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Impacts of Energy Subsidy Reforms on the Industrial Energy Structures in the Malaysian Economy: A Computable General Equilibrium Approach

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ABSTRACT

The objective of this study is to analyze the effects of fuel subsidy removal on the industrial energy structures, which are crude oil, natural gas and coal, electricity and gas and petroleum products. A computable general equilibrium model and social accounting matrix for the Malaysian economy in 2005 are employed. Simulations based on different groups of scenarios (removing fuel subsidies, energy tax subsidies and both fuel subsidies and energy tax subsidies) were developed. The results showed that the fuel and tax subsidy reform policy had a stronger effect on energy consumption structures, which successfully reduced total energy consumption by 3.56%. This meant that removing fuel and tax subsidies could increase the potential energy savings by 1286.35 ktoe. On the other hand, the higher fossil fuel price due to the subsidy removal encouraged the utilization of alternative energy, and consequently reduce dependency on fossil fuel. The energy subsidy reform policy not only significantly reduced the amount of the fossil fuel consumption, but simultaneously improved the real gross domestic product and fiscal deficit in the government's budget. Importantly, the study concluded that the energy subsidy reform policy was found to be an efficient policy mechanism that supported the National Energy Efficiency Master Plan for 2010, as well as supported utilization of "fifth fuel" policy under the Malaysian Fuel Diversification Policy.

Keywords: Fuel Subsidy, Tax Subsidy, Industrial Energy Structures, Computable General Equilibrium, Macroeconomic Performance, Malaysia
JEL Classifications: H2, Q43

1. INTRODUCTION

Subsidies for the production and consumption of energy are common fiscal policy instruments that have been widely used by many governments, especially in developing nations. It is a government intervention that affects energy prices or costs to maintain lower end-use consumer fuel prices in the economy. However, subsidies on fossil fuel consumption can result in overuse, inefficient use and increase depletion of limited energy resources as well as contribute to environmental pollution (Indati and Bekhet, 2014). Some researchers found that energy subsidy policies may be inefficient and as their benefits are often not received by the poor. For instance, Solaymani and Kari (2014), Karami et al. (2012), Morgan (2007) and Saunders and Schneider (2000) found that subsidy cuts reduce the consumer surplus or welfare gains. On the producer side, subsidy cuts or removal increase the marginal cost and reduce the monetary benefit and producer surplus. The subsidy cuts bring marginal benefit to the government as the government payments decrease, which in turn increases the government revenue addition. The subsidy also distorts price signals and fails to reflect the true economic costs of supply. Theoretically, subsidy removal would cause consumers to pay a higher price and would reduce the amount of a quantity purchase.

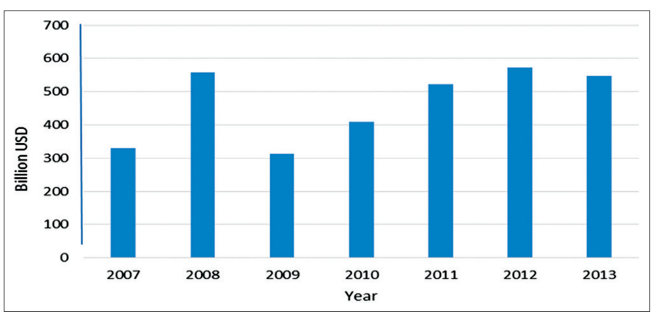
Specifically, energy subsidies lead to inefficient consumption of energy products and also impose a heavy burden on the government budget (Bekhet and Yusoff, 2009). Therefore, successful energy subsidy reforms bring positive effects to the whole economy, removing some of the current market distortions and failures, but require cooperation of the non-governmental organizations and the private market (Riedy and Diesendorf, 2003; Shim, 2006). Many studies have confirmed that removing fuel subsidies can bring many benefits to the economy, environment and social equity

(Dhawan and Jeske, 2008; Toh and Lin, 2005; Hope and Singh, 1995; Manzoor et al., 2009; Oktaviani et al., 2007; Clements et al., 2007; Jensen and Tarr, 2002). In terms of worldwide energy subsidies, as of 2013 the fossil fuel subsidies amounted to USD $548 Billion (Figure 1). Venezuela has the largest energy subsidies, followed by Iran, China, Saudi Arabia, India, Indonesia, Ukraine and Egypt, each with subsidies in excess of USD $10 billion per year (IEA, 2014).

Malaysia pays a high level of subsidies on food, energy, education and other social sectors of the economy. Specifically, this is to improve poor households' access to many commodities, especially modern forms of energy, along with reducing their poverty. In 2013, Malaysia spent around 20.5% of government expenditures on total subsidies (RM billion 43.35), which is about 5.5% of gross domestic product (GDP). In terms of fossil fuel subsidies, it spent up to 3.81% of government expenditures (RM billion 9.61), which is about 2.2% of GDP (Figure 2). Since fuel subsidies make up a large item of expenditures, their reform could do much to reduce deficit and debt levels (Bekhet and Yusoff, 2013). Recently, under the new Economic Transformation Programs (ETP) model, a road map for Malaysia towards Vision 2020 realization, the Malaysian government put a great deal of effort to rationalize the subsidy reform framework by putting it under one of their 12 National Key Economic Areas (NKEAs).

