the increase in GDP by 0.04% (or RM 0.31  
39  
40 billion) tends to be smaller than in the fixed fiscal expenditure setting. As education, health and  
41  
42 other public services are primarily produced and consumed domestically, the increased government  
43  
44 expenditure on them stimulates relocation of resources to these sectors. Correspondingly, other  
45  
46 sectors have to shrink and their exports would decrease. Also because of the re-spending of the  
47  
48 saved subsidy, budget deficit would slightly decrease by 0.53% (or RM 0.17 billion) and  
49  
50 government consumption would shoot up by 8.19% (or RM 8.7 billion). The service-dominated and  
51  
52 thus less energy intensive government consumption consequently leads to greater carbon emissions  
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54 reduction by 2.09% (or 3.9 million ton CO<sub>2</sub>) under the floating fiscal expenditure.  
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4 All four household groups are worse off due to rising price level after the petroleum subsidy  
5  
6 removal. The pattern that lower-income groups are relatively less affected remains. Interestingly,  
7  
8 even if compared to the impacts in the fixed fiscal expenditure setting, the lower-income groups are  
9  
10 less affected as well. The potential reasons could be: first, the shares of income received by lower  
11  
12 income groups are relatively higher in the education, health and other services sectors than the  
13  
14 average. So lower income groups could benefit from growth in these sectors stemming from more  
15  
16 government consumption. Second, the extra government expenditure would increase supply of  
17  
18 education, health and other services (mainly public administration) or/and enlarge government  
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20 coverages of tuition fee and healthcare cost, etc. Regardless the exact policy tools, all income  
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22 groups would be able to consume more these services at lower prices.  
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28 For gas subsidy removal, there is almost no difference in GDP growth between the fixed and  
29  
30 floating fiscal expenditure scenarios. But exports would drop more in the floating setting due to the  
31  
32 increased government expenditure on domestic services. As gas subsidies are provided by  
33  
34 PETRONAS, removing gas subsidies can only indirectly affect the fiscal budget through higher tax  
35  
36 revenue. According to fiscal expenditure style in 2010, the government spends more than its income.  
37  
38 Therefore, budget deficit and government consumption both end up with an increase in the two sub-  
39  
40 scenarios. The impacts on carbon emissions reduction and different income groups are quite similar  
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42 to those in the fixed fiscal expenditure sub-scenarios. Particularly, when gas subsidies are removed  
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44 in all sectors, even the lowest-income group would be slightly better off than the baseline.  
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50 As in Scenario 3a, the macro impacts are close to the accumulated impacts of individual cases  
51  
52 when all fuel subsidies are removed. Budget deficit would almost remain unchanged after the  
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54 impacts of removing petroleum and gas subsidies offset with each other. As in separate removal  
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56 scenarios, carbon emissions reduction is more significant than under the setting of fixed fiscal  
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58 expenditure.  
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4 Table 6 shows the response of each sector to the fuel subsidy reforms. The major differences  
5  
6 between the results in Table 4 and Table 6 lie in the Education, Health and Other Services sectors.  
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8 The three sectors are overall moderately affected in the fixed fiscal expenditure scenarios, but  
9  
10 significantly expand with the increased government expenditure on them. The expansion also  
11  
12 causes resource re-allocation within the economy and makes other sectors also more or less perform  
13  
14 differently than in Table 4. The impacts on some sectors, such as Vehicles, Construction and  
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16 Housing, would even reverse in some sub-scenarios.  
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### 22 23 **4.3. Impacts of compensation policy**

