

# Chapter 2

## Economic, Social, and Environmental Impacts of Energy Subsidies: A Case Study of Malaysia

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# Chapter 2

## Economic, Social, and Environmental Impacts of Energy Subsidies:

### Case Study of Malaysia

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#### **Abstract**

The Malaysian government has shown a strong intention to reduce energy subsidies in recent years. This study quantitatively investigates the potential impacts of removing energy subsidies on Malaysia's macroeconomic indicators, household welfare, and carbon emissions. A computable general equilibrium model with a breakdown of households by income level is constructed to perform the assessment. We show that either a petroleum or gas subsidy removal, or both, would improve economic efficiency and increase real gross domestic product by up to 0.97 %. The budget deficit would be largely reduced after removing the government-funded petroleum subsidies, especially as the saved subsidy costs could be entirely used to buy back government bonds. Households would be worse off in most scenarios due to higher price levels, but compensating policies through labour income tax rebates or direct transfer payments could make the poorest income group no worse than the baseline, with almost no extra impacts on the economy. The overall positive economic and environmental impact suggests that fossil fuel subsidies should be removed and the saved subsidy costs or increased tax revenue used to reduce fiscal deficits and compensate the most affected households and industries.

## 1. Introduction

Energy subsidies are economically unfavourable but prevail in the world due to social and political concerns. Generally, energy prices after a subsidy cannot reflect the true costs of energy supply and thus tend to induce energy waste in production and overconsumption by households. In addition, as differentiating consumers by income is costly in practice, energy subsidies are usually applied equally to all consumers, which is against the good intention of assisting disadvantaged groups. In the Association of Southeast Asian Nations (ASEAN), subsidies not only discourage the development of clean energy, fossil fuel exploration, and infrastructure investment and prevent the integration of energy markets as required by the ASEAN Economic Community, but they also limit the possibility to optimise the trade of low-carbon resources. Reform of fossil fuel subsidies, together with the promotion of renewables and energy efficiency, regional market integration, and connectivity, are key instruments to achieving a cleaner and more sustainable energy mix for ASEAN (Shi, 2016). Economists and global leaders have voted to remove energy subsidies for more than a decade, but progress in many countries is still limited. Major concerns are that disadvantaged groups would not be able to afford the higher market prices of fuels and electricity, and that the general public would not support such policies.

Malaysia is a good case for the subsidy study since energy subsidies have long been present in Malaysia at an unsustainable level and the government has taken steps to reduce them. If the proposed marketisation could be actualised, how and to what extent would the different sectors and income groups be affected? Is there any alternative financial assistance for disadvantaged groups to compensate their welfare loss arising from higher energy prices? Will the subsidy removal lead to a significant reduction in fossil fuel consumption and contribute to global efforts for climate change mitigation? To answer these questions, it is important to quantitatively evaluate the potential economic, social, and environmental impacts of energy subsidy reform in Malaysia. The evaluation can provide policymakers with better insights in improving the current policy configurations. The objectives of this study consist of (1) reviewing the evolution of energy subsidies in Malaysia and what the government has done or planned to do regarding the subsidy policy; and (2) quantitatively assessing the impacts of the fossil fuel subsidy removal, with and without other forms of financial assistance on issues such as gross domestic product (GDP), production at the sectoral level, government expenditure, household consumption and welfare, investment, and carbon emissions. A computable general equilibrium (CGE) model is constructed to perform the assessment.

Studies on energy subsidies relevant to Malaysia have appeared in the recent literature. By using a multiregional CGE approach, Kojima and Bhattacharya (2011) find that even a partial removal of energy subsidies in East Asia, including Malaysia, would result in an improvement of market efficiency. They estimate that a per annum subsidy reduction of approximately US\$500 million in the East Asia region could improve regional GDP by around 0.05 %, while reducing emissions by about 0.5 %. Hamid, Rashid, and Mohammad (2011) use input-output

(I-O) analysis to evaluate the impacts of an exogenous increase in energy prices, with a specific focus on food industries. They find that resilient economies, especially developed East Asian economies have had consistent performance in terms of value added and imported inputs during periods of energy price surges. Recently, Solaymani and Kari (2014) used a CGE model to analyse the impacts of a petroleum subsidy removal and electricity rebate removal on the Malaysian economy, especially for the transportation sector. They show that the output of land transport, water transport, and air transport would decrease by 3.54 %, 1.15 %, and 2.14 %, respectively.