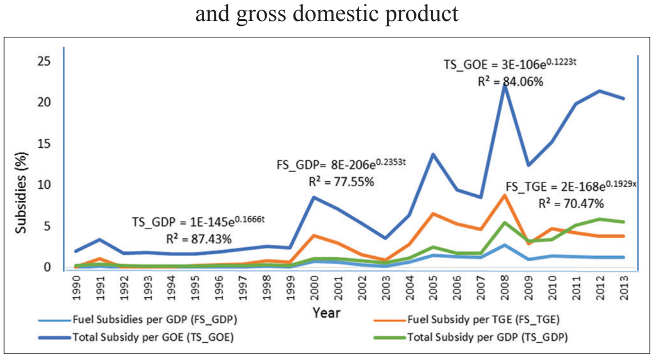
The ETP model is a comprehensive effort that would transform Malaysia into a high-income nation by 2020. Specifically, the subsidy rationalization framework under this model is inevitable and crucial as Malaysia has subsidized its fuel prices since the last decade. The global warming, energy efficiency considerations,

Figure 1: Global energy subsidy



Source: EIA, 2015

Figure 2: Total subsidy and fuel subsidy of government expenditure and gross domestic product



Source: Ministry of finance, 2015

energy security issue, CO_2 emission reduction commitment and enormous budget deficit have been issues for the government to consider in restructuring its fuel prices as well as fuel subsidies. Subsequently, in July 2010, subsidies for petroleum products, specifically petrol, diesel and liquefied petroleum gas (LPG) as well as for sugar, were reduced as the first step in an ETP gradual subsidy rationalization program without disregarding the welfare of the poor people and political stability in the country (EPU, 2013).

Thus, the aim of this study is to analyze the potential impact of fuel subsidy removal policy on the industrial energy structures, which are in crude oil, natural gas and coal, electricity and gas and petroleum products. A computable general equilibrium model (CGE) and a social accounting matrix (SAM) for 2005 in the Malaysian economy are employed. The rest of this article is structured as follows. Section 2 discusses the Malaysian context. Section 3 presents a literature review. Section 4 introduces data sources and methodology. Section 5 includes results and discussion. In Section 6, conclusions and policy implications are reported.

2. MALAYSIAN CONTEXT

The oil, gas and energy industry is central to Malaysia's economic growth. This is because it has contributed one-fifth of the national GDP over the past decade. Given the rise in global energy demand and economic growth, the contribution from the oil and gas industry is expected to increase by approximately 20% over the next 5 years to reach RM 81.9 billion (11.1% of GDP) at the end of 2015. On the other hand, the NKEAs have set a 5% annual growth rate for the energy sector up to 2020, which will transform Malaysia into a regional oil trading as well as ensure long-term energy supply security to the domestic market (ETP, 2013). This calls for encouraging energy efficiency, rationalizing subsidies and using renewable sources of energy that collectively have the potential to generate cost savings while expanding technological know-how and innovation (Bekhet and Yasmin, 2013).

Consistent with this, the New Energy Policy (2011-2015) was initiated, which has an emphasis on energy security and economic efficiency as well as environmental and social considerations. Collectively, the previous energy policies (i.e. The National Depletion Policy, 1980; Four-Fuel Diversification Policy, 1981; Electricity Supply Act, 1990; Gas Supply Acts, 1993; Electricity Regulations, 1994; Gas Supply Regulation, 1997) focused on adequate resources and a secure and cost-effective energy supply. Also, these policies encouraged developing and utilizing alternative sources of energy (both non-renewable and renewable energy that can reduce dependency on fossil energy resources, which could be harmful to the environment (Bekhet and Ivy-Yap, 2014a; Ivy-Yap and Bekhet, 2014b; Indati and Bekhet, 2015). Correspondingly, under the National Energy Efficiency Master Plan (2010), a roadmap to drive efficiency measures was set up to target achieving cumulative energy savings of 4000 kilo tonnes of oil equivalent (ktoe) across sectors by 2015. Under the 10^{th} Malaysia Plan, renewable energy was targeted for 5 percent of the country's total capacity mix in 2015. This represents

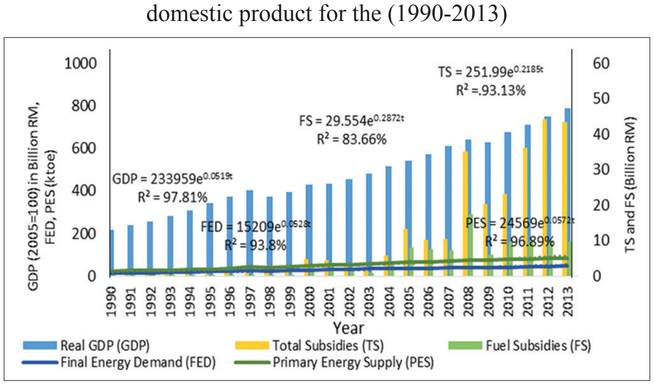
985 megawatts of the country's renewable generating capacity and is an increase of less than one percent of renewable energy from the country's former energy mix.

However, all the objectives of energy policies and strategies should also be consistent and aligned with the various national economic frameworks toward sustainable energy with environmental friendly and sustainable economic growth. Recently, the Malaysian government put forth a great deal of effort to rationalize the subsidy reform framework by putting it under one of their 12 NKEAs. So it is being forced to reconsider its policies by imposing a series of gradual fuel subsidy removal policies. This is purposely to reduce the substantial increase in the fuel subsidies as well as the revenue losses due to tax exemptions. The fuel subsidies have been growing progressively from RM 8.154 billion in 2005 to RM 24.73 billion and RM 23.46 billion for 2012 and 2013, respectively (Figure 2). Furthermore, the gradual removal of fuel subsidies could also help government to reduce the level of fossil energy use in the economy and shift to alternative "green" energies sources that could reduce the carbon emissions in the environment. This in turn could support the Malaysia commitment to the Kyoto Protocol II, which is a voluntary reduction of up to 40% in terms of emissions intensity of GDP in 2020.

