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The Effect of Abolishing the Oil Fund on the Thai Economy: a Computable General Equilibrium Analysis

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Abstract – *The Oil Fund of Thailand has been established to stabilize domestic fuel prices. Nonetheless, it could have a significant bearing on the energy market, resulting in an inefficient resource allocation and low economic growth. The main purpose of this study is to analyze the impacts of the Oil Fund abolition on Thailand's economy and energy efficiency using a computable general equilibrium (CGE) model. The study shows that the abolition would lead to lower economic growth in the short run but a higher growth in the long run. However, the gain from economic growth could be outweighed by the loss from inefficient energy utilization both in the short run and in the long run. In addition, the Oil Fund abolition would undermine policies to promote alternative green energy, particularly the use of ethanol. In summary, the existence of the Oil Fund served the purpose of stabilizing domestic fuel prices and supporting the alternative green energy policy and energy efficiency, but suppressed economic growth. These findings highlight the need to carefully weigh the costs and benefits of energy market interventions.*

Keywords – computable general equilibrium (CGE), energy, energy policy, energy efficiency, Oil Fund.

1. INTRODUCTION

In 2011, the World Bank announced that Thailand had moved the lower-middle income category to upper-middle income [1].Such improvement was in part driven by Thailand's intensive energy usage which relied on imported fossil fuels. In 2013, Thailand's imported crude oil represented 72 percent of final energy consumption which totaled 75,214 kilotons of oil equivalent (ktoe) and of this amount, refined oil products accounted for 47.8 percent [2]. Hence, the Thai economy is subject to volatility of fuel prices that directly affects both macroeconomic and microeconomic activities.

The Oil Fund of Thailand was established with a view to stabilizing domestic retail fuel prices and inflation [3]. However, its scope was further expanded to enhance energy consumption pattern, including compensation for imported and domestically produced liquefied petroleum gas (LPG) and compressed natural gas (CNG). Moreover, the Oil Fund was used to support biofuel industries such as gasohol and biodiesel in order to meet the target of biofuel usage according to the alternative energy plan. To achieve this end, in 2013 the Oil Fund contribution was set at different rate for each type of fuel to encourage more use of biofuel. For example, gasoline types and LPG used by industries were subject to the highest rates to encourage the switching toward alternative biofuel and domestically refined fuel products, while those of CNG and fuel oil including jet fuel were among the lowest so that it would not affect the cost of transportation. The Oil Fund contribution was then used to subsidize mixed diesel, gasohol E20 and gasohol E85 (Table 1).

Despite the policy objectives mentioned above, the subsidization by the Oil Fund could distort energy market mechanism, thereby resulting in an inefficient resource allocation within the economy [4]. This raised the question whether policymakers would give priority to more efficient resource utilization by removing distorted energy policy or promotion of biofuel usage.

Table 1. Retail oil price and average rate of the Oil Fund per unit in 2013.

Baht/liter	Retail Price	Oil Fund
LPG (household)	20.13	2.60
LPG (transport)	21.38	3.77
LPG (industry)	30.23	11.95
Mixed Diesel	29.99	-0.7
Gasoline 95	48.05	10.00
Gasoline 91	45.19	6.42
Fuel oil	27.24	0.06
Jet fuel	31.63	0.00
Gasohol 91-E10	38.08	1.20
Gasohol 95-E10	40.53	3.30
Gasohol E20	35.58	-1.30
Gasohol E85	24.28	-11.60
CNG	10.48	0.00

Note: LPG and CNG (Baht per kilogram)
Source: Energy Policy and Planning Office, Ministry of Energy.

This study aims to assess the impacts of the removal of the Oil Fund on the overall economy, key economic sectors, and the efficiency of energy usage.

