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Economy-Wide Effects of Fuel Subsidy Removals in Malaysia

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ABSTRACT

Malaysia has been subsidizing substantially the use of natural gas input in the power sector. From the economic viewpoint, such subsidies result in inefficient energy and electricity consumption while raising environmental pollution and widen the government's fiscal deficit. Of late, the government has embarked on reducing fuel subsidies as part of her subsidy rationalization program. This paper considers the economy-wide effects of gas subsidy removals within the power sector using the computable general equilibrium (CGE) model with explicit production function for the electricity sector. Results indicate gas subsidy reductions lead to increases in the price of electricity followed by a decline in demand for electricity by other economic sectors. It will also have negative effects on Gross Domestic Product (GDP) and consumer prices. By utilizing a revenue recycling policy, the additional revenue from subsidy removals can be allocated for the promotion of renewable energy within the power generation sector.

Keywords: Electricity, Malaysia, Fuel subsidy removals, CGE model, Renewable energy.

ABSTRAK

Malaysia telah memberi subsidi yang banyak bagi penggunaan input gas asli dalam sektor kuasa. Dari sudut pandangan ekonomi, subsidi tersebut menyebabkan penggunaan tenaga elektrik yang tidak efisien serta meningkatkan pencemaran alam sekitar dan meluaskan defisit fiskal kerajaan. Sejak kebelakangan ini, kerajaan telah memulakan langkah bagi mengurangkan subsidi bahan api sebagai sebahagian daripada program untuk merasionalkan subsidi tersebut. Kajian ini mengambil kira kesan ekonomi secara menyeluruh terhadap pengurangan subsidi gas dalam sektor kuasa dengan menggunakan model Keseimbangan Umum Boleh Kira (CGE) bersama fungsi pengeluaran eksplisit bagi sektor bekalan elektrik. Hasil kajian menunjukkan pengurangan subsidi gas membawa kepada peningkatan harga elektrik disertai dengan penurunan dalam permintaan bagi bekalan elektrik dalam sektor-sektor ekonomi yang lain. Pengurangan subsidi juga mempunyai kesan yang negatif terhadap Keluaran Dalam Negara Kasar (KDNK) dan harga pengguna. Namun, dengan menggunakan dasar kitar semula pendapatan kerajaan, pendapatan tambahan daripada pengurangan subsidi akan dapat diperuntukkan untuk mempromosikan tenaga boleh diperbaharui dalam sektor jana kuasa.

Kata kunci: Bekalan elektrik, Malaysia, Pemansuhan subsidi bahan api, Model CGE, Tenaga boleh perbaharui

INTRODUCTION

As a developing nation, Malaysia has utilised subsidies to promote its social agenda.Among the industries subsidised is natural gas used for power generation in the electricity sector. PETRONAS, the national oil corporation, imports 36% of Malaysia's natural gas which is then supplied to the country's power company Tenaga Nasional Berhad (TNB) at a costwhich is approximately 25% of the imported price(Hamid & Rashid, 2012). Currently, the power producer's natural gas price is capped at RM15.20 per million metric British Thermal Units (MMBTU) while the international market price is around RM50 per MMBTU(Kok, 2013). As such the electricity producerenjoys a 75% discount on the purchased gas price.

As shown in**Error! Reference source not found.**,natural gas has the highest share of energy input in the electricity generationfuel mix and selling it at a lower price translates into lower input and production costs. From an economic view, a subsidy on electricity production reduces the cost of production, leads to higher energy consumption and lower efficiency as well as indirectly contributing to greater environmental pollution.At the same time, the growing gas subsidy arising from the increase in electricity consumption imposes a heavy burden on the government budget. Asshown in **Error! Reference source not found.**, subsidy payments to the energy sector have surged from RM6.9 million in 2005 to RM11.6 billion in 2011. In addition, with Malaysia reaching 53% of the energy mix for natural gas in 2010 and projections that her gas reserves will last about 32 years, the sustainability and security of the sector will come under increasing pressure. As such, it is imperative that solutions such as a switch to alternative or greener energy sources are explored.