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25 In addition to household consumption in volume, compensating variation (CV) and equivalent  
26  
27 variation (EV) are also considered in this study to discuss the loss of welfare arising from energy  
28  
29 subsidy removal. Intuitively, CV refers to the amount of money a household must be compensated  
30  
31 for the price changes, and EV refers to the amount of money a household would accept in lieu of the  
32  
33 price changes (see Eqs. A13-A14 in the Appendix A). Negative sign implies that the price changes  
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35 would make the household worse off.  
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40 Table 7 lists the simulated CV and EV values for each income group, the signs of which are  
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42 consistent with household consumption in volume.<sup>9</sup> The figures imply that, compared to the huge  
43  
44 amount of fuel subsidies provided directly or indirectly, the government does not need to pay much  
45  
46 to compensate households' loss of welfare stemming from the subsidy reforms. For example, to  
47  
48 make the bottom 15% of households no worse off than baseline, less than RM 0.3 billion is required.  
49  
50 Even if the compensation extends to the lower-middle 40% of households, the total transfer  
51  
52 payment needed is less than 15% of petroleum subsidies paid in 2010.  
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60 <sup>9</sup> The figures are displayed in Billion RM so as to have a direct comparison with subsidies in size.  
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4 Both direct government transfer and labor income tax rebate are considered as potential  
5  
6 compensation policy instruments. Although different in transmission mechanism, the simulation  
7  
8 results show that the two compensation instruments are almost indifferent in terms of economic  
9  
10 impacts. To save space, only the impact of direct government transfer are reported here. No  
11  
12 compensation is needed in Scenario *2b\_PIC* as all income groups are better off after the reform. In  
13  
14 this study, the compensation is provided to the point that the bottom 15% households (H1) are no  
15  
16 worse than the baseline status. Figures in Table 8 show that compensating the lowest income group  
17  
18 would have almost no additional impacts on GDP, exports, carbon emissions reduction and the other  
19  
20 three uncompensated income groups. Only budget deficit and government consumption would  
21  
22 display slightly larger differences from their counterparts in Table 4 and Table 6.  
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## 30 **5. Discussions and Conclusion**

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33 In ASEAN, subsidies not only discourage development of clean energy, fossil fuel exploration  
34  
35 and infrastructure investment, prevent integration of energy markets as required by the ASEAN  
36  
37 Economic Community, but also limit the possibility to optimize the trade of low-carbon resources.  
38  
39 Reform of fossil fuel subsidies, together with promotion of renewables and energy efficiency,  
40  
41 regional market integration and connectivity, are key instruments to achieving a cleaner, and more  
42  
43 sustainable energy mix for ASEAN (Shi, 2016). Low oil prices in recent few years provide an  
44  
45 appropriate timing of fuel subsidy removal, the delay of which will primarily increase costs for the  
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47 government and leave little room for policy space when energy prices are higher than expected (Wu  
48  
49 *et al.*, 2012).  
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55 This study quantitatively investigates the impacts of removing fuel subsidies on Malaysia's  
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57 economic performance, household welfare and carbon emissions. A dedicated Malaysia CGE model  
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59 was built, with breakdown of households by income incorporated to allow estimating the  
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3 differentiated impacts on households. The simulation results demonstrate that removing fuel  
4 subsidies could improve economic efficiency and relocate resources to less energy intensive sectors,  
5  
6 producing both economic and environment benefits. In the interest of economic gain, all fuel  
7  
8 subsidies should be removed to maximize the GDP growth. But from the perspective of climate  
9  
10 change mitigation, retaining gas subsidy in industries and commercial sectors is favored, because  
11  
12 slightly higher reduction in carbon emissions could be achieved. However, the small amount of  
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14 additional emissions reduction would be at the expense of nearly halved GDP growth, which seems  
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16 not worth.  
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23 Households at all income levels would be worse off in most scenarios as the impacts of rising  
24 price level dominate. In petroleum subsidy scenarios, lower income groups tend to suffer less than  
25 their high income peers because petroleum products account for smaller portions in their  
26 consumption baskets. In gas subsidy removal scenarios, the two high income groups (H3 and H4)  
27 are always better off than baseline. This is because gas subsidy removal turns the gas supplier's  
28 forgone revenue into operating surplus or capital income, which is then distributed disproportionately  
29 to different income groups. The small shares received by the two low income groups (H1 and H2)  
30 can hardly or narrowly help offset the impacts of higher price level. From the public policy  
31 perspective, protection of disadvantaged groups is one of the key tasks for the government. The  
32 simulated results demonstrate that compensation policy through direct transfer payment could make  