Figure 3 shows the relationship between real GDP growth, final energy demand, primary energy supply, total subsidy and fuel subsidy. It indicates that the real GDP growth and energy supply and demand have similar positive growth trends for 1990-2013. This reflects that the energy market growth is highly correlated with GDP growth performance. Indeed, the annual growth rate per annum of real GDP, primary energy supply and final energy demand, were close, which are estimated at 5.2%, 5.72% and 5.28%, respectively. For instance in 2009, the real GDP growth decreased by 1.5% as compared to the previous year. This was followed by a decline in the energy supply and demand, where the energy supply decreased to 74,582 ktoe as compared to 75,490 ktoe in 2009, representing a decrease of 1.2%.

Likewise, final energy demand also recorded negative growth of 9.0 percent, from 44,901 ktoe to 40,845 ktoe in 2009. In terms of subsidy, the average annual growth rate of total subsidy and fuel subsidy had prominent growth, which were 21.9% and 28.7%, respectively. Indeed, the large progressing growth rate of these

Figure 3: Primary energy supply, final energy demand and gross domestic product for the (1990-2013)



Source: EPU (2012) and energy balance report (2012)

subsidies reflects the enormous operating expenditures budgets that the government had, which increased the fiscal deficit on the government account. The continued weakening in the government account and its adverse impact on domestic energy demand and the environment forced the government to pursue a stronger expansionary fiscal stimulus. This was done through its gradual subsidy removal plans and by reallocating subsidy savings back to the economy, specifically to target groups through its transfers mechanism plan and strategies.

3. LITERATURE REVIEW

Recently, there have been growing numbers of researchers, policy planners and environmentalists applying the general and partial equilibrium approach to analyze the effects of energy pricing, tax and subsidy reforms on the economy. This is especially in assessing the impact of reforms on macroeconomic variables, energy efficiency improvement and environmental protections. In terms of energy policy instruments, the imposition of subsidy, tax and energy pricing policies on the energy markets is not new, but until the 1970s, these issues had been limited in use, especially to promote oil and gas development (Lazzari, 2005). From the extensive survey on the methodology and approach used, the study found that the input-output (I-O), CGE and partial equilibrium models were the main approaches that have been used widely by researchers in assessing the impact of fossil-fuel subsidy reform or of higher energy prices on the economy (Ellis et al., 2010). This is because removing fossil fuel subsidies can be translated into a direct hike on energy or fossil fuel prices.

For instance, Al Amin et al. (2008), Nurdianto and Resosudarmo (2012), Solaymani and Kari (2014), Dhawan and Jeske (2008), Toh and Lin (2005), Hope and Singh (1995), Manzoor et al. (2009), Oktaviani et al. (2007), Clements et al. (2007), Bohringer et al. (2003), Nikensari (2001), Garbaccio et al. (1999), Clements et al., (2007) and Jensen and Tarr (2002) used CGE models in their studies. Lin and Jiang (2010), Abouleinein et al. (2009) and Larsen and Shah (1992) applied an integrated model of CGE, I-O and price-gap approaches in their studies. For partial equilibrium approaches, Burniaux et al. (2009), Birol et al. (1995) and Freund and Wallich (2000) employed price gap approaches and standard econometric procedures in their studies.

In the case of Malaysia, few studies were conducted by researchers analyzing the energy policy impact on the Malaysian economy and trade and environmental effects that applied the CGE model. Most of the studies focused on the energy carbon tax impact on emissions and the economy. For instance, Al-Amin et al. (2008) studied the impact of an emission tax under the trade liberalization on the Malaysian economy. The findings of that study found that implementing an energy tariff and output-specific carbon tax reduced carbon emissions and decreased GDP and trade in Malaysia. Furthermore, Nurdianto and Resosudarmo (2012) explored the effects of a carbon tax on the economy and environment of each ASEAN country. The results showed that with the carbon tax policy, the carbon emissions decreased, as well as decreasing the real GDP, household income and sectoral output.

On the other hand (Solaymani et al., 2013, 2014), used the focused CGE model to analyze the effects of subsidy reforms on the transport sector, environmental effects, household sector and the economy. Specifically, they apply a poverty-CGE focus model to estimate the effects of total subsidy policy reforms on welfare, poverty and the economy in Malaysia. The theoretical structure of the core model of their study closely followed the model of Robinson et al. (1990), with an extension to incorporate the poverty and income modeling following Chala (2010). The poverty-CGE model in this study was calibrated for 2005 using a SAM that was aggregated into 19 sectors. The results for the impact of the subsidy removal on macroeconomic variables showed that the government subsidy policy increased real GDP by about 0.02%, whereas its positive effect on nominal GDP was greater by about 0.44%.

Toh and Lin (2005) applied a CGE model to analyze the effects of the 1994 tax reform in China. The results of their simulations showed that small aggregate welfare gains were obtained from the 1994 tax reform. However, the household groups were worse off because of the redistribution of resources from household to government sectors. There was a substantial increase in the government revenue and the prudent and productive use of the increased revenue could improve the welfare of the households. This result also suggested that the statutory rates introduced in 1994 may be too high from the equal yield standpoint. It was suggested that further improvements in the tax system can be made by extending a consumption-type VAT to other sectors currently not included in the reform.