The government has taken the necessary steps to address this issue including reforming the subsidy mechanism of the energy sector. In the Tenth Malaysia Plan (2011-2015), the government outlined subsidy-rationalisation plans that,while continuing to promote economic growth,would also include forward-looking policies and strategies for reducing dependence on polluting energy sources(EPU, 2010). Accordingly, in January 2014, TNB announced that to reduce subsidy costs, the average electricity tariff would be raised by 15% due to the increase in natural gas prices supplied to the power sector by 10% from RM13.70/MMBTU to RM15.20/MMBTU and the increase in other fuel costs (Yuen, 2013).

This study is structured as follows:The Introduction in Section 1 is followed by a review of the literature on energy subsidies in Section 2, Section3introduces the modelstructure andexplains the data and scenarios, Section 4examines the simulation results, and the conclusions are in Section 5.

BRIEF REVIEW OF THE LITERATURE

Arange of empirical studies on reforms in fossil energy subsidies have been conducted by researchers who have analysed their effects on the economy, society andenvironment.Some researchers have demonstrated that reforms of energy subsidiesimpact economies negatively.Lin and Jiang (2011)use the CGE model to simulate the economic and environmental impacts of energy subsidy reform, including coal, oil, gas and electricity subsidies. The result indicates that the removal of energy subsidies without any attempt at policy reallocation, would decrease GDP and employment substantially, as well as result in notable decreases in emissions.A similar study by Liu and Li (2011), analysed that compared to reducing oil subsidies, any reduction in coal subsidies had fewer negative economic impacts while also benefiting the environment and energy consumption. The negative effects on the socio-economic sector will be moderated if coal or oil subsidies are reduced gradually. Liu and Li's contribution was introducing CO_2 emissions account in CGE model for environmental analysis.

Abouleinein, El Laithy, and al-Dīn (2009)studied the effects of removing fuel subsidiesin Egypt over a five-year period. The results of the CGE model show that with no offsetting policy to the subsidy removal,the average annual GDP growth rate would declineby 1.4 percent, while the welfare of all households at all income distribution levelswould be reduced.Using a CGE/MPSGE model in Iran's energy sector, Manzoor, Shahmoradi, and Haqiqi (2009) noted that the removal of energy subsidies reduced output as well as decreasedrural and urban welfare by 12% and 13% respectively.ESMAP (2004)also analysed the impacts of electricity subsidy removal using a dynamic CGE model in Mexico.According to simulation results,a number of macroeconomic variables such as GDP, employment, exportsand importswill be negatively affected by the removal of all subsidies.

Other studies that document the effects on the economy of energy subsidy reforms include that by Hartono and Resosudarmo (2006)who developed a dynamic CGE model based on Indonesia's energy sector. They note that a subsidy reduction that is followed or not by an escalation in energy utilization efficiency leads to GDP growth, improvements in income distribution, a rise in the import of energy, and finally a decline in domestic trade and energy exports. In Malaysia, little attention has been paid to energy-subsidy related issues, particularly on studying reforms in subsidies in the electricity sector.However, a study by Hamid and Rashid (2012)used Leontief's production function and a CGE model based on national and social accounts of the Malaysian economyto prove that phasing out fuel subsidies of three energy sectors (i.e. Crude oil and natural gas; Petroleum refinery; and Electricity and gas)would result in an increase in GDP and output.They also used these models to explain the effects of fuel subsidy reallocation on related sectors.

A review of the literature shows that none of the studies have examined the effectson the Malaysian economy of a fuel subsidy reductiontargeted specifically on the electricity sector.However, in the study by Hamid and Rashid (2012) the production structure forthe electricity sector is same as other sectors and also there is no substitution possibility between electricity generation technologies. Another important difference is the existence of promoting the use of renewable energy in the electricity generation which implemented in this study.Therefore, in focusing on the electricity sector the implementation of a more integrated model such as a CGE model will provide potential insights as to the effects of theseshocks on the economy.This paper attempts to contribute to the literature by applying the CGE model to analyze the short-run effects of a decrease in the gas-based electricity subsidy on the Malaysian economy.