33 the poorest income group no worse than baseline while have almost no extra impacts on GDP  
34 growth and emissions reduction.  
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52 A comparison of the simulation results between fixed fiscal expenditure and floating  
53 expenditure shows that the two setting have their respective advantages. The former setting is  
54 featured with significant reductions in budget deficit, which is the primary intention of the reform.  
55 The latter setting tends to slightly compromise GDP growth but perform better in emission  
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4 reduction. More importantly, all income groups except for the top 15% households will be less  
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6 affected in the floating expenditure scenarios because of the increased supplies of education, health  
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8 and other public services by the government. At sectoral level, changes in outputs differ across  
9  
10 sectors and display no common preference over any specific scenario. Generally, petroleum  
11  
12 intensive sectors are more affected by petroleum subsidy removal, while electricity intensive sectors  
13  
14 are more affected by gas subsidy removal.  
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17  
18 The first policy impaction based on the simulation results is that fuel subsidies should be  
19  
20 phased out completely. However, although the simulation results support complete removal, the  
21  
22 politically sensitivity demands holistic approach, strategic planning and actions (Shi, 2016). While  
23  
24 preparation of subsides removal will take time, there is no excuse to delay initial actions, such as  
25  
26 public education and information campaign (Shi, 2016). Communications to the public and  
27  
28 industries are particularly important, especially in an energy-producing country where the citizens  
29  
30 take low energy prices for granted (OECD, 2013). Traditional media, official websites, roadshows  
31  
32 and public workshops, etc., are all useful platforms to communicate why the reform must be carried  
33  
34 out, in what ways the saved subsidy cost would be utilized and how the vulnerable groups would be  
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36 protected, as well the public's feedback and concerns. The effectiveness of the communications  
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38 depends on the public's trust in the government, which is in turn firmly related to the transparency  
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40 and credibility of the government.  
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48 The second policy implication is on the use of the saved or increased budget. For the benefit of  
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50 immediate fiscal deficit reduction and economic growth, the fiscal expenditure should be fixed.  
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52 However, increasing expenditure on education, health and other services sectors could alleviate the  
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54 welfare loss of most households due to more services available to them at lower prices, which  
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56 makes it easier to gain their supports for the reform. Furthermore, more schools and hospitals, less  
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58 time on the waitlist and in the queue, better facilities and equipment, etc., can all be visually  
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4 observed. The public will know that the government takes away their fuel subsidies but is utilizing  
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6 the money on citizens in an alternative way. Additionally, the increased education is an investment  
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8 in future productivity, and will earn the country more growth potential in the long run. Therefore, it  
9  
10 is crucial for the government to balance between cutting budget deficit and supplying more  
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12 education, healthcare and other public services.  
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16 Last, compensation schedule is necessary and can be affordable. Compensation schedule that  
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18 make the bottom 15% household not worsen off would cost little when compared with the save cost.  
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20 Furthermore, given the simulated economic benefits and also to reduce opposition, it may be  
21  
22 possible to extend the compensation to households of income group H2 and even industries that  
23  
24 significantly lose competitiveness without the subsidies. However, based on other countries  
25  
26 experiences, it is essential to make it explicit that the compensation is temporary in design (OECD,  
27  
28 2013). Otherwise, the support may turn into another type of distortion and burden if people  
29  
30 considered it as entitled. In implementation, the rules of the compensation should be transparent so  
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32 as to avoid unnecessary concerns over corruption and abuse. Direct government transfer is one of  
33  
34 the most feasible options for Malaysia based on the country's exiting institutional infrastructures,  
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36 but the exact magnitude, scope and coverage as well as other complementary instruments require  
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38 more in-depth considerations and discussions beyond the simulations in this study.  
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48  
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53  
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55  
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57  
58 comments and suggestions. All errors are authors' own responsibilities.  
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# Appendix A. Key Model Specifications