Compared with the existing literature, this study makes the following contributions. First, households are disaggregated into four income groups based on Malaysia's household income and expenditure survey. This allows us to compare imbalanced impacts of energy subsidy removal on different income groups and introduce compensating policies that can target disadvantaged groups. Although subsidies have been traditionally justified on the base of protecting poor people, numerous studies have shown that the rich can benefit more (Shi and Kimura, 2014). In the case of Malaysia, estimates show that higher-income groups received more than 70 % of the fuel subsidies (National Economic Advisory Council, 2009). Additionally, increased commodity prices due to higher energy prices after subsidy removal were expected to hurt the poor more than high-income groups (International Institute for Sustainable Development, 2013). Secondly, in addition to petroleum subsidies, which are often the subject of studies, this study also includes natural gas subsidies provided by state-owned gas supplier. The two strands of subsidies have different funding mechanisms and thus are modelled separately. Lastly, this study uses the most recent Malaysian I-O table (2010), which can better capture recent economic structure changes than earlier versions used in the existing literature. With debates on further subsidy removal, this is a timely study for policymaking in Malaysia as it offers reference to the most vulnerable sectors and income groups. Accordingly, the government can formulate compensatory policy to minimise political opposition.

The study proceeds as follow. The next section briefly explains fuel subsidies in Malaysia and the existing literature. Section 3 introduces the CGE model. Section 4 reports the simulation results, followed by discussions and policy implications. The last section concludes.

## **2. Energy Subsidies and Recent Developments in Malaysia**

Subsidies to fossil fuels are prevailing and serious in ASEAN. According to the International Energy Agency (2013), the total cost of fossil fuel subsidies in ASEAN amounted to US\$51 billion in 2011. Malaysia is an outstanding example in the region. In 2011, the share of after-tax fossil fuel subsidies to GDP was roughly 7.21 % in Malaysia, only less than Brunei Darussalam's 8.41 %, but higher than 5.36 % in Indonesia and 4.72 % in Thailand, and much higher than the world average of 2.72 %. In terms of the ratio of energy subsidies to the overall government budget, Malaysia had the highest ratio in ASEAN at about 32.94 %, followed by 30.07 % in Indonesia and 20.85 % in Thailand, and significantly higher than the

world average of 8.13 %.

As early as 1983, an automatic pricing mechanism was introduced in Malaysia to determine the retail prices of petrol, diesel, and liquefied petroleum gas based on factors such as the reference product cost (i.e. the Mean of Platts Singapore), operational costs, the margins of oil companies and station operators, sales tax, and subsidies. In reality, the automatic pricing mechanism has been used to determine the sales tax exemption and subsidy needed to cover the difference between a fixed retail price and the market price (IISD, 2013). The budget for petroleum subsidies has grown substantially overtime since the 1990s. According to Malaysia's own statistics, the budget was only RM27 million in 1990, but increased to RM3.2 billion in 2000 and 9.6 RM billion in 2010. The number reached an all-time high of RM17.6 billion in 2008 when oil prices reached a historically high level (Hamid and Rashid, 2012). International estimates are often significantly higher than Malaysia's own statistics, probably due to the adoption of different methodologies. For example, petroleum subsidies in 2009 are estimated to be RM13.95 billion by the International Energy Agency, more than twice the RM 6.19 billion estimated by Malaysia's own sources (IISD, 2013).

The end-user price of natural gas in Malaysia is ranked as the second lowest in ASEAN, only higher than that in Brunei, and more than half of Malaysia's electricity is generated by natural gas. Unlike petroleum products, natural gas is not directly subsidised by the government. Instead, Petronas, Malaysia's national oil and gas company, bears the cost. The company is required to sell natural gas to national power corporations and independent power producers at a controlled low price, which is around a quarter of the market price. Natural gas sold to non-power sectors, such as to industries and the commercial sector, are also heavily subsidised, although to a lesser extent than for power sectors. Based on data provided by Petronas, it is estimated that the company's foregone revenue in 2010 amounted to RM11.2 billion for supplying gas to power sectors and RM7.9 billion for supplying gas to non-power sectors (Ilias, Lankanathan, and Poh, 2012).

To reduce the budget deficit, the Malaysian government proposed to gradually rationalise price control on subsidised commodities and achieve market pricing by 2015 in the "2010-2015 Malaysia Plan". A follow-up subsidy rationalisation programme was launched in May 2010, which intended to increase the price of subsidised commodities by a pre-specified amount every 6 months until 2014. A poll conducted by the government showed that 61 % of the Malaysian public supported reducing subsidies (IISD, 2013). However, many price adjustments did not take place as scheduled, and the short-lived subsidy rationalisation programme was officially suspended in March 2012. The official explanation for the suspension was that rising commodity prices since 2011 shifted the government's focus to the cost of living (Teoh, 2012). On 3 September 2013, the Malaysian government decided to cut fuel subsidies for the first time since 2011, which raised the price of certain gasoline and diesel fuels by between 10.5 % and 11.1 % (Gangopadhyay, 2013).