Lin and Jiang (2010) applied an integrated CGE approach and the price-gap approach to estimate China's energy subsidies. The results indicated that China's energy subsidies had amounted to China Yen (CNY) 356.73 billion in 2007, which was equivalent to 1.43% of GDP. Subsidies for oil products consumption were the largest, followed by subsidies for the electricity and coal sectors. The findings also showed that removing energy subsidies resulted in a significant fall in energy demand and emissions, but had negative impacts on macroeconomic variables. They concluded that offsetting policies could be adopted such that certain shares of these subsidies are reallocated to support other sustainable development measures, which could lead to reducing energy intensity favorable to the environment.

Birol et al. (1995) investigated the economic impact of subsidy phase-out in oil exporting developing countries (Algeria, Iran and Nigeria). The study applied a standard econometric approach and found that the effects of different deregulation policies were substantial. They also analyzed the impact of a policy based on autonomous energy-efficiency improvement. The results showed that a policy geared toward a more rational use of energy would permit these countries to save enough oil to meet future increases in demand while maintaining stable production capacity. Furthermore, such an energy policy could result in additional oil revenues that would enhance their economic development.

Hope and Singh (1995) conducted an economy-wide impact study of energy price reform in six developing countries including Malaysia. They aimed to estimate the impact of energy prices on spending using survey data on household spending patterns. The results showed that in Malaysia, GDP continued to increase, except for 1 year, after subsidy removal in 1984-1985. It also found that in all six countries, there were no significant changes in the consumer price index (CPI) during the period of energy price increases. In Columbia, Indonesia and Ghana, GDP growth rates were higher during the time of energy price increases, compared to the preceding 2 years. For Malaysia, Turkey and Zimbabwe, a fall in GDP growth rates was experienced during the period of subsidy reform but GDP growth recovered quickly in the year following the reforms.

Abouleinein et al. (2009) examined the impact of phasing out of subsidies on energy products in Egypt over the short to medium term by using an integrated approach of I-O and CGE models. The results of the I-O analysis showed that adjusting all prices of petroleum products to their actual domestic costs in one step not only would remove all subsidies, but would induce a large increase in the CPI. The prices of energy intensive industries' transport and communications were expected to rise significantly. In the second approach, the CGE model was applied to assess the medium-run macroeconomic effects from the gradual elimination of energy subsidies within the period of 4 years starting in 2009/2010. The results showed that the total private consumption significantly declined. Higher energy prices also affected the welfare levels, especially of the richer people. The budget deficit turned into a surplus at the end of the 2012/2013 period.

Manzoor et al. (2009) used an energy CGE model in Iran. The results showed that removing energy subsidies resulted in shrinking of the output, reduction in urban and rural welfare respectively by 13 percent and 12 percent and hyperinflation. Furthermore in Iran, Jensen and Tarr (2002) found that due to price increases in fossil fuels, demand declined and exports increased. The output of energy-intensive sectors (steel, chemicals, aluminium, etc.) declined by 25-65% and food production and other service sectors increased. With worker retraining, the energy-intensive sectors might recover by becoming more efficient.

Burniaux et al. (2009) evaluated the impact of the gradual removal of energy subsidies from 2013 to 2020. Price-gap data from the IEA for 2007 was used for four non-OECD countries (China, India, Brazil and Russia), two non-OECD regions (oil-producing countries and non-EU Eastern European countries) and the rest of the world (ROW). They found that most non-OECD countries and regions would experience economic efficiency gains (measured in GDP and real income percentage increases) by both 2020 and 2050, if these countries and regions removed their energy subsidies unilaterally.

Based on the literature review, there were only limited studies of the Malaysia case, so the aim of this study is to fill out the gap.

4. DATA SOURCES AND METHODOLOGY

4.1. Data Sources

In the current study, the data sources used were as follows. First, cross-section data for all sectors of the economy was gathered for the I-O table for 2005. Intermediate inputs, final goods and services, production, total demand, total supply, export and import, labor and capital used and indirect taxes were employed. Second, the secondary data for 2005 was from the National Account Statistics Data published by the Department of Statistics, Malaysia (DOSM), Energy Balance Data published by the Malaysia Energy Centre, Malaysia Government Expenditures and Revenues Data published by the Ministry of Finance, and Petroleum Product Subsidy Data published by the Ministry of Consumers, Trade and Affairs. The GAMS modeling system (version 24.02) for mathematical programming and optimization was used in this study.

Based on the I-O table for 2005, the SAM for 2005 was developed. The I-O table data was reorganized by 120 industries and aggregated into 18 sectors (Appendix A.1). This was to be in line with the Malaysian 12 NKEAs. The aggregation of data was based on the International Standard Industrial Classification (ISIC, 2005). In this study, a special focus was given to the energy demand structures. The higher level of aggregation was also due to the difficulty in mapping between the sector classifications used in the data with the ISIC (DOSM, 2013). Specifically, the data consisted of 25 sectors for 18 industries, 3 institutional agents (household, private and government sectors), 2 sectors for primary production factors (labor and capital), 1 capital account sector and 1 sector for the ROW. The petroleum refined products included gas, gasoline, automotive diesel oil, industrial diesel oil, kerosene, LPG and other fuels. The rest of the 18 industries are shown in Appendix A.1. Energy sectors were classified into 3 types (Crude Petrol; Natural Gas and Coal; Petroleum Refined Products, Electricity and Gas).