## 1. Production Activity

The gross output of sector  $j$  ( $Y_j$ ) is produced following a multi-level nested production structure. At each level of the production structure, the firm maximizes profits (i.e. revenue minus costs for factor inputs, intermediate inputs and taxes, etc.) subject to production technology.

Capital ( $K_j$ ) and labor ( $L_j$ ) are combined first into a capital-labor input ( $KL_j$ ) following a constant elasticity of substitution (CES) function:

$$KL_j = a_{KL,j} (\lambda_{K,j} K_j^{\rho_{KL,j}} + \lambda_{L,j} L_j^{\rho_{KL,j}})^{\frac{1}{\rho_{KL,j}}} \quad (A1)$$

where  $a_{KL,j}$  is the scaling coefficient of  $KL_j$  input production,  $\lambda_{K,j}$  and  $\lambda_{L,j}$  are respectively the input share coefficients of capital and labor that sum up to 1, and  $\sigma_{KL,j} = \frac{1}{1 - \rho_{KL,j}}$  is the elasticity of substitution between capital and labor.

In Malaysia, there are mainly four types of fossil fuel input: crude oil, gas, petroleum and other mining (coal included). All of them are CES aggregates of domestically processed and directly imported products, and are further composited into the aggregate fossil fuel input ( $FF_j$ ) using a CES function:

$$FF_j = a_{FF,j} (\sum \lambda_{F,i,j} F_{i,j}^{\rho_{FF,j}})^{\frac{1}{\rho_{FF,j}}} \quad (A2)$$

where  $a_{F,j}$  is the scaling coefficient of  $FF_j$  input production,  $\lambda_{F,i,j}$  is the input share coefficient of the  $i$ -th fossil fuel input ( $F_{i,j}$ ) that sum up to 1 ( $i$ =crude oil, gas, petroleum and other mining), and

$\sigma_{FF,j} = \frac{1}{1 - \rho_{FF,j}}$  is the elasticity of substitution among the fossil fuel inputs.

The total energy input ( $E_j$ ) is a CES composite of the aggregate fossil fuel input and electricity ( $ELC_j$ ):

$$E_j = a_{E,j} (\lambda_{FF,j} FF_j^{\rho_{E,j}} + \lambda_{ELC,j} ELC_j^{\rho_{E,j}})^{\frac{1}{\rho_{E,j}}} \quad (A3)$$

where  $a_{E,j}$  is the scaling coefficient of  $E_j$  input production,  $\lambda_{FF,j}$  and  $\lambda_{ELC,j}$  are the input share

coefficients that sum up to 1, and  $\sigma_{E,j} = \frac{1}{1-\rho_{E,j}}$  is the elasticity of substitution between the fossil fuel input and electricity.

Then the capital-labor input and energy input are combined into the capital-labor-energy input ( $KLE_j$ ) following a CES function:

$$KLE_j = a_{KLE,j} (\lambda_{KL,j} KL_j^{\rho_{KLE,j}} + \lambda_{E,j} E_j^{\rho_{KLE,j}})^{\frac{1}{\rho_{KLE,j}}} \quad (A4)$$

where  $a_{KLE,j}$  is the scaling coefficient of  $KLE_j$  input production,  $\lambda_{KL,j}$  and  $\lambda_{E,j}$  are the input share coefficients that sum up to 1, and  $\sigma_{KLE,j} = \frac{1}{1-\rho_{KLE,j}}$  is the elasticity of substitution between the capital-labor input and energy input.

Finally,  $h$  non-energy intermediate inputs ( $IN_j$ ) and the capital-labor-energy input are aggregated into gross output following a Leontief function:

$$Y_j = \min\left(\frac{IN_{1,j}}{\phi_{1,j}}, \frac{IN_{2,j}}{\phi_{2,j}}, \dots, \frac{IN_{h,j}}{\phi_{h,j}}, \frac{KLE_j}{\phi_{KLE,j}}\right) \quad (A5)$$

where  $\phi_{h,j}$  and  $\phi_{KLE,j}$  are the input requirement coefficients of the  $h$ -th non-energy intermediate input and the capital-labor-energy input for a unit output of  $Y_j$ , respectively. Each non-energy intermediate input is a CES composite of domestic and imported commodities of the same variety.

For some of the sectors, the gross output is further transformed into domestic commodities ( $D_j$ ) and export commodities ( $X_j$ ) using a constant elasticity of transformation (CET) function:

$$Y_j = a_{Y,j} (\beta_{D,j} D_j^{\rho_{Y,j}} + \beta_{X,j} X_j^{\rho_{Y,j}})^{\frac{1}{\rho_{Y,j}}} \quad (A6)$$

where  $a_{Y,j}$  is the scaling coefficient of the transformation,  $\beta_{D,j}$  and  $\beta_{X,j}$  are respectively the output share coefficients of the domestic and export commodities that sum up to 1, and  $\sigma_{Y,j} = \frac{1}{\rho_{Y,j}-1}$  is the elasticity of transformation for gross output  $j$ .

## 2. Household

Household income are mainly from payments for factor inputs and transfer payment from the government. The disposable income (i.e. net of income tax) is then used on consumption of



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4 commodities, savings, non-tax payments to the government and transfer payment to the rest of the  
5 world. The representative household is assumed to maximize its utility from total consumption ( $C$ )  
6 subject to budget constraint.  
7

8  
9 For each variety of commodity except for electricity, the household have both domestic and  
10 imported choices. So the consumption of each commodity ( $C_i$ ) is a CES composite of consumption  
11 of domestic commodity ( $DC_i$ ) and consumption of imported commodity ( $MC_i$ ):  
12  
13

$$14 \quad C_i = (\omega_{DC,i}^{\frac{1}{\gamma_{C,i}-1}} DC_i^{\frac{\gamma_{C,i}-1}{\gamma_{C,i}}} + \omega_{MC,i}^{\frac{1}{\gamma_{C,i}-1}} MC_i^{\frac{\gamma_{C,i}-1}{\gamma_{C,i}}})^{\gamma_{C,i}-1} \quad (A7)$$