The results on macroeconomic activities from removing the levy and the subsidies on energy are mixed. Based on literature review, it was illustrated that removing energy subsidies would lead to an increase in

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Gross Domestic Product (GDP) in the eight biggest non-OECD countries [5], as well as in the case of Malaysia [6]. On the contrary, removing fuel subsidies would slow China's GDP [7], [8], and similarly, eliminating energy subsidies in Iran would cause a fall in GDP [9]. Thus, the impact of the removal of energy subsidies or levies seems to vary, depending on the structures of energy usage and the overall economy.

Furthermore, the evidence reveals that removal of energy subsidies leads to a fall in GDP during adjustment period as industries adapt to higher costs [10]. The effect of removing energy subsidies also trickles down to the household sector that trims its expenditure due to rising energy prices, [6] and an increase in domestic prices [11], [12]. The removal also leads to a trade deficit [6] as the economy shifts towards greater imports and a decline in exports [13].

Other studies show that energy subsidy reform in Iran would decrease the output of the energy and manufacturing sectors [13]. The same is also observed in the case of the transportation sector in Malaysia [6]. Electricity subsidy reform in Kuwait similarly caused a significant contraction in its energy sector [15].The existing evidence suggests that we also would likely observe significant impacts from the removal of subsidies in Thailand. As such, Thai policymakers will greatly benefit from a careful assessment of the effect of abolishing the energy levy and subsidy on the economy and key economic sectors, as well as the efficiency of energy utilization.

The rest of this study is organized as follows. First, it covers the economic model used for the assessment of abolishing the fuel levy and subsidy, namely the theoretical framework and assumptions of CGE. This section also explains the structure of production of the CGE model based on energy composite and data used for this model, which we obtain from the input-output table and behavioral parameters. After solving the CGE model, the second section discusses the results, covering both macroeconomic and sectoral impacts as well as energy efficiency after removing the Oil Fund. The third section summarizes and provide policy implications before closing with suggestions for future research.

2. MODELLING APPROACH

This section has five main components as follows: the theoretical framework and assumptions of CGE model, input-output table data, behavioural parameters for the model, model closure and solution, and a simulation scenario.

2.1 The Theoretical Frameworks and Assumptions

The model used in this study follows the CGE model developed by Wianwiwat and Adjaye [16]. It is a comparative-static, multi-sector, multi-product, and single country computable general equilibrium (CGE) model that builds upon the Australian ORANI model [17]. The model uses neo-classical assumptions in terms of economic activities for both production and consumption structures. In essence, the economic agents in the model comprise several producers and investors, and one agent from the household, government, and export sector. Demands for commodities by producers and investors were derived from the minimization of cost or the maximization of profit functions, whereas those for commodities by household and government sectors were derived from maximization of utility functions subject to budget constraint. This study assumes perfect competition, constant returns to scale production technologies and multi-product industries with a constant elasticity of transformation (CET) [17], as well as producers' ability to adjust product mix according to relative prices for maximized profits.

The structure of production comprises four levels of nested functions. The first level consists of non-energy input, energy input (used as feedstock) and a factor-energy composite. All types of inputs are assumed to be in fixed proportions (Leontief technology). In the second level, the factor-energy composite is a CES (Constant Elasticity of Substitution) bundle of energy-capital composite, labor and land. Labor is a CES composite of skilled and unskilled labor. The energy-capital composite also combines energy and capital with a CES function.

The energy composite, the third level of the nests, is obtained by combining all energy inputs utilizing CRESH technologies called inter-fuel substitution. The next lower level of the nests, modified from Wianwiwat and Adjaye's model [16], was the energy composite. It consists of 17 commodities combining with CRESH technology; namely coal, charcoal, raw natural gas, fuel oil, jet fuel, diesel, mixed diesel, liquefied petroleum gas (LPG), electricity, other petroleum and gasoline-gasohol composite.

At the bottom of the nests is the gasoline-gasohol composite, combined by CRESH technology and consisting of gasoline 95, gasoline 91, gasohol 95-E10, gasohol 91-E10, gasohol E20, and gasohol E85. The relation among the levels of nests is shown in Figure 1. In this study, a set of equations are also introduced to the model in order to calculate aggregate energy consumption and energy intensity, an element that has not been covered in any study of this field in Thailand.