The low oil price at the end of 2014 made it possible for Malaysia to overhaul fossil fuel subsidies to some extent (Bloomberg, 2014). In November 2014, Prime Minister Najib Razak announced that subsidies for gasoline and diesel would be removed from 1 December 2014. Since then, a managed float system that takes into account recent changes in production and

markets has been used to price petroleum products. However, it is not clear whether the fossil fuel subsidies will come back if oil prices increase again since the fundamentals of the subsidy policy have not been changed (Shi, 2016). An incentive-based regulation framework for the natural gas sector was scheduled to be introduced in January 2016, but so far no further action has been announced.

### **3. Methodology and Data**

We build a Malaysian CGE model to quantitatively evaluate the potential impacts of energy subsidy reform. Generally, a CGE model is a top-down macroeconomic framework based on general equilibrium theory and actual data. The behaviour of each agent, such as households, firms, and the government, are described by a system of non-linear functions. An overall equilibrium can be obtained against a given external shock through the interactions of the agents. Comparing alternative equilibriums obtained under different scenarios provides policymakers with quantitative insight for long-run economic planning and policymaking. Therefore, CGE models have been widely used in analysis of government regulation, tax reform, trade liberalization, regional cooperation, and environmental issues (e.g. Hudson and Jorgenson [1975]; Ballard et al. [1985]; Burniaux, Martin, and Oliveira-Martins [1992]; Harrison and Rutherford [1997]; Dixon [2006]; Hosoe [2007]; Perali, Pieroni, and Standardi [2012]; and Parrado and de Cian [2014]).

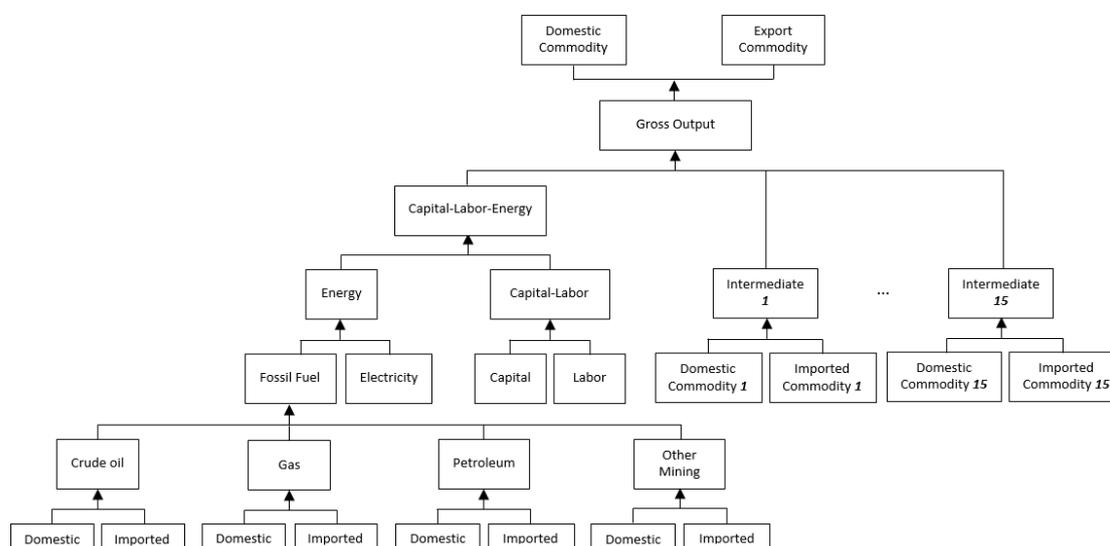
In this study, to be consistent with the classifications of the I-O table and household income and expenditure survey, the economy is divided into 15 non-energy sectors: agriculture (AR), food and wear (FW), wood and paper (WP), chemicals and metal (CM), machinery (MN), vehicles (VH), construction (CS), wholesale and retail trade (WR), hotels and restaurants (HR), transport (TP), communications and amusement (CA), housing (HS), education (ED), health (HE), and other services (OS); and 5 energy sectors: electricity (EC), crude oil (OL), natural gas (NG), other mining (OM), and petroleum (PL). In Malaysia's I-O table, coal is not separately listed but combined in the other mining sector, which is why the sector is considered as an energy sector in this study. The natural gas sector in this study is aggregated from the natural gas and gas sectors in the I-O table. Each sector is assumed to have one representative producer. The economy has four representative households, which represent the bottom 15 % (H1), lower-middle 40 % (H2), upper-middle 30 % (H3), and top 15 % (H4) of households by income.

