

The Impacts of Oil Fund Levied on Petroleum Products in Thailand on Social Welfare

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Abstract— Thailand has used an oil fund to maintain price stability of petroleum products. However, such a policy distorts market prices. This paper aims to assess direct social welfare from this policy. We estimate demand of 9 main petroleum products in Thailand using monthly data from January 2006 to September 2014 to analyze price, income and cross price elasticities of demand. Also, we analyze social welfare by considering consumer surplus, producer surplus, and deadweight loss. The result shows that most petroleum products have low price and income elasticities of demand in the short run. For the direct social welfare, we found that this policy generates a small negative effect.

Keywords—Oil Fund, Petroleum, Thailand, Welfare

I. INTRODUCTION

THAILAND is one of the small oil-importing countries as it does not own enough resources. Therefore, it is a price taker which depends mainly on oil prices from the Singapore oil market. There are 3 main types of oil price in the market; 1) Ex-refinery Price 2) Wholesale Price which is the summation of ex-refinery price, excise tax, municipal tax (10% of excise tax), oil fund levy, and energy conservation funds and 3) Retail Price which is the summation of wholesale price, Value Added Tax (VAT) 7% of wholesale price, oil fund levy 2, marketing margin, and VAT of oil fund levy 2 plus marketing margin.

In 1977, Organization of the Petroleum Exporting Countries (OPEC) increased crude oil prices and Thai government accordingly raised retail prices which were still low compared with the cost of crude oil. The Thai government then decreased tax rates of each petroleum products to help reduce costs. However, the decreased tax rate for fuel oil was not enough to compensate the cost. The government dealt with this problem by using some parts of the decreased taxes levied on benzene to set up the oil stabilization fund which aimed to subsidize fuel oil traders. Later in 1978, the oil stabilization fund (foreign exchange) was set up to collect the windfall profits of the oil traders from baht appreciation, to prevent oil shortage and to stabilize domestic prices. In 1979, the government merged these two oil stabilization funds, as the international oil prices increased sharply. This fund was set up because the government does not want to change domestic

prices according to changes in world oil prices. The new oil fund has been managed by the Energy Fund Administration Institute (EFAI), which is responsible for procurement of fund to stabilize domestic retail oil prices and for other tasks in compliance with the government policies relevant to the Energy Fund Administration.

All price structures were initially set up and controlled by the government for a long time. In 1991, the government started to deregulate these price structures by allowing the ex-refinery price and marketing margins to be determined by a market mechanism. However, the government has still controlled retail prices via oil funds, tax rates, and energy conservation funds. Since the energy conservation funds have almost been unchanged for many years, the government mostly gets its desired retail prices by manipulating the oil funds and tax rates.

This intervention has been used to eliminate energy price fluctuation, and thus undesired high inflation, which affects consumers' cost of living. Recently, the government has used an oil fund to cross subsidize some petroleum products, such as Gasohol95 E20 (Unleaded Gasoline Octane95 with 20% of Ethanol) and Gasohol95 E85 (Unleaded Gasoline Octane95 with 85% of Ethanol). In other words, the government encourages consumers to switch to those alternatives. However, this scheme causes a market distortion in some petroleum products since consumers do not realize the real price. If we can calculate social welfare from this scheme and know consumers' response when oil prices change, it might help the government to plan an effective energy policy.

II. RELATED LITERATURES

A. Energy Demand and Elasticities

Most early works in demand for energy showed that the demand for energy depends heavily on its own price and income, e.g. [9] and [11] estimate price and income elasticities of energy demand in Thailand and ASEAN, respectively, by using a double-log functional form and Ordinary Least Square (OLS) method. Reference [2], [10], [12], and [14] analyze price and income elasticity of demand for gasoline in short and long run to see the consumers' adjustment to changes in gasoline price. Reference [2], [9], [10], [11], [12] and [14] get the same result. That is, price and income elasticities of demand for gasoline are low. Also, price and income elasticities tend to be more elastic in the long run. Reference

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[4] adds substitution goods, namely alcohol, to the model to estimate cross price elasticity of demand for gasoline in Brazil and found that they are substitutes but imperfect ones.