THEORETICAL FRAMEWORK OF THE CGE MODEL FOR MALAYSIA

This study analyses the macroeconomic consequences of reducing gas-based electricity subsidies in Malaysia under two different scenarios by applying a comparative static CGE model that reflects the interdependent linkbetweeneconomic sectors.A CGE model can provide more detailedeconomic interrelationships than partial equilibrium or econometric models.

Model

The main methodology applied in this study is the multi-sectoral CGE model that is developed based on the ORANI-Gmodel (Horridge, Parmenter, & Pearson, 2000). The ORANI-Gis an applied generalequilibrium (AGE) model of the Australian economy and is an enhanced version of the well-knownORANI that was first developed in the late 1970sas a tool for practical policyanalysis(Dixon, Parmenter, Sutton, & Vincent, 1982). It is in the Johansen class that is written as a system of linear equations inpercentage changes from the variables and solved using GEMPACK software(Harrison & Pearson, 1996). The model satisfies three equilibrium conditions: the zero profit condition that requires industriesto maximize their profit by costminimization;the market clearance condition which requires that supply and demand be equal, and the income balance conditionwhich requires that agentsgain goods under income condition. In addition, utility maximization for households and perfect competition with constant returns to scale in the economy are assumed.

It is astatic model with a top level Leontief production function and CES sub-structures.The CGE model adopts the linear expenditure system (LES) demand functionwhich is derived from the maximization of a Klein-Rubin (1947–1948) utility function that distinguishes between necessary and luxury goods for household consumption.Also, householdchoices between domestic and imported commoditiesare modelledby CES[1]function.

ProductionStructure

In the case of the electricity sector, technological information is especially pertinent and has a key role in analyzing the effects of subsidy reduction in this study, particularly due toa wide range of generation technologies.So the ORANI-G model has been modified to includea CES function for electricity generation composite to allow substitution possibilities among four types of electricity generation, instead of locating electricity commodity under Leontief function in the same level similar to other intermediate inputs. Accordingly, the electricity industry is disaggregated into five industries based on different generation technologies.Four of these relate to electricity generation while the fifth covers the electricity supply industry. The output of the different generation sectors is the input for the electricity supply industry which then transmits and distributes it to other industries and final users.

As

FIGURE 2shows, electricity output is produced from intermediate input composites, electricity generation composites, primary factor composites and other cost ticketsusing a Leontief production function at the top level. Therefore, the electricity supply industry requires these inputs directly with no substitution. At the subsequent level, the CES production function is used to aggregate domestic and imported goods to obtain each intermediate commodity composite (Armington assumption[2]).The electricity generation composite is a CES aggregation of four types of generations according to the energy input used, namely electricity generated from gas, coal, oil and RE[3]sources. Each generation is assumed to produce a particular type of product (coal-electricity, gas-electricity, etc.) using relatively fixed input proportions (Leontief function). In this approach, electricity generation is allowed to shift from highly subsidized gas generation to other generationtechnologies (e.g., coal and

[1]Constant Elasticity of Substitution
[2]The Armington(Armington, 1969)assumed that domestically produced and imported commodities are imperfect substitutes.
[3]Renewable Energy

renewable energy electricity). As such, the CES production function is employed to form anelectricity generation composite. At the next level, the aggregateprimary factor is a CES combination of labor, land, and capital. At the lowest level, the composite oflabor is a CES aggregation of skilled and unskilled workers.Like the ORANI model, the consideration of the supply side of the output structure shows that each industry applies the CET[1]function to produce a variety of commodities (the multi production matrix is not diagonal). Moreover, the industry transforms the commodities into goods for domestic use and export by a CET transformation frontier.

Database

The main data used in the paper is the official 2005Input-Output Tables (I-O) of Malaysia,developed by theDepartment of Statistics (2010). The data consists of 120industries and commodities.Since the electricity sector in the I-O tables was aggregated with the gas sector and represented by one sector, the disaggregationshares are taken fromthe GTAP database(Narayanan, Aguiar, & McDougall, 2012).In general, other unessential sectors are aggregated, and the economic activities extendedto 52 sectors.Since the focus of this study is on the electricity sector, the 52 sectorshave been divided into47 non- electricity sectors that use commercial electricity[2]as an important input in the production process and five new electricity industries(electricity-coal, electricity-oil, electricity-gas, electricity-RE and electricity supply) disaggregated from the aggregate electricity sector. Investments made in the electricity sector (APERC, 2009)and the output shares of electricity generation by type of fuels are used for splitting the electricity sector(Energy Commission, 2006). In the constructed I-O there are twolabor groups which are disaggregated based on the method used by Nagaraj and Goh (2006).