4.2. Research Framework and Research Model

The CGE model and SAM for 2005 were used to simulate the impact of removing Malaysian fuel subsidies on the energy structures and economy. The simulation analysis process simulated the implementation of energy subsidies reform in three parts by removing: (1) Fuel subsidies on consumer-side subsidies; (2) energy tax subsidies on consumer-side subsidies; and (3) both fuel subsidies and energy tax subsidies on consumer-side subsidies. Furthermore, on the basis of the standardised CGE model developed by Lofgren et al. (2002), an energy subsidies CGE (ESCGE) model was established. The mechanism interaction among economy and energy sectors created by them was used in this study. To elaborate the details, some core equations for this model were introduced. Four blocks of equations (Price Block, Production and Factor Block, Domestic Institution Block and Model Equilibrium Conditions and System Constraints) were developed. The details of each block, including full definition of the parameters, set of notations and references, are discussed as follows.

4.2.1. Price block

This block presents the set of price equations of goods and services, commodity price, activity price and value added price. Equation (1) states that it is a transformation of the world price of these imports (*pwm*), considering the exchange rate (*EXR*) and import tariffs (*tm*) plus transaction costs per unit of the import (*icm*). The exchange rate and domestic import price are flexible, while the tariff rate and the world import price are fixed, which fixed the "small-country" assumption. The export price (*PE*) in Equation (2) is the price received by domestic producers when they sell their output in export markets. The study assumed that the set of exported commodities are all produced domestically.

$$PM_c = .(1+tm_c).EXR.pwm_c \qquad c \in CM \qquad (1)$$

$$PE_c = .(1-te_c).EXR.pwe_c \qquad c \in CE \qquad (2)$$

For each domestically produced commodity (*QX*), the marketed output value at producer prices (*PX*) is stated as the sum of the values of domestic sales and exports, which is shown in Equation (3). Domestic sales (*QD*) and exports (*QE*) are valued at the prices received from the suppliers, *PDS* and *PE* are both adjusted downwards to account for the cost of trade inputs. Equation (4) shows the activity price (*PA*) is the return from selling the output or the gross revenue per activity unit.

$$PX_c.QX_c = PD_c.QD_c + (PE_c.QE_c) \qquad c \in CM \qquad (3)$$

$$PA_a = \sum_{c \in C} PX_c.\theta_{ac} \qquad \alpha \in A \qquad (4)$$

Equations (5) and (6) define the *CPI* and the producer price index for domestically marketed output. The *CPI* is fixed and functions as the *numraire*. A *numraire* was required since the model is homogeneous of degree zero in prices. All simulated price and income changes should be interpreted as changes of the *numraire* price index.

$$PVA_a = PA_a - \sum_{c \in C} PQ_c.ica_{ca} \qquad \alpha A \qquad (5)$$

$$\overline{CPI} = \sum_{c \in C} PQ_c.cwts_c \qquad \alpha \in A \qquad (6)$$

$$PPI = \sum_{c \in C} PDS_c.dwts_c \qquad \alpha \in A \qquad (7)$$

4.2.2. Production and factor block

This block describes the demand and supply of the commodity both domestically and abroad. It is a two-level nested function. Specifically, it indicates that the first-level production function is the Leontief production function. The second-level production functions are the Cobb-Douglas production functions, which consist of composite value added (labor and capital) and intermediate inputs, excluding the energy intermediate inputs. For each activity, the demand for disaggregated intermediate inputs ($QINT_{ca}$) is determined via a standard Leontief formulation, which is shown by Equation (8). The aggregated output function of any commodity (QXc is defined as a *CES* aggregate of the output levels of the different activities producing the commodity Equation (9). It reflects the assumption of imperfect transformability between these two destinations.

$$QINT_{ca} = ica_{ca}.QA_a \qquad c \in C, \alpha \in A \qquad (8)$$

$$QX_c = \sum_{\alpha \in A} \theta_{ac}.QA_a \qquad c \in CX \qquad (9)$$

The *CET* function, which applies to commodities that are both exported and sold domestically, is identical to a *CES* function except for negative elasticities of substitution. The elasticity of transformation between the two destinations is a transformation of p_c^t for which the lower limit is one. Equations (10) and (11) address the allocation of marketed domestic output: Domestic sales and exports.

$$QX_c = \alpha_c^t.\left(\delta_c^t.QE_c^{p_c^t}\left(1-\delta_c^t\right)QD_c^{p_c^t}\right)^{\frac{-1}{p_c^t}} \qquad c \in CE \qquad (10)$$

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}.\frac{1-\alpha_c^t}{\delta_c^t}\right)^{\frac{1}{p_{c-1}^t}} \qquad c \in CE \qquad (11)$$

Imperfect substitutability between imports and domestic output sold domestically is captured by a *CES* aggregation function (Equation 12). When this function is limited to commodities that are both imported and produced domestically, it is called an Armington function. The elasticity of substitution between commodities from these two sources is a transformation for which the lower limit is minus one.

$$QQ_c = aq_c.\left(\delta_c^q.QM_c^{-p_c^q}(1-\delta_c^q).QD_c^{-p_c^q}\right)^{-\frac{1}{p_c^q}} \quad c \in CM \qquad (12)$$