Some literature studies energy demand and elasticities which point in the same way as [2], [4], [9], [10], [11], [12] and [14], that most of petroleum products have low price and income elasticities of demand because they are necessary goods and hard to find perfect substitutes. Also, it would be difficult to change usage from one fuel to another since some fuels depend particularly on specific equipments which are not easily replaced and people need time to adapt themselves or change their consumption behavior.

B. Effect of Change in Retail Price of Food and Energy on Consumers' Welfare and Deadweight Loss

Some studies, such as [5] and [6], analyze welfare effects in the sense that who gains or losses from the subsidy scheme. Reference [6] examines the welfare effects of an increase in household energy prices in Poland using household budget survey data between January and June, 1993, while [5] studies a cycle of subsidized energy prices and estimate its welfare impacts on households in the Buenos Aires Metropolitan Region, Argentina, during 2003 to 2010. Both [5] and [6] find that the policy of subsidizing household energy prices helps the poor, but it is more useful to the rich who consume more energy.

Speaking of consumers' welfare, [1] and [7] show that an increase in food or energy prices hurts poor people more than rich people. Reference [1] uses Madagascar data in 2005, while [7] uses US data during 1960 to 2006. They find that the demands for food and energy are inelastic to price changes in the short run, and that it would take a large increase in their prices to offset even a small increase in the demands for food and energy or a small decrease in their available quantities in the market. In addition, an increase in food and energy prices would substantially increase compensated expenditures or incur a substantial consumer welfare loss. This generates a special heavy burden for low income households.

Reference [3] and [8] compare social welfare before and after deregulation of gasoline and Liquefied Petroleum Gas (LPG) prices. Reference [3] looks into a subsidy scheme in Iran during 1968 – 2002, while [8] uses a simulation technique to compare 5 price systems of LPG. Their results stated that the price system yields the highest efficiency when there is no intervention from the government. Reference [13] also use a simulation technique to calculate the deadweight loss from the price stabilization policy during 1980 – 1990 in Gasoline, Diesel, LPG, and Fuel Oil markets by assuming price and cross elasticities for each estimate product in high and low cases. The result shows that total deadweight loss incurred by oil funds during that period, for high and low cases, are 15,381.4 million baht and 6,760.2 million baht, respectively.

Most literatures about consumer's energy welfare concludes that rich people get more benefit from price subsidy, while poor people take more burdens from an increase in prices. Also, allowing prices to be flexible causes lower deadweight loss.

III. DEMAND ESTIMATION AND ELASTICITIES

This study uses monthly data from January 2006 to September 2014 to estimate demand for 9 types of petroleum products, namely Unleaded Gasoline Octane95 (Benzene), Unleaded Gasoline Octane91 with 10% of Ethanol (Gasohol91 E10), Unleaded Gasoline Octane95 with 10% of Ethanol (Gasohol95 E10), Unleaded Gasoline Octane95 with 20% of Ethanol (Gasohol95 E20), Unleaded Gasoline Octane95 with 85% of Ethanol (Gasohol95 E85), Diesel, LPG in Household Sector (LPGc), LPG in Automobile Sector (LPGa), and LPG in Industrial Sector (LPGi).

All demand equations are in a double-log functional form. The estimation method is OLS. All equations are being tested for heteroskedasticity using the Breusch-Pagan test, for autocorrelation using the Durbin-Watson statistic, and for omitted variable and specification error using the Ramsey RESET test. None of our equations has those problems except Benzene. Benzene has an autocorrelation problem and is being solved by using the Prais-Winsten estimation.