15  
16 where  $\omega_{DC,i}$  and  $\omega_{MC,i}$  are respectively the consumption share coefficients that sum up to 1, and  
17  
18  $\gamma_{C,i}$  is the elasticity of substitution between domestic and imported commodities of variety  $i$ .  
19  
20  
21

22  
23 The total consumption aggregates consumption of individual commodities following a CES  
24 function:  
25

$$26 \quad C = (\sum \omega_{H,i}^{\frac{1}{\gamma_{H,i}-1}} C_i^{\frac{\gamma_{H,i}-1}{\gamma_{H,i}}})^{\gamma_{H,i}-1} \quad (A8)$$

27  
28 where  $\omega_{H,i}$  is the consumption share of composite commodity  $i$  that sum up to 1, and  $\gamma_{H,i}$  is the  
29  
30 elasticity of substitution among commodities.  
31  
32  
33

### 34 35 36 37 **3. Government**

38  
39 Government collects tax and non-tax revenues, which are partly saved for  
40 development/infrastructure investment and partly spent on consumption of commodities. So total  
41 government consumption ( $G$ ) is assumed to be a composition of consumption of commodities ( $G_i$ )  
42 based on a Cobb-Douglas function:  
43  
44

$$45 \quad G = \prod G_i^{\mu_{G,i}} \quad (A9)$$

46  
47 where  $\mu_{G,i}$  is the consumption share of each commodity in total government consumption and  $G_i$  is  
48  
49 a CES aggregate of domestic commodity ( $DG_i$ ) and imported commodity ( $MG_i$ ):  
50  
51  
52

$$53 \quad G_i = (\omega_{DG,i}^{\frac{1}{\gamma_{G,i}-1}} DG_i^{\frac{\gamma_{G,i}-1}{\gamma_{G,i}}} + \omega_{MG,i}^{\frac{1}{\gamma_{G,i}-1}} MG_i^{\frac{\gamma_{G,i}-1}{\gamma_{G,i}}})^{\gamma_{G,i}-1} \quad (A10)$$

54  
55 where  $\omega_{DG,i}$  and  $\omega_{MG,i}$  are the consumption share coefficients that sum up to 1, and  $\gamma_{G,i}$  is the  
56  
57 elasticity of substitution between domestic and imported commodities of variety  $i$ .  
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#### 4. Investment

Household savings, government savings and foreign savings are assumed to be entirely used for investment. Similar to government consumption, total investment ( $V$ ) is a Cobb-Douglas composite of investment on individual commodities ( $V_i$ ):

$$V = \prod V_i^{\mu_{V,i}} \quad (\text{A11})$$

where  $\mu_{V,i}$  is the consumption share of each commodity in total investment, and investment on each individual commodity is a CES composite of domestic commodity ( $DV_i$ ) and imported commodity ( $MV_i$ ):

$$V_i = (\omega_{DV,i}^{\frac{1}{\gamma_{V,i}}} DV_i^{\frac{\gamma_{V,i}-1}{\gamma_{V,i}}} + \omega_{MV,i}^{\frac{1}{\gamma_{V,i}}} MV_i^{\frac{\gamma_{V,i}-1}{\gamma_{V,i}}})^{\gamma_{V,i}} \quad (\text{A12})$$

where  $\omega_{DV,i}$  and  $\omega_{MV,i}$  are the investment share coefficients that sum up to 1, and  $\gamma_{V,i}$  is the elasticity of substitution between domestic and imported commodities of variety  $i$ .

#### 5. Compensating variation (CV) and equivalent variation (EV)

In addition to household consumption in volume, compensating variation (CV) and equivalent variation (EV) are also considered in this study to discuss the loss of welfare arising from energy subsidy removal.  $CV_s$  refers to the amount of money the  $s$ -th household must be compensated for the price changes, while  $EV_s$  refers to the amount of money the  $s$ -th household would accept in lieu of the price changes. They can be calculated following the functions:

$$CV_s = \frac{DI_s^1}{p_s^1 / p_s^0} - DI_s^0 \quad (\text{A13})$$

$$EV_s = DI_s^1 - \frac{p_s^1}{p_s^0} DI_s^0 \quad (\text{A14})$$

whand  $DI_s^0$  and  $DI_s^1$  are respectively the disposable income of the  $s$ -th household before and after the price changes, and  $p_s^0$  and  $p_s^1$  are respectively the consumer price indexes of the  $s$ -th household before and after the price changes. Negative sign implies that the price changes would make the household worse off.