#### **3.1. The Model**

Figure 1 describes the nested production structure for all sectors, which consists of three broad categories of inputs: factor inputs (i.e. labour and capital), energy inputs, and non-energy intermediate inputs. At each level of the production structure, the producer is

assumed to choose a bundle of inputs that maximises profit subject to its production technology. Domestic inputs and imported input of the same variety are treated as imperfect substitutes in production and aggregated using a constant elasticity of substitution function. The fossil fuel bundle, energy bundle, capital-labour bundle, and capital-labour-energy bundle are all constant elasticity of substitution aggregations. Following a Leontief function, the capital-labour-energy input and non-energy intermediate inputs are then aggregated into the gross output, which is either supplied to the domestic market or exported. For crude oil, natural gas, other mining, and petroleum, the domestic supply and exports are not differentiated. For the remaining sectors, the gross output is further transformed into domestic and export commodities using a constant elasticity of transformation function. The representative households receive factor income by supplying capital and labour and receive transfer payments from the government and the rest of the world. After paying income taxes and making non-tax payments to the government, the households consume and save. As the Malaysian government has a budget deficit, one form of household saving is to purchase government bonds. The total consumption of each representative household is subject to its budget constraint, and the consumption of each commodity  $j$ , as well as the share of domestic commodity  $j$  and imported commodity  $j$ , are determined following a nested constant elasticity of substitution structure.

**Figure 2.1. Nested Production Structure**



Source: Authors.

Government revenue comes mainly from tax collection. According to the data, taxes in the model include (1) labour income tax, (2) capital income tax, (3) production tax on gross output, (4) sales tax on final consumption and investment, and (5) sales tax on exports. Tax revenue and non-tax payments allow the government to spend on goods and services, such as education, healthcare, and national defence, provide subsidies, save for investment, and also

make transfer payments to households and the rest of the world. In this study, government subsidies are provided for products in the agriculture, food and wear, chemical and metal, and petroleum sectors. On top of the constant elasticity of substitution combination of domestic and imported commodities, the total government consumption is a composition of commodities based on a Cobb-Douglas function. That is, the government is assumed to consume each commodity in a fixed proportion of the total government consumption.

Domestic savings by the government and households, as well as foreign savings arising from the trade balance, are assumed to be entirely used on investment. Like government consumption, the total investment on commodities is also based on a Cobb-Douglas function, and substitution between domestic and imported products follows a constant elasticity of substitution function. In addition to the market-clearing conditions for commodities, labour, and capital, several other assumptions are made to complete the model: (a) household saving rates are exogenous, (b) prices of exports and imports are exogenous, and (c) foreign savings are fixed while the exchange rate is floating.

### **3.2. Data**

We construct a social accounting matrix according to the framework presented in Section 3.1. Most data used are from Malaysia's I-O Table 2010. Other non-energy data, such as factor income taxes, non-tax payments, and government transfer payments, are collected from Malaysia's Statistical Handbook and Yearbook of Statistics. The household disaggregation is based on information from the Malaysia Household Income and Basic Amenities Survey Report 2009 and Malaysia Report on Household Expenditure Survey 2009. The figures show that income inequality is quite serious in Malaysia. Energy-related data, such as the energy supply, sectoral consumption of fossil fuels, and retail fuel prices in Malaysia, are obtained from the Malaysia National Energy Balance and Malaysia Energy Statistics Handbook. These data are utilised to disaggregate the crude oil and natural gas sector and the electricity and gas sector in the I-O table and calculate the CO<sub>2</sub> emissions from fossil fuel combustion.<sup>1</sup> Emission factors used in the calculation are set following the IPCC (2006). Most parameter values used in the simulation, such as tax rates and saving rates, are calibrated on a basis of the social accounting matrix, but the elasticities of substitution/transformation in production and the consumption and investment functions are set in line with those used in the Massachusetts Institute of Technology Emissions Prediction and Policy Analysis model (e.g. Paltsev et al., 2005), the Global Trade Analysis Project (GTAP) model (e.g. Huff et al., 1997), and Solaymani and Kari (2014).

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<sup>1</sup> Emissions from gas flaring reinjection and use (specified in the National Energy Balance table) are not considered in this study.