A General form of demand function in this study is defined as follows :

$$\ln(Q_{i,t}) = \alpha_0 + \alpha_1 \ln(P_{i,t}) + \sum_{j \neq i} \beta_j \ln(P_{j,t}) + \gamma_1 \ln(MPI_t) + \phi_1 \ln(Q_{i,t-1}) + \theta_1 D_{ULG91} + \delta Trend_t + \varepsilon_{i,t} \quad (1)$$

where $Q_{i,t}$ denotes selling quantities of product i at time t ; $P_{i,t}$ is a real retail price of product i at time t ; $P_{j,t}$ represents a real retail price of substitutes of product i at time t ; MPI_t is a manufacturing production index of an energy sector at time t , which is a proxy of income; $Q_{i,t-1}$ is a lagged selling quantities of product i ; D_{ULG91} is a dummy of Unleaded Gasoline Octane 91 Cancellation (Year 2006 - 2012 = 0 and year 2013 - 2014 = 1); $Trend$ is a time trend; and $\varepsilon_{i,t}$ is a residual. All variables, except a dummy variable and time trend, are in a logarithm functional form.

Since the demand function is in a double-log form, the estimated coefficient can be directly interpreted as a short run elasticity of demand. While long run price, income, and cross price elasticities of demand is equal to $\frac{\alpha_1}{1-\theta_1}$, $\frac{\gamma_1}{1-\theta_1}$ and $\frac{\beta_j}{1-\theta_1}$, respectively.

Table I shows substitutes for each petroleum products and Table II shows results of demand estimation.

TABLE I
SUBSTITUTES FOR EACH PETROLEUM PRODUCT

Products	Substitutes (j)
Benzene	Gasohol95 E10, Gasohol95 E20
Gasohol91 E10	Benzene, LPGa
Gasohol95 E10	Benzene
Gasohol95 E20	Benzene, Gasohol95 E10
Gasohol95 E85	Gasohol95 E10
Diesel	NGV
LPGc	Electricity
LPGa	Benzene
LPGi	NGV

TABLE II (A)
DEMAND ESTIMATION RESULTS

	Benzene	G91 E10	G95 E10	E20	E85
Benzene	-0.4517** (0.2033)	1.1716*** (0.2322)	1.0648*** (0.3086)	0.9718*** (0.3062)	0.2546 (0.4900)
Gasohol91E10	-	-0.6614*** (0.1288)	-	-	-
Gasohol95E10	0.3972 (0.3123)	-	-0.9694*** (0.2739)	2.0649*** (0.6386)	3.1045*** (0.6407)
Gasohol95E20	-0.3173 (0.3157)	-	-	-2.5503*** (0.5393)	-
Gasohol95E85	-	-	-	-	-2.4984*** (0.4926)
Diesel	-	-	-	-	-
LPGc	-	-	-	-	-
LPGa	-	0.2075* (0.1174)	-	-	-
LPGi	-	-	-	-	-
MPI	0.1971*** (0.0470)	0.3422*** (0.0841)	0.2834*** (0.0766)	0.4207*** (0.1154)	0.5056*** (0.1290)
Lagged	0.6569*** (0.0614)	0.4634*** (0.1007)	0.8210*** (0.4542)	0.6871*** (0.0946)	0.5198*** (0.0488)
D _{ULG91}	0.0796***	0.0299**	-0.0199	-0.0146*	0.0103
α_0	2.2625***	-1.9863**	-0.9162**	-3.9490**	-10.5157***
R ²	0.9788	0.9864	0.9579	0.9967	0.9986

***, **, and * indicate significance at 1% , 5%, and 10% levels, respectively
G91 E10 is Gasohol91 E10, G95 E10 is Gasohol95 E10, E20 is Gasohol95 E20, and E85 is Gasohol95 E85

TABLE II (B)