4.2.3. Domestic institution block

This block consists of equations that map the flow of income from value added to institutions and ultimately to households. These equations counteract the inter-institutional cell entries in the SAM balances account framework. All the incomes and expenditures for all institutions are presented in equations form. Equations (13 and 14) defines the total income of each factor (YF_f). Equation (15) is the household consumption expenditure. This equation becomes a reference to the set of domestic institutions (household, enterprises, and the government, a subset of the set of institutions), which also includes the ROW. Total government revenue (*YG*) is the sum of revenues from taxes (*TINS*), factors (tf_f) and transfers from the ROW [$trnsfr_{govrow}$] (Equation 16). The total government spending (*EG*) include the sum of government spending on consumption and transfers is shown in Equation (17). Total fuel subsidy (*TFSUB*) is the sum of government subsidies on fuel consumption as shown in Equation (18).

$$YF_f = shry_{hf}\sum_{\alpha \in A} WF_f.WFDIST_{fa}.QF_{fa} \qquad h \in H,\ f \in F \quad (13)$$

$$YH_h = \sum_{f \in F} YF_{hf} + tr_{h,gov} + EXR.tr_{h,gov} \qquad h \in H \qquad (14)$$

$$QH_{ch} = \frac{\beta_{ch}.(1-mps_h).(1-ty_h).YH_h}{PQ_c} \qquad c \in C \qquad (15)$$

$$\begin{aligned} YG = {} & \sum\nolimits_{i \in INSDNG} TINS_i\, YI_i + \sum\nolimits_{f \in F} tf_f\, YF_f \\ & + \sum\nolimits_{a \in A} tva_a.PVA_a.QVA_a + \sum\nolimits_{a \in A} ta_a.PA_a.QA_a \\ & + \sum\nolimits_{c \in CM} tm_c.pwm_c.QM_c \text{ EXR} \\ & + \sum\nolimits_{c \in CE} te_c.pwe_c.QE_c \text{ EXR} + \sum\nolimits_{c \in C} tq_c.PQ_c.QQ_c \\ & + \sum\nolimits_{f \in F} YIF_{gov\ f} + trnsfr_{govrow} \text{ EXR} \end{aligned} \qquad (16)$$

$$EG = \sum_{h \in H} tr_{h,gov} + \sum_{i \in INSDNG} PQ_c.\, qg_c \qquad (17)$$

$$TFSUB = \sum\nolimits_{i \in I} (FSUB_c + HFSUB_c) \qquad (18)$$

4.2.4. Model equilibrium conditions and system constraints block

In this block, Equation (19) imposes equality between the total quantity demanded (QF) and the total quantity supplied (*QFS*) for each factor. All factors are mobile between demanding activities. Equation (20) imposes equality between quantities supplied and demanded of the composite commodity. The demand side includes an endogenous term and a new exogenous term for stock change. Among the endogenous terms, *QG* and *QINV* are fixed in the basic model version.

$$\sum_{a \in A} QF_{fa} = \overline{QFS}_f \qquad f \in F \qquad (19)$$

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + qg_c. + QINV_c \qquad c \in C \qquad (20)$$

The current-account balance in Equation (21), which is expressed in foreign currency, imposes equality between the country's spending (imports and factors outflow to the ROW) and its earning of foreign exchange (export, factor inflows from the ROW and foreign savings). For the basic model version, foreign savings (FSAV) are fixed; the (real) exchange rate (EXR) serves the role of equilibrating variable to the current-account balance. Equation (22) states that total savings and total investment have to be equal. The total savings is the sum of savings from domestic non-government institutions, the government and the ROW, with the last item converted into domestic currency. Total investment is the sum of the values of fixed investment (gross fixed capital formation) and stock changes.

$$\sum_{c \in C} pwm_c.QE_c + \sum_{f \in F} tr_{i,row} + FSAV = \sum_{c \in CM} pwm_c.QM_c \qquad (21)$$

$$\begin{aligned} & \sum_{h \in H} mps_i.\left(1-ty_h\right) + YH_h + \left(YG - EG\right) + EXR.\, FSAV \\ & = \sum_{c \in C} PQ_c.\, QINV_c + WALRAS \end{aligned} \qquad (22)$$

5. RESULTS AND DISCUSSION

5.1. Effects on Energy Structures

Table 1 presents the effects of subsidy removal on the domestic energy commodity price index. The simulation results showed that energy subsidy reform increased the domestic energy price index. For instance, the total energy subsidy removal (Scenario 1), increased the index price of crude oil; natural gas and coal; and petroleum refined product and electricity and gas input by 8.026%, 3.423% and 1.316%, respectively. However, the energy tax removal (Scenario 2) has a slight impact on the energy price index. The mixed effects of fuel subsidy removal and energy tax subsidy removal (Scenario 3) are quite similar to the results of Scenario 1. These simulation results are consistent with other previous findings, which showed that removing the energy subsidy would immediately increase the domestic energy commodity price (Solaymani et al., 2013; Lin et al., 2011; Saunder and Scnieder, 2000; Burniaux et al., 1992; Anderson and McKibbin, 1997).

The effects of energy subsidy reform on the industrial final demand by types of energy input and total industrial final demand were also considered. Figure 4 shows the aggregate impact of fuels subsidy removal (Scenario 1) on the industrial energy consumption for crude oil, natural gas and coal, electricity and gas and petroleum products as compared to the baseline level. The total final demand at the baseline level was 36,100.50 ktoe. However, it reveals that removing the total fuel subsidies would decrease both crude oil, natural gas and coal consumption and petroleum products by 0.27% and 0.17%, respectively.