For the simulation, parameters in the model have been adoptedfrom the literature. The value for Armingtonelasticities and the primary factor substitution elasticity except for capital are taken from ORANI-G. The four new elasticities between electricity generation shave been taken from McDougall (1993).

Simulation Scenarios

Price regulations and tax credits are the most common tools used for energy subsidies. UNEP (2008) noted that tax would compensate the price distortion resulting from energy subsidies. To examine the effect of reducing gas subsidies on the electricity sector and economic growth, a simulation of levying a tax on subsidized gas was done to restrict excessive energy consumption.For solvingthe modela standardshort-run closure is applied, but the characteristic of some exogenous and endogenous variableshave been changedfor this study, to simulate the effects of an increase in the indirect tax[3] representing a removal of gas subsidy.

Implementing a specific tax on the consumption of natural gas would increase the cost of production of electricity generation using this input. At the same time the revenues from this tax could be used to produce electricity using RE sources rather than non-RE ones.

The 10% shock on the indirect tax on natural gas commodity usedfor gas based electricity generation is simulated underscenario 1. Scenario 2 models a situation where the revenuesfrom a subsidy removal are reallocated to the REelectricity generation industry in the form of a subsidy in production costs.Therefore, in this study two simulations have been done; in both cases subsidy removal is activated while in scenario 2 an extra modificationis applied where the revenues from the first shock are reallocated to promoteRE electricity production.

RESULTS AND DISCUSSIONS

Macroeconomic Effects

Running the simulation scenarios in GEMPACK provide some insights on the Malaysian economy and the electricity sector. **Error! Reference source not found.**shows the short-run effects ofremoving a gas subsidy,with and without reallocating, on the key macroeconomic variables.

Scenario 1 indicates that removingagas subsidy from the electricity generation sector would raise the price of electricity. Since electricity is used as anintermediate input in most industries, a rise in

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[1]Constant Elasticity of Transformation
[2]Electricity-supply commodity
[3]Increase in the tax variable for sales of natural gas to the gas-based electricity generator.

its price will lead to an increase in the cost of production and hencecontracteconomic activity.This is reflected by a 0.002% decrease in real GDP, and 0.013% in total employment due to the reduction in production.Some of the key price variables are influenced positively by the shock. The consumer price index (CPI) increased by 0.012%, in line with general economic theories, while the average price of exports in local currency termsalso increased due to domestic inflation.

Scenario 2 shows that the removal of a gas subsidy and reallocating it into the economy in the form of a RE electricity production subsidy will produce positive macroeconomic effects. GDP and employment will increase by 0.013% and 0.005% respectively. As expected, when revenues are redistributed, the negative impacts on macroeconomic variables are mitigated. However, the CPI still risesbut at a lower rate (0.007%) compared to the situation under scenario 1.

SectoralEffects

Under both scenarios, an increase in production costs caused by the rise in input price resulted in a reduction in the output of the majority of sectors. As described in **Error! Reference source not found.**,the shock would also decrease the output of electricity-gas as a result of higher cost of power generation by burning gas, which is the economicand normal response to this variable to the shock. However, in the second scenario, its output decline is higher due to increasing demand from renewable energy electricity generation arising from its production subsidy. Despite the contraction in the output of the gas generation sector, the ‘electricity-coal’ and‘electricity-oil’industries,as expected, show positive output change because of the substitution of coal and oilfor natural gas in electricity generation.Moving to coal and oil for electricity generation will increase emissions; however,by producing electricity by renewable energy the emissions would be compensated, to some extent, due to small contribution of renewable energy in total electricity production.