DEMAND ESTIMATION RESULTS

	Diesel	LPGc	LPGa	LPGi
Benzene	-	-	0.2183** (0.0841)	-
Diesel	-0.3070** (0.1203)	-	-	-
LPGc	-	-0.0167 (0.1013)	-	-
LPGa	-	-	-0.2446*** (0.0794)	-
LPGi	-	-	-	-0.7694*** (0.1004)
NGV	0.0797 (0.0893)	-	-	0.4958** (0.2084)
Electricity	-	-0.0506 (0.0896)	-	-
MPI	0.2354*** (0.0693)	0.1853*** (0.0651)	0.2990*** (0.0772)	0.2174*** (0.0676)
Lagged	0.5324*** (0.0674)	0.2231** (0.0887)	0.9032*** (0.0420)	0.0662 (0.1029)
D _{ULG91}	-	-	0.0630	-
α_0	3.1261***	3.0160***	-1.1319*	3.9821***
R ²	0.5898	0.9596	0.9838	0.8213

***, **, and * indicate significance at 1% , 5%, and 10% levels, respectively
NGV is Natural Gas Vehicle

The estimation results in Table II show that most petroleum products have a quite low price elasticity of demand, except Gasohol95 E20 and Gasohol95 E85. The reason is that the data used are small in numbers, since Gasohol95 E20 and Gasohol95 E85 were produced to sell in 2008 and 2009, respectively. For income elasticity of demand, all petroleum products have low short-run income elasticity of demand. Also, we found that long-run price, income, and cross-price elasticities of demand is higher than the short-run's.

IV. CONSUMER SURPLUS

After getting a demand function of each product, now we can use it to calculate for the consumer surplus. Since Thailand is a small country importing oil, the supply function in this

situation is the real retail price of each product which is perfectly elastic. We will use a simulation method to analyze how much selling quantities and consumer surplus change after cutting oil fund out of real retail price. Table III shows consumer surplus gain and loss from 2006 to 2014.

TABLE III (A)

CONSUMER SURPLUS GAIN/LOSS (NET) FROM 2006 – 2010 (MILLION BAHT)

	2006	2007	2008	2009	2010
Benzene	-2,845.47 (-9.88%)	-3,816.21 (-12.73%)	-3,691.25 (-10.87%)	-6,270.54 (-20.31%)	-7,163.47 (-20.67%)
Gasohol91E10	-	-1,044.25 (-2.12%)	-603.35 (-1.04%)	-2,311.59 (-4.46%)	-2,666.36 (-4.61%)
Gasohol95E10	-2,856.98 (-2.76%)	-2,955.18 (-2.80%)	-2,803.65 (-2.45%)	-5,594.90 (-5.59%)	-8,222.52 (-7.44%)
Gasohol95E20	-	-	85.71 (0.52%)	413.65 (3.19%)	164.80 (1.32%)
Gasohol95E85	-	-	-	11.34 (28.37%)	18.31 (37.84%)
Diesel	-22,025.06 (-4.44%)	-14,740.62 (-2.95%)	5,379.72 (0.92%)	746.90 (0.16%)	-1,462.79 (-0.27%)
LPGc	17,176.61 (57.02%)	15,523.23 (51.22%)	13,175.09 (40.55%)	13,288.37 (40.99%)	12,557.74 (38.67%)
LPGa	16,417.90 (52.82%)	15,012.07 (47.70%)	12,902.73 (38.25%)	12,402.43 (38.65%)	12,150.12 (36.55%)
LPGi	6,186.83 (48.42%)	5,725.68 (44.32%)	4,999.74 (35.97%)	4,539.57 (36.34%)	4,624.21 (34.44%)
Yearly Total	12,053.83 (1.72%)	13,704.72 (1.80%)	29,444.74 (3.32%)	17,225.23 (2.33%)	10,000.04 (1.20%)

The number in parenthesis represents a percentage change of consumer surplus compared with total sales.