2.2 Input – Output Table Data

The data from an 80-commodity and 73-industry input-output table in 2013 is used in this study. The 2013 input-output table was constructed from the 2010input-output table of Thailand, which provided the latest data published by the Office of the National Economic and Social Development Board (NESDB) [18], [19]. Thailand's input-output tables are released every five years, consisting of 16, 26, 58 and 180 sector versions. The 180 sector version was chosen since it contains the energy commodities and industries.

The 180 by 180 input-output table was grouped into 60 by 60 sectors and updated for the year 2013 after balancing the input-output table by RAS method [20]. The energy-related components of the 2013 input-output table were further broken down into additional 20 commodities and 13 industries, deriving data of the 80 commodities and 73 industries input-output table in 2013, based on data from the Ministry of Industry[21], the Department of Alternative Energy Development and Efficiency (DEDE) [22], the Bank of Thailand [23], [24], [25], Energy Policy and Planning Office, Ministry of Energy [26] and the Thai Customs Department [27].

2.3 Behavioral Parameters for the Model

In addition to employing input-output table to disaggregate the energy sectors as explained in the previous section, parameters in the CGE model are also required for determining production, utility, and other functions. Parameters in this study were mainly collected from GTAP 6 data base [28], [29]. They comprise the elasticity of substitution between domestic and imported commodity (varying from 0.9 to 5.2) known as Armington elasticity [30], the elasticity of substitution between capital and energy (varying from 1.68 to 2.0), the elasticity of substitution between skilled and unskilled labor (varying from 0.2 to 0.6), the elasticity of transformation between outputs for domestic consumption(varying from 0.0 to 8.8) and elasticity of collective export demand of 4.13, computed from the weighted average of collective export products. Moreover, the elasticities of household expenditure and government expenditure (varying from 0.9 to 1.6) were obtained from PARA model [31]. The Frisch parameter for Thailand is set at -3.03 according to Tanboon [32].In addition, due to a diversity of fuel types, the study computes the CRESH elasticity parameter of substitution of energy i in sector j (σ_{ij}) from the formula 2-2S_{ij}, adapting from Wianwiwat and Asafu-Adjaye [33] where S_{ij} was the energy use share of energy i in sector j. In the case of Thailand, the CRESH elasticity parameter of substitution between fuels used in each sector ranges from 0.5 to 2.0, while the CRESH elasticity parameter of substitution between gasoline and gasohol used in each sector ranges from 0.14 to 2.0.