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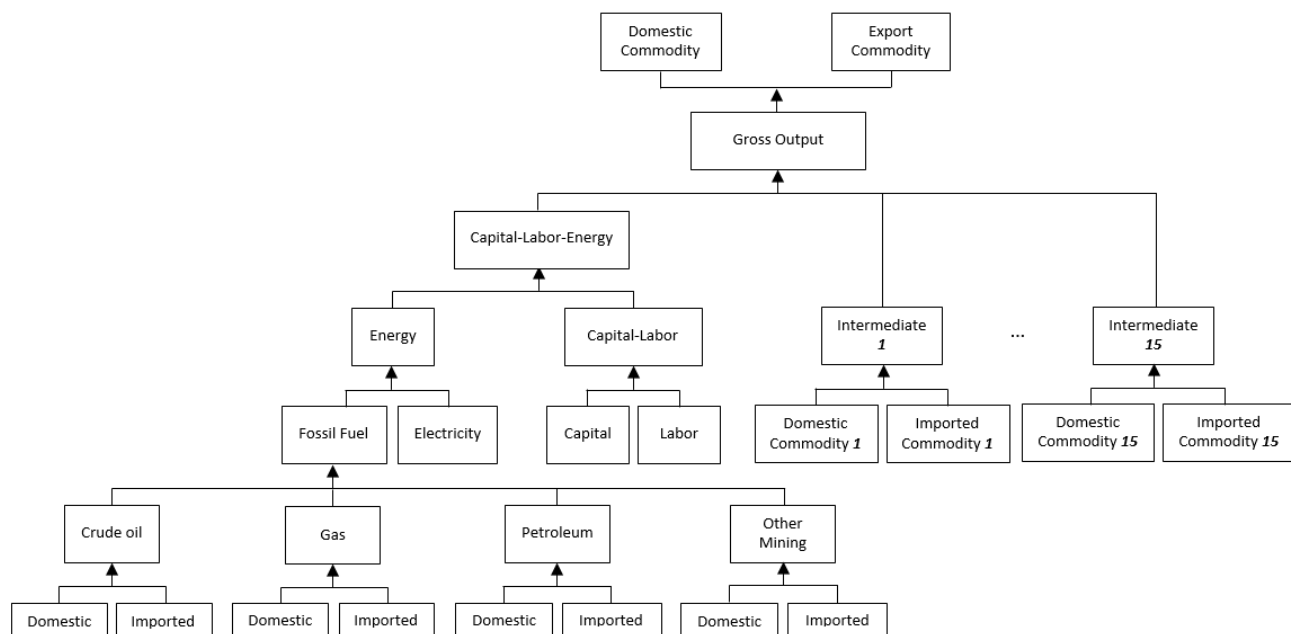


Figure 1. Nested production structure

**Table 1.** Overview of Malaysia’s fuel subsidy policies

Subsidies	Policy summary	Results
On Petroleum Products	<ul style="list-style-type: none"> <li>· Provided by the government</li> <li>· Officially, an Automatic Pricing Mechanism (APM) used to price petroleum products based on factors such as: reference product cost, operational costs and cooperate margins, tax and subsidy, etc.</li> <li>· Actually, APM used to determine sale tax exemption or subsidy needed to cover the gap between a fixed retail price and the market price (IISD, 2013).</li> </ul>	<ul style="list-style-type: none"> <li>· Based on Malaysia’s official statistics, the budget for petroleum subsidies:               <ul style="list-style-type: none"> <li>– only RM 27 million in 1990</li> <li>– rose to RM 3.2 billion in 2000</li> <li>– peaked at RM 17.6 billion in 2008</li> <li>– RM 9.6 billion in 2010</li> </ul> </li> <li>(Hamid and Rashid, 2012)</li> </ul>
On Natural Gas	<ul style="list-style-type: none"> <li>· Provided by PETRONAS, Malaysia’s state-owned oil and gas company</li> <li>· To power generators at around 1/4 of the market price</li> <li>· To industries and commercial sector at heavily subsidized prices as well, but lesser than to power generators</li> </ul>	<ul style="list-style-type: none"> <li>· PETRONAS’s foregone revenue in 2010 was estimated to be:               <ul style="list-style-type: none"> <li>– RM 11.2 billion for gas to power sector</li> <li>– RM 7.9 billion for gas to non-power sectors</li> </ul> </li> <li>(Ilias et al., 2012)</li> </ul>
Reforms	<ul style="list-style-type: none"> <li>· In May 2010, Subsidy Rationalization Programme (SRP) was launched, aiming to increase the prices of subsidized commodities including petroleum products by pre-specified amounts every 6 months until 2014</li> <li>· In September 2013, an ad hoc increase in the price of diesel and petrol, the first adjustment since 2011</li> <li>· At the end of 2014, subsidies for gasoline and diesel removed (Adam and Pakiam, 2014)</li> </ul>	<ul style="list-style-type: none"> <li>· Most price adjustments did not take place</li> <li>· Suspended in March 2012</li> <li>· Government’s concern on cost of living due to rising commodity prices (Teoh, 2012)</li> <li>· No reform made to the APM.</li> <li>· Compensate the poor through extended 1Malaysia People’s Aid (BR1M) program</li> <li>· Upgrade database system for previous welfare assistance program</li> <li>· Possible due to diminished gap between reference prices and market price due to the low oil price</li> </ul>