TABLE III (B)

CONSUMER SURPLUS GAIN/LOSS (NET) FROM 2011 – 2014 (MILLION BAHT)

	2011	2012	2013	2014
Benzene	-4,495.99 (-12.03%)	-4,889.87.25 (-12.31%)	-9,184.34 (-21.41%)	-7,369.86 (-22.10%)
Gasohol91E10	730.40 (1.18%)	-298.17 (-0.45%)	-2,413.32 (-3.52%)	-2,126.38 (-4.00%)
Gasohol95E10	-5,126.91 (-4.37%)	-5,741.68 (-4.58%)	-9,949.59 (-7.59%)	-7,746.79 (-7.64%)
Gasohol95E20	635.05 (5.11%)	506.11 (3.62%)	484.92 (3.04%)	242.09 (2.01%)
Gasohol95E85	18.58 (40.34%)	19.74 (37.14%)	19.50 (34.13%)	13.08 (31.44%)
Diesel	9,127.60 (1.62%)	-13,821.25 (-2.34%)	-29,857.51 (-5.04%)	-5,930.64 (-1.32%)
LPGc	11,686.45 (35.95%)	12,138.72 (37.30%)	11,122.64 (33.40%)	4,728.43 (15.94%)
LPGa	11,565.58 (34.10%)	7,723.92 (20.39%)	6,359.73 (16.19%)	5,628.22 (18.89%)
LPGi	4,203.52 (29.28%)	-1,543.45 (-9.41%)	-2,604.35 (-15.19%)	-1,820.65 (-13.79%)
Yearly Total	28,344.28 (3.24%)	-5,905.94 (-0.64%)	-36,022.31 (-3.83%)	-14,382.50 (-1.99%)

The number in parenthesis represents a percentage change of consumer surplus compared with total sales.

We can see from Table III that those who loss the most are Benzene users, since they have to pay around 10 baht/liter to oil fund which is very high compare to its real retail price around 45 baht/liter (As of September 30, 2014). Even though Gasohol95 E85 has not gained much consumer surplus, it is very high if we look at the percentage change. This is because Gasohol95 E85 is still not widely used in Thailand, since there are some limitations, such as number of stations and car models. That means most cars on the road now cannot directly switch to Gasohol95 E85. If old cars want to use Gasohol95

E85, they have to modify the engine or set up additional equipments, which may cause the owner a lot of money and may not worth doing it if oil prices change only in the short-run. LPG is another product that used to get a high subsidize rate from the oil fund because the government think that LPG is an important goods and may affect consumers' cost of living. Therefore, LPG prices in Thailand are always much cheaper than the world LPG prices. Nevertheless, the government currently tries to lift up LPG retail prices to get close to the real cost starting in the industrial sector, then automobile and household sector, respectively. For diesel, even though it gives us a high loss of consumer surplus, it has the highest total sales compared with other products. If we look at the percentage change, they are only around 0.1 – 5% of total sales, which is very low.

V. PRODUCER SURPLUS

For producer's side, their profits are coming from marketing margin, so that producer surplus will be equal to marketing margin times selling quantities. By using a simulation technique, we can find a change in producer surplus between the cases with and without oil fund to see whether producers will be gain or loss in each product. Table IV shows producer surplus gain and loss from 2006 to 2014.

There are gains in producer surplus in products that got subsidized from the oil fund, such as Gasohol95 E20, Gasohol95 E85, and LPG. This is because producer can sell more since the price is low. Total producer surplus is positive in 2006 to 2011 and has started to be negative in 2012. That the producer surplus of LPGi is negative could be due to the fact that the government has decided to raise the price of LPGi getting closer to the real cost.

TABLE IV (A)