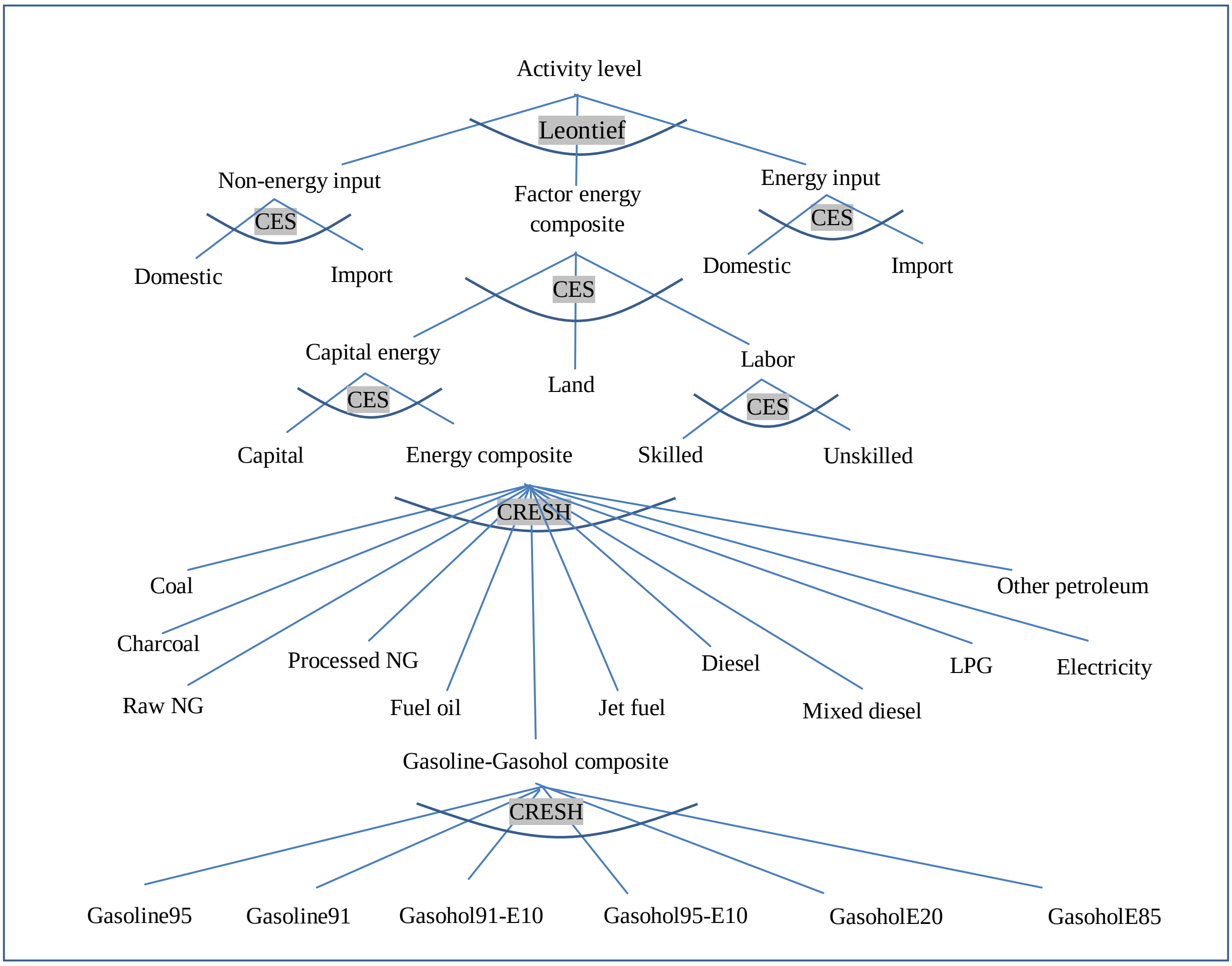

Fig. 1. Structure of production and energy composite.

2.4 Model Closure and Solution

A linearized equation system was used to solve the model [34]. In general form, Az = 0, where A is a matrix of coefficients and z is a vector of variables in percentage change. The model of the study contains 280,818 variables and 256,274 equations, and hence, 24,544 exogenous variables were required to solve the problem. This is a linearized CGE model which only considers the real side of the economy and does not include the monetary sector. The absolute price level is therefore not determined. As a result, one of the price variables must be chosen as numeraire, *i.e.* exogenous variable, which is used to express other prices as relative to the numeraire. Common candidates for numeraire are the nominal exchange rate, GDP price index, and the CPI. This study chose the nominal exchange rate as the numeraire as Thai Baht exchange rate was quite stable under the Bank of Thailand's intervention [33]. Furthermore, it is convenient for interpreting effects of the policies on domestic price variables such as the CPI when the nominal exchange rate is assumed to be unchanged. In fact, simulation results of quantity and real terms are not affected by the choices of numeraire.

In static CGE modeling, there are two main types of closures: short-run and long-run. The short-run period is assumed here to be about two years, while the long-run is assumed to be more than five years so that all factors, particularly, capital stock and land adjustment, have reached the equilibrium. For the short-run closure, based on the study by Wianwiwat and Asafu-Adjaye [16] we assume that capital stock, aggregate investment, real wage, land stock in oil palm and rubber tree sectors are fixed. On the contrary, in the long run, capital stock, aggregate investment, real wage, and land stock in all agricultural sectors were free to adjust, while the economy-wide rate of return, the sectoral gross rate of return, and employment were fixed.