**Table 2. Scenario assumptions**

			Fiscal Expenditure	
			Fixed	Floating
<i>Scenario 1.</i>	No petroleum subsidies		<i>1a</i>	<i>1b</i>
<i>Scenario 2.</i>	No gas subsidy	Power only ( <i>P</i> )	<i>2a_P</i>	<i>2b_P</i>
		Power, Industries & Commercial ( <i>PIC</i> )	<i>2a_PIC</i>	<i>2b_PIC</i>
<i>Scenario 3.</i>	No petroleum & gas subsidies	Power only ( <i>P</i> )	<i>3a_P</i>	<i>3b_P</i>
		Power, Industries & Commercial ( <i>PIC</i> )	<i>3a_PIC</i>	<i>3b_PIC</i>

**Table 3. Macro impacts with fixed fiscal expenditure in %**

	<i>1a</i>	<i>2a</i>		<i>3a</i>	
		<i>P</i>	<i>PIC</i>	<i>P</i>	<i>PIC</i>
GDP	0.07	0.28	0.53	0.38	0.65
Exports	1.01	-0.53	-0.72	0.43	0.21
Budget deficit	-28.2	-3.92	-7.84	-31.7	-35.0
CO <sub>2</sub> emissions	-1.84	-4.64	-4.22	-6.37	-5.90
H1 consumption	-1.13	-0.25	-0.01	-1.32	-1.02
H2 consumption	-1.25	-0.09	0.21	-1.27	-0.92
H3 consumption	-1.42	0.08	0.48	-1.25	-0.79
H4 consumption	-1.61	0.23	0.73	-1.28	-0.71

**Table 4. Impacts on sectoral output with fixed fiscal expenditure in %**

	<i>1a</i>	<i>2a</i>		<i>3a</i>	
		<i>P</i>	<i>PIC</i>	<i>P</i>	<i>PIC</i>
Agriculture	-1.37	0.89	0.61	-0.38	-0.59
Food & Wear	-1.76	1.13	-0.15	-0.52	-1.71
Wood & Paper	-0.45	-0.74	-0.43	-1.09	-0.77
Chemicals & Metal	-2.48	-0.71	-6.27	-2.97	-8.09
Machinery	3.77	-2.82	-1.89	0.62	1.24
Vehicles	1.05	0.29	-0.21	1.38	0.87
Construction	1.99	0.72	0.85	2.71	2.82
Wholesale & Retail Trade	-0.90	0.56	0.86	-0.28	0.07
Hotel & Restaurant	-1.08	-0.20	0.15	-1.21	-0.82
Transport	-4.57	1.30	2.59	-3.20	-1.90
Communications & Amusement	-0.50	-0.25	0.54	-0.73	0.08
Housing	-0.62	0.07	0.50	-0.51	-0.00
Education	-0.46	0.06	0.24	-0.38	-0.17
Health	-0.60	0.04	0.14	-0.53	-0.39
Other Services	-0.15	-0.32	0.04	-0.45	-0.09
Electricity	-0.72	-10.1	-8.98	-10.7	-9.53