With regard to the reallocation of subsidies in second scenario, coal and oil electricity outputwill still rise but moderately[1] compared with first scenarioand is favorable in emission reduction.As would be expected, the output of ‘Electricity-renewable’ grows dramatically by 13.9% in scenario 2 due to reallocating the subsidy removalrevenue to production in this industry. Generally, thedistribution of electricity by the electricity supply industry in both scenarios is reducedby0.06% and 0.03% respectively,due to lower demand for electricity by consumers in response to an increase in the price of electricity. The output adjustments of other sectors mainly depend on their inter-sectoral relationship and the share of electricity in their input mix.

CONCLUSION AND POLICY IMPLICATIONS

This study applies the CGE model with particular emphasis on the electricity industry to investigate the macroeconomic and sectoralshort-run effects of a reduction in the natural gas subsidy.A subsidy removal policy with and without reallocating revenue is simulated in scenarios 1 and 2 respectively. The simulation results underscenario 1 show negative effects on macroeconomic variables such as real GDP and employment as well as result in a 0.012% increase in the inflation rate. Since electricity generation is mostly dependent on subsidised gas, the subsidy removal results in a decrease in the outputs of the gas generation and electricity supply industry. This is followed by a decline in the demand for gas generation by the electricity supply industry and, subsequently,a decrease in electricity demand by other sectors and final demanders. On the other hand, the output of electricity generations using coal, oil and renewable energy increases because of the substitution effect. The results will be different whena gas subsidy reduction is implemented and the savings reallocated for supporting renewable energy generation. Malaysia GDP is projected to increase slightly while substantial growth in electricity generation from RE can be earned.Therefore, it is not advisable for gas subsidies to be reduced or entirely removed without them being reallocated as the oil and coal substitutes will contribute to higher emissions.Any subsidy removal should be accompaniedby a reallocation of resourcesto alternative, greener fuel subsector as it would lead to positive macroeconomic impacts as well as promote environmental sustainability for Malaysia.

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[1] Due to the input share of renewable energy in electricity generation is low.

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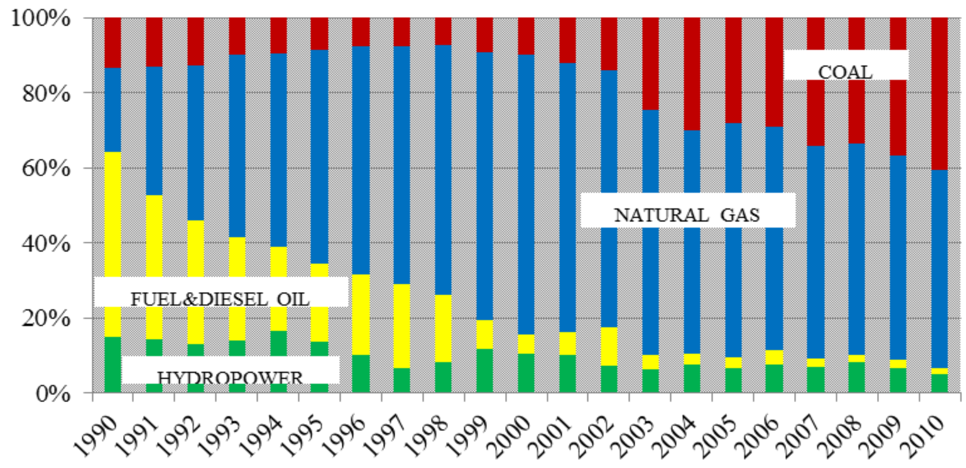