2.5 Simulation Scenario

In order to analyze the impact of removing the fuel levy and subsidy via the Oil Fund on efficiency of resource allocation, we calculate the percentage of the levy and the subsidy as compared to the price of each fuel. These percentage changes would provide a basis for shocks to the model in the assessment of the Oil Fund abolition as set out in the objective of this study. When the fuel levy and subsidy are removed, as expected we primarily observe an increase in the price for subsidized fuels such as gasohol E85, gasohol E20 and mixed diesel, and a decline in price for levy-imposed fuels as shown in Table 2. Detailed results of this impact are discussed in the next section.

Table 2. Percentage shock from removing the fuel levy and subsidy.

Types of fuel	Price at refinery + taxes + Oil Fund	Price at refinery + taxes	% shock
LPG (household)	16.87	14.28	-15.39
LPG (transport)	18.12	14.36	-20.78
LPG (industry)	26.98	15.03	-44.29
Mixed diesel	28.84	29.54	2.43
Gasoline 95	47.09	37.09	-21.24
Gasoline 91	43.62	37.2	-14.72
Fuel oil	27.24	27.18	-0.22
Jet Fuel	31.63	31.63	0.00
Gasohol 95-E10	39.43	36.13	-8.37
Gasohol 91-E10	36.94	35.74	-3.25
Gasohol E20	33.95	35.25	3.83
Gasohol E85	18.38	29.98	63.12
CNG	10.48	10.48	0.00

3. RESULTS AND DISCUSSION

3.1 Macroeconomic Effects

Generally, when distortions in the market such as subsidy are removed we expect a more efficient outcome on resource allocation. By the same token, we expect that the abolition of the Oil Fund in Thailand would lead to an increase in GDP, which is similar to a pattern observed in the non-OECD countries [5]. However, the results in our case showed that real GDP contracted in the short run but recovered and expanded in the long run after the removal of the Oil Fund.

In the short run, when the real wage and aggregate capital stock are assumed to be fixed, the impact of removal of the Oil Fund leads to a decline in average energy retail price. Consequently, the consumer price index (CPI) declines by 0.06 percent compared to the status quo, while real household consumption increases by 0.18 percent (see Table 3). Based on the assumption that foreign prices and nominal exchange rate are unchanged, a lower domestic price index leads to a depreciation in the real exchange rate, and consequently to a 0.30 percent increase in real export. However, the government's disposable revenue would fall due to a burden in meeting the Fund's debt obligations prior to its liquidation. Therefore, real government expenditure drops by 2.15 percent, significantly leading to a decline of 0.22 percent in real GDP. Therefore, aggregate employment falls by 0.5 percent.

In addition, the decline in fuel prices leads to a 0.44 increase in aggregate energy consumption. Consequently, there is a 1.06 percent increase in petroleum imports, leading mainly to a 0.28 increase in the import index. In addition, an increase in aggregate energy consumption and a decline in real GDP would lead to a 0.67 percent increase in energy intensity (energy use divided by GDP), reflecting less efficient energy utilization.

In the long run, assuming full employment, a decline in fuel prices leads to a 0.32 percent decline in the CPI compared to the status quo, while real wage increases by 0.54 percent due to an expansion of production (see Table 3). As a consequence, aggregate household consumption jumps by 1.19 percent. A 0.47

percent decline in real exchange rate also benefits the export sector. In addition, there is an expansion of real investment of 1.53 percent as well as a 1.36 percent increase in aggregate capital stock. The latter is due to a number of industries that benefit from the policy expanding their investment and capital stock. Consequently, though there is a drop in government's revenue and expenditure, the overall economy still grows by 0.87 percent, which is better than the short-run situation.