PRODUCER SURPLUS GAIN/LOSS (NET) FROM 2006 – 2010 (MILLION BAHT)					
	2006	2007	2008	2009	2010
Benzene	-53.96 (-0.19%)	-74.13 (-0.25%)	-150.93 (-0.44%)	-366.12 (-1.19%)	-330.08 (-0.95%)
Gasohol91E10	-	-31.16 (-0.06%)	-85.11 (-0.15%)	-109.81 (-0.21%)	-113.57 (-0.20%)
Gasohol95E10	-150.30 (-0.15%)	-175.05 (-0.17%)	-408.06 (-0.36%)	-381.54 (-0.38%)	-486.13 (-0.44%)
Gasohol95E20	-	-	6.05 (0.04%)	106.41 (0.82%)	30.10 (0.24%)
Gasohol95E85	-	-	-	5.15 (12.88%)	8.50 (17.56%)
Diesel	-209.03 (-0.04%)	-228.06 (-0.05%)	-148.14 (-0.03%)	-9.01 (-0.002%)	-46.73 (-0.01%)
LPGc	43.82 (0.15%)	40.20 (0.13%)	33.09 (0.10%)	33.31 (0.10%)	32.13 (0.10%)
LPGa	929.79 (2.99%)	863.28 (2.74%)	719.92 (2.13%)	690.71 (2.15%)	690.84 (2.08%)
LPGi	721.75 (5.69%)	679.08 (5.26%)	576.55 (4.15%)	522.44 (4.18%)	543.63 (4.05%)
Yearly Total	1,282.09 (0.18%)	1,074.15 (0.14%)	543.37 (0.06%)	491.53 (0.07%)	328.69 (0.04%)

The number in parenthesis represents a percentage change of producer surplus compared with total sales.

TABLE IV (B)

PRODUCER SURPLUS GAIN/LOSS (NET) FROM 2011 – 2014 (MILLION BAHT)				
	2011	2012	2013	2014
Benzene	-180.57 (-0.48%)	-192.50 (-0.48%)	-197.57 (-0.46%)	-150.99 (-0.45%)
Gasohol91E10	19.14 (0.03%)	-10.67 (-0.02%)	-72.54 (-0.11%)	-63.84 (-0.12%)
Gasohol95E10	-217.70 (-0.19%)	-275.00 (-0.22%)	-463.04 (-0.35%)	-363.34 (-0.36%)
Gasohol95E20	113.24 (0.91%)	91.55 (0.65%)	68.26 (0.43%)	33.28 (0.28%)
Gasohol95E85	12.13 (26.35%)	16.56 (31.15%)	9.92 (17.37%)	5.92 (14.22%)
Diesel	3.55 (0.001%)	-228.74 (-0.04%)	-478.65 (-0.08%)	-106.34 (-0.02%)
LPGc	29.86 (0.09%)	30.86 (0.09%)	28.12 (0.08%)	10.82 (0.04%)
LPGa	656.83 (1.94%)	409.09 (1.08%)	331.86 (0.85%)	290.15 (0.97%)
LPGi	455.55 (3.17%)	-140.01 (-0.85%)	-236.25 (-1.38%)	-162.56 (-1.23%)
Yearly Total	892.04 (0.10%)	-298.85 (-0.03%)	-1,009.88 (-0.11%)	-506.91 (-0.07%)

The number in parenthesis represents a percentage change of producer surplus compared with total sales.

VI. SOCIAL WELFARE

After we have producer and consumer surplus, we also has to calculate for deadweight loss. Deadweight loss happens when products got subsidized from the oil fund because oil fund has paid more than what consumer gain from the consumer surplus. When we all have consumer surplus, producer surplus, and deadweight loss, we can estimate a net total welfare that comes from an oil fund scheme. Table V shows social welfare gain and loss from 2006 to 2014.

TABLE V (A)

SOCIAL WELFARE GAIN/LOSS (NET) FROM 2006 – 2010 (MILLION BAHT)					
	2006	2007	2008	2009	2010
Benzene	-121.72 (-0.42%)	-188.26 (-0.63%)	-255.66 (-0.75%)	-675.51 (-2.19%)	-684.14 (-1.97%)
Gasohol91E10	-	-46.33 (-0.09%)	-113.10 (-0.20%)	-167.85 (-0.32%)	-158.15 (-0.27%)
Gasohol95E10	-206.60 (-0.20%)	-235.42 (-0.22%)	-529.42 (-0.46%)	-615.53 (-0.61%)	-847.92 (-0.77%)
Gasohol95E20	-	-	2.70 (0.02%)	44.32 (0.34%)	20.71 (0.17%)
Gasohol95E85	-	-	-	-4.47 (-11.19%)	-10.27 (-21.21%)
Diesel	-441.81 (-0.09%)	-310.54 (-0.06%)	-256.92 (-0.04%)	-83.49 (-0.02%)	-56.26 (-0.01%)
LPGc	-85.81 (-0.28%)	-67.41 (-0.22%)	-41.81 (-0.13%)	-42.93 (-0.13%)	-36.55 (-0.11%)
LPGa	-1,820.28 (-5.86%)	-1,446.11 (-4.60%)	-909.78 (-2.70%)	-890.57 (-2.78%)	-785.42 (-2.36%)
LPGi	-1,412.74 (-11.15%)	-1,136.32 (-8.80%)	-728.60 (-5.24%)	-673.93 (-5.39%)	-617.72 (-4.60%)
Yearly Total	-4,088.96 (-0.58%)	-3,430.38 (-0.45%)	-2,832.59 (-0.32%)	-3,109.96 (-0.42%)	-3,175.73 (-0.38%)