Conversely, removing fuel subsidies would increase electricity and gas consumption, which increased 0.44% or by 0.92 ktoe. The estimated results implied that there could be substitution effects between the energy inputs. However, if fuel subsidies were removed, the total industrial energy consumption could be improved significantly, which was reduced by 2.83% or 998 ktoe (Figure 4).

In contrast, removing fuel tax subsidies (Scenario 2) would increase the proportion of both petroleum products and electricity and gas consumption from the total energy consumption, which increased by 1.06% and 0.26%, respectively (Figure 5). Nevertheless, in terms of total effects, the results established that removing tax subsidies would exert a weaker influence on energy consumption than removing fuel subsidies, where total energy consumption by industry sectors decreased by 616.481 toes and 998 cats, respectively.

On the other hand, if both fuel and tax subsidies were removed (Scenario 3), the total energy consumption could be improved significantly, which reduced by 3.56% or 1,286.35 ktoe (Figure 6). The significant reduction or potential improvement of the energy consumption would be enhanced if both the fuel and tax subsidies were removed. However, in terms of the type of energy consumption, the results found that both demand for crude oil, natural gas and coal and petroleum products consumption decreased by 0.07% and 0.18% of the total energy shares. Conversely, the electricity and gas input share in total energy consumption increased by 1.07% or by 259.65 ktoe. The estimated results implied that there could be substitution effects between petroleum products consumption and electricity and gas input.

5.2. Effects on Macroeconomics Performance

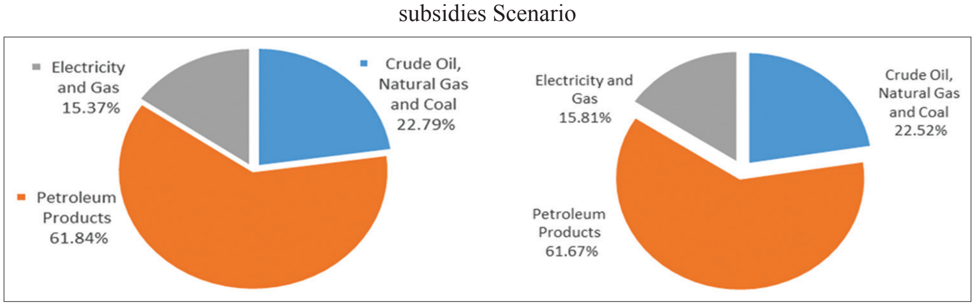
Table 2 shows the effects of energy subsidy reform on the real GDP and government fiscal budget via government expenditures and revenue. Fuel subsidies increased from RM 8.514 billion (1.74% of GDP) in 2005 to RM 13.387 billion (2.28% of GDP) in 2011, which was 64.18%. (Ministry of Finance, 2014). The estimated results showed that the removal of fuel subsidy (Scenario 1) and fuel tax subsidy (Scenario 3) increased the real GDP by 5.74%

Table 1: Effects of energy subsidy reform on the energy commodity price index

Sectors	EPI at year 2005	EPI and change from baseline (%) Scenario					
		1		2		3	
		EPI	%	EPI	%	EPI	%
Crude oil, natural gas and coal	0.922	0.996	8.026	0.922	0.000	0.996	8.026
Petroleum products	0.964	0.997	3.423	0.965	0.104	0.998	3.527
Electricity and gas	0.988	1.001	1.316	0.988	0.000	1.001	1.316

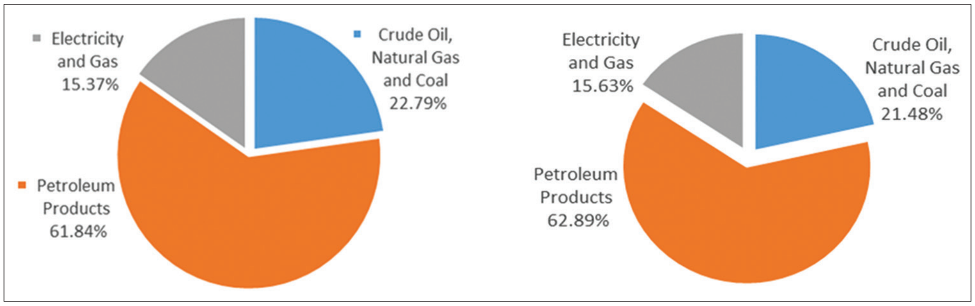
Source: Output of GAMS version 24.02. EPI: Energy price index

Figure 4: Effects of removing fuel subsidies (Scenario 1) on industrial energy consumption structure (a) baseline Scenario, 2005 (b) remove fuel subsidies Scenario



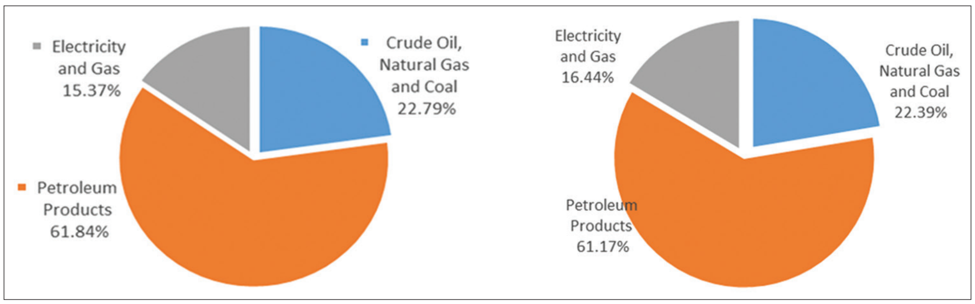
Sources: Malaysia Energy balance report 2012, and the simulation results of the computable general equilibrium simulation