However, the decline in the average retail price of energy results in a 1.98 percent increase in energy consumption. As a consequence, there is a 3.28 percent increase in petroleum imports, leading to a 1.49 percent increase in real imports. In addition, energy intensity increases continuously from the short run to the long run by 1.11 percent.

Table 3. Macroeconomic impacts from abolishing the Oil Fund.

Indicators	% Change	
	short run	long run
Real GDP	-0.22	0.87
Consumer expenditure	0.18	1.19
Aggregate investment	0.00	1.53
Aggregate government expenditure	-2.15	-1.54
Export index	0.30	1.57
Import index	0.28	1.49
Consumer price index	-0.06	-0.32
Real exchange rate	-0.15	-0.47
Real wage	0.00	0.54
Aggregate employment	-0.50	0.00
Aggregate energy consumption	0.44	1.98
Petroleum imports	1.06	3.28
Aggregate capital stock	0.00	1.36
Energy intensity	0.67	1.11

Table 4. Top five sectors with positive impacts.

Sectors	% change
In the short run	
Gasohol 95-E10	7.81
Petroleum refinery	1.07
Cassava milling	0.65
Private transportation	0.63
Wholesale	0.49
In the long run	
Gasohol 95-E10	10.09
Petroleum refinery	3.60
Iron and steel product	3.37
Gasohol 91-E10	3.09
Private transportation	2.57

3.2 Sectoral Impacts

The results indicate that sectors involved in fuels with high ethanol concentrations would be big losers, while sectors that relate to gasoline and gasohol E10 benefit from the policy.

In the short run, the gasohol 95-E10 production achieves the highest growth of 7.81 percent because the price of gasohol 95-E10 was discounted more than other gasohol prices (see Table 4). Refined petroleum products grow by 1.07 percent mainly because gasoline is more in demand for private transportation and gasohol E10 production. Cassava milling production expands by 0.65 percent due to a smaller demand for cassava in ethanol production. Furthermore, private transportation and wholesale sectors benefit from an increase in household purchasing power and a decline in prices of fuels such as LPG, gasoline, and gasohol E10.

In contrast, gasohol E85 is the biggest loser whose production drops by 96.00 percent in the short run (see Table 5). This is because when the price of gasohol E85 is no longer subsidized it becomes uncompetitive. Like gasohol E85, gasohol E20 production decreases by 10.32 percent due to discontinuation of subsidy. Owing to a drop in mixtures with high ethanol concentrations, the demand for ethanol from cassava drops by 56.37 percent, leading to a 2.72 decline in cassava production. In addition, public transportation declines by 2.15 percent due to an increase in the price of diesel.

In the long run, when gasoline and E10 fuels are no longer levied, demand for these fuels grow continuously from the short run. Demand for gasohol95-E10 increases by 10.09 percent compared to the status quo (see Table 4). Also, petroleum refinery output grows by 3.6 percent. The demand for gasohol91-E10 also increases by 3.09 percent. In addition, private transportation expands by 2.57 percent. The iron and steel product sector expands by 3.37 percent because there of a significant increase in aggregate investment.

On the other hand, some sectors are negatively affected by the policy and fare marginally worse than in the short run (see Table 5). Gasohol E85 would no longer be produced as its production drops by more than 100 percent. Gasohol E20 production falls by 10.25 percent. Demand for ethanol from cassava drops by 68.45 percent, leading to a 7.20 decline in cassava production and consequently a 3.12 percent decline in cassava milling.

Table 5. Top five sectors with the negative impacts.

Sectors	% change
In the short run	
Gasohol E85	-96.00
Ethanol from cassava	-56.37
Gasohol E20	-10.32
Cassava	-2.72
Public transportation	-2.15
In the long run	
Gasohol E85	-116.65
Ethanol from cassava	-68.45
Gasohol E20	-10.25
Cassava	-7.20
Cassava milling	-3.12

Table 6. Top five sectors with the lowest energy intensity.