The number in parenthesis represents a percentage change of social welfare compared with total sales.

TABLE V (B)
SOCIAL WELFARE GAIN/LOSS (NET) FROM 2011 – 2014 (MILLION BAHT)

	2011	2012	2013	2014
Benzene	-366.32 (-0.98%)	-363.45 (-0.91%)	-671.17 (-1.56%)	-542.48 (-1.63%)
Gasohol91E10	-4.41 (-0.01%)	-24.50 (-0.04%)	-104.46 (-0.15%)	-96.60 (-0.18%)
Gasohol95E10	-371.67 (-0.32%)	-445.44 (-0.36%)	-912.33 (-0.70%)	-718.06 (-0.71%)
Gasohol95E20	12.83 (0.10%)	29.73 (0.21%)	19.34 (0.12%)	9.56 (0.08%)
Gasohol95E85	-7.92 (-17.19%)	-3.34 (-6.28%)	-8.33 (-14.59%)	-5.49 (-13.20%)
Diesel	-713.68 (-0.13%)	-331.79 (-0.06%)	-871.17 (-0.15%)	-151.93 (-0.03%)
LPGc	-30.08 (-0.09%)	-33.41 (-0.10%)	-25.88 (-0.08%)	-1.43 (-0.005%)
LPGa	-661.47 (-1.95%)	-166.35 (-0.44%)	-33.25 (-0.08%)	-81.77 (-0.27%)
LPGi	-457.81 (-3.19%)	-250.32 (-1.53%)	-392.27 (-2.29%)	-260.63 (-1.97%)
Yearly Total	-2,600.52 (-0.30%)	-1,588.86 (-0.17%)	-2,999.53 (-0.32%)	-1,848.83 (-0.26%)

The number in parenthesis represents a percentage change of social welfare compared with total sales.

We can see from Table V that total welfare is negative in every case. Even though some products have positive consumer and producer surplus, e.g., LPGc, LPGa, the total welfare is still negative. This is because deadweight loss is more than those gains in consumer and producer surplus. Considering the yearly total social welfare, we can see that it tends to get less negative each year. This could be because the Thai government has adjusted some petroleum prices to meet their real cost especially LPG in all 3 sectors. This might help to reduce a market distortion.

VII. CONCLUSION

This study starts with estimating demand of each petroleum product and found that, price and income elasticities of demand are low, except for Gasohol95 E20 and Gasohol95 E85. We also found that price and income elasticities of demand are higher in the long-run than those in the short-run. For the effect of oil fund on social welfare, we can see that although total welfare is negative, it is less than 1% of total sales. If this scheme can help boosting a use of alternative fuels and also help stabilizing petroleum prices, it might worth keep using this policy. However, this policy has to be reviewed from time to time since subsidization induces a market distortion which may result in more losses of social welfare. If the government adapts this policy in accordance with the real world situation and give consumer time to adjust themselves, this policy will be much more effective.

It would be interesting to develop this study by including indirect effects, such as losses in goods that use oil as an input, and impacts on environment or other externalities since this work focus on a direct effect only.

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