#### 4. Simulation and Results

The aim of this study is to assess how the Malaysian economy, different income groups, and carbon emissions will be affected by a reform of energy subsidies – more specifically, government-funded petroleum subsidies and a producer-funded gas subsidy. Accordingly, three broad categories of scenarios are designed for the simulation: (1) no petroleum subsidies, (2) no gas subsidy, and (3) no petroleum subsidies and no gas subsidy. A gas subsidy removal in power generation only, and a removal in power generation as well as industries and commercial sectors, are simulated separately as sub-scenarios. A petroleum subsidy removal would directly reduce fiscal expenditure, and a gas subsidy removal is expected to improve economy efficiency and overall increase government revenue. How should the extra money be used? Two additional sub-scenarios are specified for government behaviour: (a) use the increased revenue to cut the budget deficit (i.e. fixed fiscal expenditure setting), which is the primary incentive for the government to abandon the subsidy policy; or (b) spend the extra money following the expenditure pattern in 2010 (i.e. flexible fiscal expenditure setting). Regarding the compensating policy for the disadvantaged group, two options are simulated, labour income tax rebates and direct government transfer payments. The compensation is provided up to the point where the bottom 15 % of households (H1) are no worse than the baseline status. Table 2.1 summarises the major scenario assumptions and additional scenarios for the compensating policy. In all the simulations, the gross outputs of the crude oil, natural gas, other mining, and petroleum sectors are fixed at their 2010 capacities based on the sectors' production features in the short run. Outputs that cannot be absorbed in domestic markets are assumed to be entirely exported.

**Table 2.1. Scenario Assumptions**

<i>Major Scenarios</i>		<i>a.</i>	<i>b.</i>
		Fixed fiscal expenditure	Flexible fiscal expenditure
1.	No petroleum subsidies	<i>1a</i>	<i>1b</i>
2.	No gas subsidy	<i>2a<sub>P</sub></i>	<i>2b<sub>P</sub></i>
	Power generation only ( <i>P</i> )		
3.	No petroleum subsidies and no gas subsidy	<i>3a<sub>P</sub></i>	<i>3b<sub>P</sub></i>
	Power generation only ( <i>P</i> )		
	Power generation, industries, and commercial sector ( <i>PIC</i> )	<i>2a<sub>PIC</sub></i>	<i>2b<sub>PIC</sub></i>
	Power generation, industries, and commercial sector ( <i>PIC</i> )	<i>3a<sub>PIC</sub></i>	<i>3b<sub>PIC</sub></i>

*Compensation Scenarios*

I. Income tax rebate to *H1*

II. Transfer payment to *H1*

Source: Authors.

#### 4.1. Impacts of Subsidy Removal

Table 2.2 shows the simulation results for 10 scenarios or sub-scenarios when there is no compensating policy for the disadvantaged groups. When petroleum subsidies are completely removed, economic efficiency improves and real GDP increases by 0.38 % when the saved subsidy is used to reduce the budget deficit (i.e. Scenario 1a), and by 0.34 % when the save subsidy is spent on government consumption and infrastructure investment (i.e. Scenario 1b). The budget deficit declines significantly, by 27.92 %, under the former setting and negligibly, by 0.80 %, under the latter setting. Generally, lower-income groups are less affected than higher-income groups, which is mainly because petroleum products account for a larger proportion in the consumption baskets of higher income groups. Investment increases in Scenario 1a as the private savings previously used to purchase government bonds are now channelled to investment, which dominates other factors such as inflation and reduced government tax revenue. In Malaysia, government tax revenue is not linearly related

to the economy's overall performance. This is because capital income tax and production tax on gross output, which account for more than two-thirds of Malaysian government tax revenue, have quite different tax rates across sectors. However, exports and imports increase along with the overall economy in this scenario. Investment, exports, and imports all decrease in Scenario 1b as the saved subsidy cost is spent on domestic services, such as education, health, and other public services. In both Scenarios 1a and 1b, a higher petroleum price lowers the country's consumption of petroleum and consequently reduces the total carbon emissions. As government consumption is service dominated and less energy intensive than investment and household consumption, the carbon emission reduction is larger in Scenario 1b.

**Table 2.2 Macro Impacts (%)**

	<i>Scenario</i>									
	<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>	<i>P</i>	<i>PIC</i>	<i>P</i>	<i>PIC</i>
GDP	0.38	0.34	0.28	0.54	0.28	0.53	0.69	0.97	0.66	0.93
Budget deficit	-27.92	-0.80	-3.45	-7.02	0.14	0.30	-30.79	-33.70	-0.59	-0.38
H1 consumption	-1.12	-0.97	-0.21	0.06	-0.20	0.09	-1.26	-0.94	-1.11	-0.78
H2 consumption	-1.24	-1.10	-0.07	0.24	-0.06	0.27	-1.24	-0.88	-1.08	-0.72
H3 consumption	-1.42	-1.33	0.09	0.50	0.10	0.51	-1.24	-0.77	-1.14	-0.68
H4 consumption	-1.61	-1.70	0.24	0.74	0.23	0.72	-1.27	-0.70	-1.36	-0.81
Government consumption		8.16			0.77	1.65			8.73	9.40
Investment	3.32	-1.31	0.92	1.10	0.48	0.16	4.20	4.33	-0.75	-1.00
Exports	1.01	-0.27	-0.54	-0.73	-0.64	-0.99	0.42	0.20	-0.93	-1.28
Imports	1.20	-0.33	-0.64	-0.87	-0.76	-1.18	0.50	0.24	-1.10	-1.52
CO <sub>2</sub> emissions	-1.84	-2.09	-4.64	-4.22	-4.66	-4.27	-6.37	-5.89	-6.63	-6.17