Sectors	% change
In the short run	
Water transportation	-0.25
Cassava	-0.08
Paddy	-0.08
Oil palm	-0.06
Sugarcane	-0.05
In the long run	
Public transportation	0.00
Private transportation	0.00
Gasohol E85	0.00
Gasohol E20	0.00
Gasohol 95-E10	0.00

Table 7. Top five sectors with the highest energy intensity.

Sectors	% change
In the short run	
Real estate	2.07
Banking and insurances	1.81
Restaurant and hotel	1.20
Wholesale	1.09
Retail	0.96
In the long run	
Real estate	2.48
Banking and insurances	2.39
Railway	1.70
Restaurant and hotel	1.59
Wholesale	1.51

3.3 Energy Efficiency

It is expected that when market distortions are mitigated, resource allocation will be more efficient, leading to an improvement in the economy. However, the results in this study suggest that though total resource allocation is more efficient in the long run, energy resource allocation is less efficient both in the short run and in the long run. This is because lower energy prices do not incentivize consumers and producers to utilize energy in an efficient manner.

In response to the removal of the fuel levy and subsidy, economic sectors show different patterns of behavioral adjustments. Sectors utilizing diesel in large proportions to total energy costs, such as water transportation, cassava, paddy, oil palm and sugarcane, tend to be the first sectors to optimize energy consumption. This improvement is plausible only in the short run, but efficiency improvement is not observed in the long run. Only some sectors such as public and private transportation, gasohol E85, gasohol E20 and gasohol E10 show constant energy intensity (see Table 6).

Moreover, the decline in fuel prices make some industries less conscious about efficient energy consumption, especially those in the service sectors such as real estate, banking and insurances, restaurant and hotel, wholesale, retail and railway(see Table 7).

4. SUMMARY AND POLICY IMPLICATIONS

The results from this study suggest that the removal of the fuel levy and subsidy under the Oil Fund in Thailand could lead to short-term pain for long-term gain in terms of economic growth. In the short run, the analysis shows that real GDP and employment decrease due to a significant decline in government expenditure. In the long run, economic growth improves as the market mechanism works effectively and relevant economic agents adapt to the new environment. The long-term benefits come from an increase in investment and household consumption including capital growth.

In terms of sectoral impacts, the effects of terminating the Oil Fund both in the short run and in the long run suggest that the economic sectors that produce and heavily consume gasoline and E10 tend to be big gainers, for instance, gasohol 95-E10 and petroleum refinery, private transportation. In contrast, sectors that rely on subsidized fuels would be adversely affected especially gasohol E85, gasohol E20, public transportation, cassava-ethanol, cassava milling, and cassava producers.

Removing market distortions would lead to greater allocating efficiency and consequently greater economic improvement. However, this study finds that the abolition of levy and subsidy results in economic improvement in the long run, but less efficient energy utilization both in the short run and in the long run. This is because a decline in prices of gasoline, LPG, and gasohol E10 lead to an increase in fuel consumption and in turn higher energy intensity. As a result, the Oil Fund abolition would undermine the policies on promotion of energy efficiency and alternative green energy, particularly the usage of ethanol.

To sum up, the existence of the Oil Fund served the purpose of stabilizing domestic fuel prices and supporting the alternative green energy policy and energy efficiency, but suppressed overall economic growth. Therefore, in formulating a proper energy policy in Thailand, policymakers should carefully weigh the costs and benefits of intervening in the energy market.

5. FUTURE RESEARCH

This study analyzes how abolition of the fuel levy and subsidy affects macroeconomic and sectoral activities, in order to assess the benefits and costs of the Oil Fund in Thailand and provide insights to energy policymakers. Besides the levy and subsidy of the Oil Fund, there is also an excise tax on fuel which is another market distortion. Thus, investigating the excise tax rates of each fuel based on its pollutant and carbon emission is another important issue that should be considered for further research, given concerns over climate change and air pollution.

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