FIGURE 1: Malaysia's Electricity Generation Fuel Mix, 1990-2010

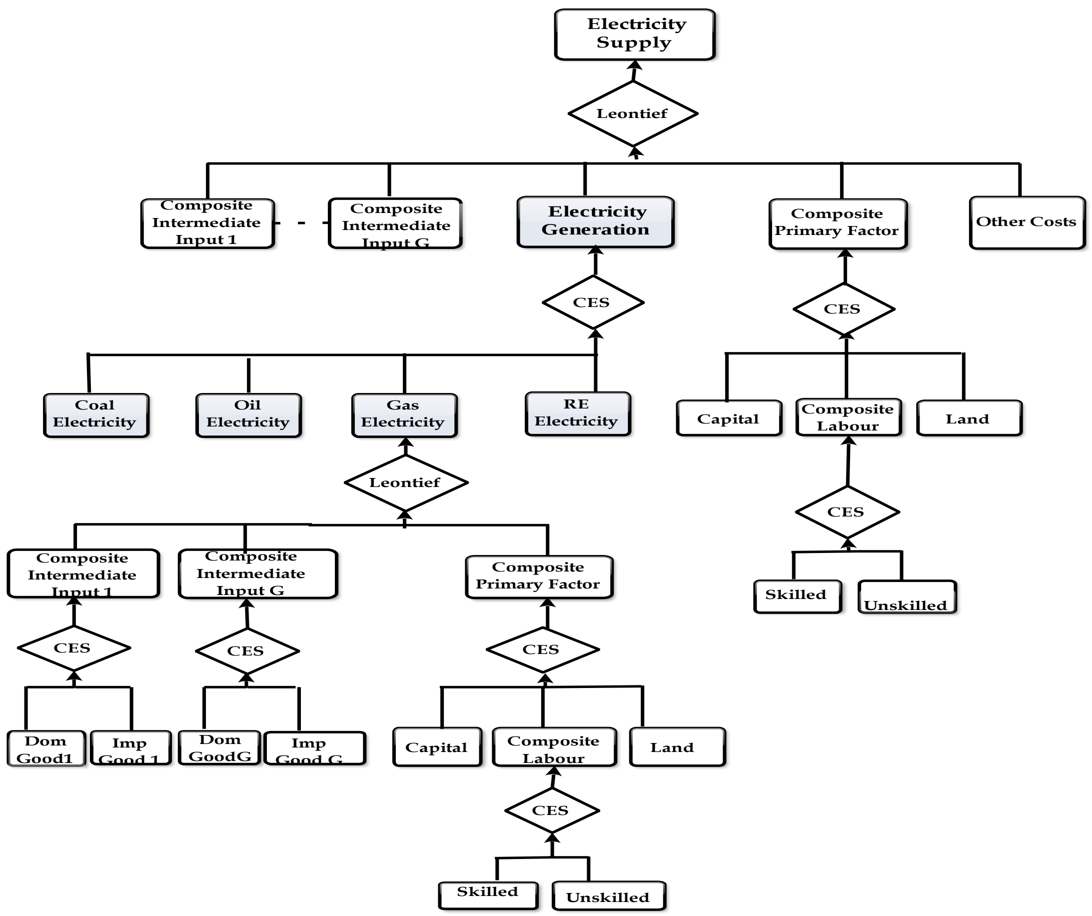

FIGURE 2: Structure of Production for Electricity Sector (Electricity generation level and it associated sub-levels added to the usual ORANI-G)

TABLE 1: Natural Gas Price and Its Subsidy (2005-2011)

Year	**Total Subsidy (RM bill)**		**Subsidized price (RM/MMBTU)**
	TNB	**IPP**	
2005	2.3	3.9	6.4
2006	5	6.5	6.4
2007	5	6.7	6.4
2008	5.7	8.1	14.31
2009	5.4	7.3	10.70
2010	5	6.2	10.70
2011	4.9	6.7	13.7

Source: PETRONAS Different Years

TABLE2: Macroeconomic Effects (Percentage change from baseline)

Variable	**Scenario1**	**Scenario2**
Real GDP	-0.002	0.013
Aggregate employment	-0.013	0.005
Real import volume[1]	-0.0001	-0.0018
Real export volume[2]	-0.002	0.010
Consumer price index (CPI)	0.012	0.007
Price of exports	0.0006	-0.0025
Terms of trade	0.0006	-0.0025
Real public consumption[3]	0	0

Source: Current Research

TABLE 3:Sectoral Effects

Sectors	**Output**		**Price**	
	Scenario1	**Scenario 2**	**Scenario1**	**Scenario2**
Electricity Supply	-0.06	-0.03	0.21	0.11
Electricity Coal	1.54	0.81	4.45	2.33
Electricity Oil	2.72	1.46	4.21	2.20
Electricity Gas	-0.88	-1.93	4.96	2.90
Electricity RE	0.66	13.9	4.64	-0.13

Source: Current Research

[1]Average for all sectors
[2]Average for all sectors
[3]Based on standard short run closure public consumption is exogenous.