GDP = gross domestic product, P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

For gas subsidy reform, real GDP increases more when the removal is across all sectors, as in Scenarios 2b and 2d, rather than only in power generation, as in Scenarios 2a and 2c. As the saved gas subsidy does not go to the government, budget deficit reduction in the fixed expenditure scenarios thus mainly arises from higher tax revenue, and is much smaller than in Scenario 1a. The budget deficit increases slightly in the flexible expenditure scenarios due to increased demand for government bonds from the households. This is set to be proportionally related to household savings in these scenarios. Lower-income households are only moderately affected by the gas subsidy removal or higher-income households are even

better off. The explanation is that: first, the natural gas used by households is not initially subsidised, so they are only indirectly affected by the increase in the electricity price; second, the previously forgone revenue turns into capital income (essentially, operating surplus), which is then distributed to households proportionally. According to the household income survey, higher-income groups receive much more than lower-income groups. Investment increases in all four sub-scenarios, but is lower under the flexible expenditure setting. Exports and imports generally decrease, mainly because exports of (electricity-intensive) machinery and petroleum products decrease. Producers and households mostly switch from more expensive natural gas and electricity towards domestic petroleum products, which thus affects exports. The carbon emission reductions in the gas subsidy removal scenarios are more than doubled in the petroleum subsidy removal scenarios. After all, more than 50 % of electricity is generated by natural gas, while less than 5 % is generated by petroleum products. The emission reduction is relatively smaller in complete removal scenarios as energy demand arising from higher productions partially offsets the decrease in energy consumption due to the increased energy price.

When the reform extends to both the petroleum and gas subsidies, the macro impacts are close to, but not equal to, the accumulated impacts of the individual cases. The figures show that when both subsidies are removed, real GDP can increase by almost 1 %, which is a significant change in any country. By comparison, the growth rate is relatively higher under the fixed government consumption and infrastructure investment setting than under the flexible setting. As in previous simulations, households are overall less affected when the government decides to spend the saved subsidy costs rather than cutting the budget deficit, and are also less affected when the gas subsidy is removed in all sectors. The carbon emission reduction is around 6 % in all four sub-scenarios, which implies that energy subsidy reform could be an important policy instrument for Malaysia to mitigate climate change and achieve its intended nationally determined contribution target.

Table 2.3 shows how the sectoral outputs are affected by the energy subsidy reform. The general principle is that petroleum-intensive sectors are more affected by the petroleum subsidy removal and electricity-intensive sectors are more affected by the gas subsidy removal. For example, the agriculture sector and transport sector are petroleum intensive, so their outputs decrease due to higher production costs when petroleum subsidies are removed, but increase due to the relocation of labour and capital from more affected sectors when the gas subsidy is removed. On the contrary, the machinery sector is electricity intensive, so its output increases in the petroleum subsidy removal scenario, but decreases in the gas subsidy removal scenario.