**Table 5.** Macro impacts with floating fiscal expenditure in %

	<i>1b</i>	<i>P</i>	<i>2b</i>	<i>P</i>	<i>3b</i>
			<i>PIC</i>		<i>PIC</i>
GDP	0.04	0.28	0.53	0.35	0.61
Exports	-0.28	-0.64	-1.00	-0.93	-1.28
Budget deficit	-0.53	0.63	1.11	0.15	0.65
Government consumption	8.19	0.82	1.73	8.80	9.50
CO <sub>2</sub> emissions	-2.09	-4.67	-4.27	-6.63	-6.17
H1 consumption	-0.99	-0.24	0.02	-1.16	-0.86
H2 consumption	-1.11	-0.08	0.23	-1.11	-0.76
H3 consumption	-1.34	0.09	0.50	-1.16	-0.70
H4 consumption	-1.70	0.22	0.71	-1.37	-0.82

**Table 6.** Impacts on sectoral output with floating fiscal expenditure in %

	<i>1b</i>	<i>P</i>	<i>2b</i>	<i>P</i>	<i>3b</i>
			<i>PIC</i>		<i>PIC</i>
Agriculture	-1.96	0.83	0.48	-1.03	-1.30
Food & Wear	-2.21	1.09	-0.26	-1.02	-2.26
Wood & Paper	-1.58	-0.86	-0.67	-2.31	-2.09
Chemicals & Metal	-4.29	-0.88	-6.65	-4.88	-10.1
Machinery	1.57	-3.00	-2.34	-1.67	-1.31
Vehicles	-1.88	0.00	-0.82	-1.77	-2.50
Construction	-1.40	0.38	0.13	-0.94	-1.12
Wholesale & Retail Trade	-1.92	0.46	0.63	-1.39	-1.14
Hotel & Restaurant	-0.83	-0.18	0.20	-0.95	-0.54
Transport	-4.92	1.26	2.51	-3.57	-2.31
Communications & Amusement	-0.17	-0.22	0.61	-0.38	0.45
Housing	-0.24	0.10	0.58	-0.11	0.38
Education	3.89	0.59	1.25	4.41	4.96
Health	2.68	0.47	0.74	3.12	3.32
Other Services	2.31	-0.12	0.55	2.13	2.76
Electricity	-0.58	-10.1	-8.95	-10.5	-9.36

**Table 7.** Compensating variation (CV) and equivalent variation (EV) in Billion RM

		<i>H1</i>	<i>H2</i>	<i>H3</i>	<i>H4</i>
<i>1a</i>	CV	-0.22	-1.27	-2.05	-2.57
	EV	-0.22	-1.25	-2.02	-2.52
<i>1b</i>	CV	-0.20	-1.12	-1.92	-2.70
	EV	-0.19	-1.11	-1.91	-2.67
<i>2a_P</i>	CV	-0.05	-0.09	0.12	0.37
	EV	-0.05	-0.09	0.12	0.37
<i>2a_PIC</i>	CV	0.00	0.21	0.69	1.16
	EV	0.00	0.21	0.68	1.15
<i>2b_P</i>	CV	-0.05	-0.08	0.13	0.35
	EV	-0.05	-0.08	0.13	0.35
<i>2b_PIC</i>	CV	0.00	0.24	0.71	1.12
	EV	0.00	0.23	0.71	1.12
<i>3a_P</i>	CV	-0.26	-1.29	-1.82	-2.05
	EV	-0.26	-1.27	-1.79	-2.01
<i>3a_PIC</i>	CV	-0.20	-0.93	-1.15	-1.13
	EV	-0.20	-0.92	-1.13	-1.11
<i>3b_P</i>	CV	-0.23	-1.12	-1.67	-2.18
	EV	-0.23	-1.11	-1.65	-2.15
<i>3b_PIC</i>	CV	-0.17	-0.76	-1.01	-1.30
	EV	-0.17	-0.76	-1.00	-1.29

**Table 8.** Macro impacts with direct government transfer to the lowest income households (H1) in %

	<i>1a</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>
			<i>P</i>	<i>PIC</i>	<i>P</i>	<i>PIC</i>
GDP	0.07	0.04	0.28	0.53	0.28	0.65
Exports	0.99	-0.27	-0.54		-0.64	0.19
Budget deficit	-27.5	-0.53	-3.77	-7.84	0.63	-34.4
Government consumption	-	8.01	-	-	0.77	-
CO <sub>2</sub> emissions	-1.84	-2.08	-4.64		-4.66	-5.89
H1 consumption	-	-	-	-	-	-
H2 consumption	-1.26	-1.12	-0.09	0.21	-0.08	-0.92
H3 consumption	-1.42	-1.34	0.08	0.48	0.09	-0.79
H4 consumption	-1.61	-1.70	0.23	0.73	0.22	-0.71