Figure 5: Effects of removing fuel tax subsidies (Scenario 2) on industrial energy consumption structure (a) baseline Scenario, 2005 (b) remove fuel tax subsidies Scenario



Sources: As defined in Figure 4

Figure 6: Effects of removing of both fuel and tax subsidies (Scenario 3) on industrial energy consumption structure (a) baseline Scenario, 2005 (b) remove fuel and tax subsidies



Sources: As defined in Figure 2

Table 2: Real GDP and government fiscal budget

Fiscal items	Value at year 2005 (Million RM)	Change from baseline (%)		
		1	2	3
Real GDP	480,258.90	5.74	−0.01	5.73
Expenditure	134,308.02	−7.13	0.0	−7.13
Revenue	115,220.94	2.99	0.03	−4.37
Surplus/(deficit)	−19,087.09	−68.22	−0.18	−23.81

Source: Output of GAMS version 24.02. GDP: Gross domestic product

and 5.73%, respectively. In terms of the government account, it was found that fuel subsidy removal (Scenario 1) decreased the government expenditures by 7.13%, and simultaneously increased the government revenue by 2.99%, as expected and theoretically supported. Nonetheless, the removal of fuel tax subsidy only (Scenario 2) would not have a significant impact on government expenditures, but would slightly improve total government revenue (0.03%) as expected. However in Scenario 3, the results found that government revenue was adversely affected by the mixed policy effects of fuel and tax subsidy removal, which decreased by 4.37%. The results of Scenario 3 on government expenditures were closer to the results in Scenario 1.

6. CONCLUSIONS AND POLICY IMPLICATIONS

The main objective of the Malaysian National Depletion Policy 1980 was to reduce dependence on fossil fuel consumption toward the goal of sustainable development of depletable resources. This policy was put in place in 2001 as part of the Energy Commission Act to achieve a safe, cost-effective, secure energy supply (EPU, 2013). Achieving these goals involved championing the development of renewable energy technologies in this country (Indati and Bekhet, 2014). Considering the strong energy reform policy effects, the simulation results estimated that the fuel and tax subsidy reform policy would exert stronger influence on energy consumption than removing fuel subsidies only, which could successfully reduce energy consumption by 3.56%. Removing both subsidies could also increase the potential energy savings by 1286.35 ktoe. On the other hand, the higher fossil fuel prices due to the subsidy removal could encourage the utilization of alternative energy, and consequently reduce dependency on fossil fuels.

There are Four Pillars in the National Green Technology Policy, which are to attain energy independence and promote efficient utilization, conserve and minimize impact on the environment, enhance national economic development through use of technology and improve the quality of life for all. Thus, the potential energy savings due to fuel and tax subsidy removal could strongly support this policy, which has provided special fiscal incentives amounting to RM1.5 billion, specifically to encourage the ongoing efforts towards “green” technology investment (EPU, 2013). It is important to note that removing energy subsidies induces technological choice within and outside the energy sector, imposes positive effects on the domestic fixed capital investment, improves the quality of the environment due to less consumption of fossil energy products and promote switches to the renewable and green energy resources. Also, the energy subsidy reform policy not only could significantly reduce the amount of fossil fuels consumption, but simultaneously could also improve the real GDP and fiscal deficit in the government budget (Yusoff and Bekhet, 2015; Ivy-Yap and Bekhet, 2015).

Most importantly, the study results suggested that the energy subsidy reform policy was found to be an efficient policy mechanism that could improve national potential energy savings, which could reduce the dependence on fossil fuels consumption. This could support the National Energy Efficiency Master Plan (2010), which is targeted to achieve cumulative energy savings of 4000 ktoe across sectors. It could also help realize the Malaysian Fuel Diversification Policy to achieve 5% renewable energy in the country's total energy capacity by the end of 2015. In practice, designing and implementing energy-subsidy reform should take into account the national circumstances and trade-offs between social, economic and environmental effects.

Indisputably, public resistance is often a major obstacle to reducing or removing subsidies. Thus, a more comprehensive study and analysis needs to be done in the future, specifically in analyzing the effect of a gradual subsidy removal plan. It would be especially for those who would be adversely affected by financial pain, for those who would stand to lose and to identify the effects on the differentiated user groups or users. This could be done by disaggregating households and consumers into different levels of income groups. The findings of the study are truly crucial as they could help policy makers to identify the other alternative policy mechanisms that could be put in place, so that the reallocation of income savings could foster economic development through effective transfer mechanisms without neglecting the poor.

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APPENDIX A.1.

Table A1.1: Aggregation of Input-Output Table 2005

Sector	Sectors number in 2005 I-O Table
Agriculture, forestry and fisheries	1-12
Crude petrol, natural gas and coal	13, 16
Petroleum refined products	44
Electricity and gas	86
Other mining and quarrying	14, 15
Petrochemical and chemical industries	45-50
Light manufacturing	17-43
Heavy manufacturing	51-85
Utility – waterworks	87
Building and construction	88-91
Wholesale and retail trade	92
Hotel and restaurants	93, 94
Transportation	95-100
Communication	101
Finance intuition, banking and insurance	102-105
Real estate and ownership of dwellings	106, 107
Business and private services	108-112
Government services	113-120

Source: DOSM, Input-Output Tables of Malaysia for 2005