**Table 2.3. Impacts on Output at the Sectoral Level (%)**

Sector	Scenario									
	1a	1b	2a		2b		3a		3b	
			P	PIC	P	PIC	P	PIC	P	PIC
AR	-1.36	-1.95	0.90	0.62	0.84	0.49	-0.37	-0.58	-1.01	-1.28
FW	-1.76	-2.21	1.14	-0.14	1.10	-0.24	-0.52	-1.70	-1.01	-2.24
WP	-0.45	-1.58	-0.75	-0.44	-0.86	-0.67	-1.10	-0.78	-2.31	-2.09
CM	-2.49	-4.29	-0.72	-6.29	-0.88	-6.65	-2.98	-8.10	-4.88	-10.06
MN	3.76	1.57	-2.83	-1.90	-2.99	-2.34	0.61	1.22	-1.67	-1.31
VH	1.05	-1.88	0.27	-0.23	0.00	-0.82	1.35	0.84	-1.77	-2.50
CS	1.98	-1.40	0.70	0.82	0.38	0.13	2.69	2.78	-0.94	-1.12
WR	-0.90	-1.92	0.56	0.86	0.46	0.64	-0.28	0.07	-1.38	-1.13
HR	-1.07	-0.82	-0.19	0.17	-0.17	0.22	-1.20	-0.80	-0.94	-0.52
TP	-4.57	-4.91	1.30	2.59	1.26	2.51	-3.20	-1.90	-3.56	-2.30
CA	-0.49	-0.17	-0.25	0.55	-0.22	0.62	-0.72	0.10	-0.37	0.47
HS	-0.61	-0.24	0.08	0.51	0.11	0.59	-0.50	-0.04	-0.11	0.39
ED	-0.46	3.88	0.06	0.24	0.57	1.21	-0.37	-0.17	4.37	4.92
HE	-0.60	2.68	0.04	0.15	0.46	0.72	-0.52	-0.38	3.11	3.29
OS	-0.15	2.30	-0.32	0.04	-0.13	0.53	-0.45	-0.09	2.11	2.73
EC	-0.72	-0.58	-10.08	-8.97	-10.07	-8.94	-10.67	-9.53	-10.50	-9.35

P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

#### 4.2. Impacts of the Compensating Policy

In addition to household consumption in volume, compensating variation and equivalent variation are also considered in this study to discuss the loss of welfare arising from the energy subsidies removal. Intuitively, compensating variation refers to the amount of money a household must be compensated for when the price changes, and equivalent variation refers to the amount of money a household would accept in lieu of the price changes. A negative sign implies that the price changes would make the household worse off. Table 2.4 lists the simulated compensating variation and equivalent variation values for each income group, the signs of which are consistent with household consumption in volume. Since the energy subsidies removal makes disadvantaged groups even worse in most situations, the labour income tax rebate and direct government transfer to the bottom 15 % households (H1) based on compensating variation and equivalent variation values are simulated in this study. Table 2.5 shows that compensating the poorest people would hardly affect macroeconomic performance or total carbon emissions, so the two compensating instruments are almost identical in terms of their economic impacts.

**Table 2.4. Compensating Variation and Equivalent Variation (RM billion)**

Scenario	Income group				
		H1	H2	H3	H4
1a	CV	-0.22	-1.26	-2.05	-2.56
	EV	-0.22	-1.24	-2.02	-2.52
1b	CV	-0.19	-1.11	-1.92	-2.69
	EV	-0.19	-1.10	-1.90	-2.67
2a_P	CV	-0.04	-0.07	0.13	0.38
	EV	-0.04	-0.07	0.13	0.37
2a_PIC	CV	0.01	0.24	0.71	1.17
	EV	0.01	0.24	0.71	1.17
2b_P	CV	-0.04	-0.06	0.15	0.36
	EV	-0.04	-0.06	0.14	0.36
2b_PIC	CV	0.02	0.27	0.73	1.13
	EV	0.02	0.27	0.73	1.13
3a_P	CV	-0.25	-1.26	-1.79	-2.04
	EV	-0.25	-1.24	-1.76	-2.00
3a_PIC	CV	-0.19	-0.89	-1.11	-1.11
	EV	-0.18	-0.87	-1.10	-1.10
3b_P	CV	-0.22	-1.09	-1.65	-2.17
	EV	-0.22	-1.08	-1.63	-2.14
3b_PIC	CV	-0.15	-0.72	-0.98	-1.28
	EV	-0.15	-0.71	-0.97	-1.27

CV = compensating variation, EV = equivalent variation, P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

**Table 2.5. Impacts of the Compensating Policy (%)**

		Scenario							
		1a	1b	2a P	2b PIC	3a P	PIC	3b P	PIC
GDP	/	0.38	0.34	0.28	0.28	0.69	0.97	0.66	0.93
	//	0.38	0.34	0.28	0.28	0.69	0.97	0.66	0.93
Budget deficit	/	-26.81	-0.76	-3.21	0.15	-29.48	-32.75	-0.54	-0.35
	//	-27.24	-0.80	-3.32	0.14	-30.01	-33.13	-0.59	-0.39
H1 consumption	/	0.00	0.02	0.02	0.00	0.04	0.01	0.01	0.01
	//	0.01	0.04	0.00	0.00	0.01	0.00	0.00	0.01
H2 consumption	/	-1.24	-1.11	-0.07	-0.06	-1.24	-0.88	-1.09	-0.72
	//	-1.24	-1.11	-0.07	-0.06	-1.24	-0.88	-1.09	-0.72
H3 consumption	/	-1.42	-1.34	0.09	0.10	-1.24	-0.77	-1.15	-0.68
	//	-1.42	-1.34	0.09	0.10	-1.24	-0.77	-1.15	-0.68
H4 consumption	/	-1.61	-1.70	0.24	0.23	-1.27	-0.70	-1.36	-0.81
	//	-1.61	-1.70	0.24	0.23	-1.27	-0.70	-1.36	-0.81
Government consumption	/		7.96		0.73			8.50	9.24
	//		7.98		0.73			8.53	9.26
Investment	/	3.21	-1.29	0.89	0.49	4.08	4.24	-0.73	-0.99
	//	3.20	-1.31	0.90	0.48	4.08	4.24	-0.75	-1.00
Exports	/	0.99	-0.26	-0.54	-0.64	0.40	0.18	-0.92	-1.27
	//	0.99	-0.27	-0.54	-0.64	0.40	0.18	-0.92	-1.27
Imports	/	1.17	-0.31	-0.64	-0.76	0.47	0.21	-1.09	-1.51
	//	1.17	-0.32	-0.64	-0.76	0.47	0.21	-1.09	-1.51
CO <sub>2</sub> emissions	/	-1.84	-2.08	-4.64	-4.66	-6.37	-5.89	-6.62	-6.16
	//	-1.84	-2.08	-4.64	-4.66	-6.37	-5.89	-6.62	-6.17

GDP = gross domestic product, P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

## 5. Discussion and Policy Implications

Subsidies removal can produce both economic and environmental benefits. We have shown that either a petroleum or gas subsidy removal, or both, would improve economic efficiency and increase real GDP. In the interest of economic growth and climate change mitigation, both the petroleum and gas subsidies should be removed, rather than only one of them. Removing the government-funded petroleum subsidies would largely reduce the budget deficit, especially if the saved subsidy costs are entirely used to reduce the budget deficit. At the sectoral level, changes in outputs are different across sectors. Generally, petroleum intensive sectors are more affected by the petroleum subsidy removal, while electricity intensive sectors are more affected by the gas subsidy removal. Compared to the flexible expenditure setting, the fixed expenditure setting performs slightly better in terms of economic benefits, but worse in terms of the CO<sub>2</sub> emissions reduction. While there is a trade-off between the fixed expenditure and flexible expenditure settings, the sustainability of the fiscal system discourages the flexible expenditure setting. Whether to use the extra money to reduce the budget deficit, or for education, healthcare, or other public services, or a combination of these, is subject to the government's preference.

Households at all income levels would be worse off in most scenarios. Low-income groups tend to suffer less than their high-income peers in the petroleum subsidy scenarios, but are worse off in other scenarios, especially when their high-income peers benefit from the gas subsidy removal due to disproportionate the employment of high income households in the gas sector. Given their low average income, it would be difficult to offset the impact for low income households. From the public policy perspective, the projection for disadvantaged groups is one of the key tasks for the government. Simulation results show that the compensating policy through labour income tax rebates or direct transfer payments could make the poorest income group no worse off than the baseline while having almost no extra impacts on GDP growth or emissions reductions. Given the significant net economic benefits, it is also possible to compensate other households and industries, which could reduce public opposition and also lead to a Pareto improvement.

Although the simulation results support phasing out of fossil fuel subsidies, the political sensitivity demands a holistic approach, strategic planning, and actions (Shi, 2016). A subsidy removal could induce unrest and possibly even riots, and fuel subsidy removal is also often used as a weapon in domestic politics (Shi and Kimura, 2014). Therefore, compensating policy for the disadvantaged groups should be carefully considered. While preparation of subsidy removals will take time, there is no excuse to delay initial actions, such as public education and campaigns (Shi, 2016). Delaying the removal of subsidies will primarily increase costs for the government and leave little room for policy space when energy prices are higher than expected (Wu, Shi, and Kimura, 2012).

## 6. Conclusion

This study quantitatively investigates the impacts of removing energy subsidies on Malaysia's macroeconomic indicators, household welfare, and carbon emissions. A dedicated Malaysia CGE model was built to incorporate a breakdown of households by income to allow estimations of the impact on households. The results show significant economic and environmental benefits for removing the petroleum and gas subsidies. However, the impacts on industrial sectors and on households are mixed. The results suggest that Malaysia should proceed to remove the subsidies, but with a comprehensive policy scheme to minimise resistance. The results also imply that a proper compensation approach to households, at least to the most disadvantaged group, is needed. Further compensation for other households and industries is also possible, given the positive overall economic benefits. With a significant budget deficit reduction and economic benefits, it is recommended to use the saved subsidy costs or increased tax revenue to reduce fiscal deficits as well as compensate the most affected households and industries.

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