

SENIOR RESEARCH

Topic: LPG Policy Analysis on Social Welfare in Automotive Sector

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Abstract

Liquefied petroleum gas (LPG) is a main fire fuel in Thailand. It has been widely used in households, industries and automobiles, so its price movement would affect cost of livings and economy. Thai government has tried hard to control LPG price within a boundary in order to protect the citizen from the price fluctuation. By continuing subsidies an LPG, the expense comes to an edge and it becomes a problem. Floating the price can totally fix the problem but Thai economy is too big to fail. Therefore, the government decides to gradually floating the price and lowering subsidy, so this becomes an LPG policy.

The research aims to measure a social welfare impact of LPG policy in automobile sector of Thailand. LPG demand in the sector has been studied using empirical data during 1994-2013. The regression finds that price elasticity of demand for LPG in automotive sector is inelastic. The policy will increase an LPG price 3 baht per kilogram or 1.86 baht per liter, which the consumer surplus will decrease around by 1,270 million baht. Therefore, government should consider other related policies such as car tax rebate policy to cover this lost.

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I. Introduction

A. Background

Liquefied petroleum gas or LPG is a main fuel for Thai households. Years ago, Thai government promoted a use of LPG to cut a use of charcoal because charcoal produces a lot of carbon dioxide (CO₂) and they also wanted to promote anti-deforestation campaign. Charcoal was banned by developed countries, so Thai government were forced to import LPG from European countries. LPG was firstly sold in only Bangkok and some city centers and it was too expensive for Thais' households to consume it. Fortunately, few years later, we found natural gas (NG) in a gulf of Thailand, which was a light at the end of the tunnel for the government. The government decided to build the first pipeline from a gulf of Thailand to Rayong province, which was a mega plan that used a lot of money, however, it has been more than worth to invest. Once Thailand could utilize the natural gas, the price of LPG plummeted and consumption skyrocketed. This was not only because of the price but government also promoted environmental campaigns and enforced the antideforestation law. Thai people have got used to a cheap price of LPG and over consumed, so these led to problems.

1) LPG market

LPG market is an oligopoly market that currently has seven sellers, which are Petroleum Thai Corporation Company Limited, Unique Gas and Petrochemicals Public Company Limited, Siam gas industry company limited, World gas (Thailand) company limited, Picnic gas and engineering public company limited, Sang Thong Gas Drum Industry Company Limited and Caltex oil (Thailand) company limited. The Petroleum Thai Corporation Company Limited is a market leader and holds around 51% of total market share.

2) Consumption and Supply Situation

LPG consumption has greatly increased year to year, which shows in figure 1.1 to figure 1.3. The figure 1.1 shows Thailand LPG consumption by sector, which obviously grows over time. The main focus of this research is an Automobile sector, which is present in a yellow shade of the graph and it clearly increases over the period of study. The consumption is also expressed more in figure 1.2 and figure 1.3. The share of LPG consumption in automobile sector has increased from around 10% to 15% (figure 1.2) but the absolute of the consumption has eight times hiked from around 139,000 tons in 1994 to 1,061,000 tons in 2012 (figure 1.3).



Figure 1.1: LPG Consumption by sector in Thailand during 1994-2012 (1000 Tons)¹

Figure 1.2 : LPG consumption in Automotive sector as a percentage of total consumption during $1994-2012^2$



 $^{1\,2}$ Data are provided by Energy Policy and Planning Office, Ministry of Energy (Source : http://www.eppo.go.th/info/2petroleum_stat.htm)





Supply of LPG comes from three mains sources, which shows in figure 1.4. The first source is gas separating plant or GSP, which the plants are run by Petroleum Thai Corporation. The GSP uses natural gas in the gulf of Thailand as raw material and it accounts for around 50% of total supply. The second source of LPG comes from refineries. The refineries use crude oil as its raw material. Last source of LPG comes from directly import. Thailand has largely imported LPG since 2008 with three times more expensive than domestic price and the import amount increases by 47% per year on average. Since the GSP use domestic resource, so it can produce the LPG with the cheapest cost, while refineries have higher cost because the crude oil is imported and its price is more expensive and fluctuated than domestic natural gas.



Figure 1.4: Supply of LPG during 1994-2012 (1000 Tons)⁴

 3 $^4\,$ Data are provided by Energy Policy and Planning Office(EPPO) , Ministry of Energy (Source : http://www.eppo.go.th/info/2petroleum_stat.htm)

3) LPG Price and Price Structure

The LPG price has been partially regulated by government since first oil crisis, which crude supply was rare and expensive as well as LPG. Government feared that oil price would inflate domestic petroleum prices and it would affect economy as a whole, so they decided to found an oil fund. The fund aimed for pegging the domestic petroleum prices during fluctuation period. After first oil crisis, government gradually floated the prices to match market price but they did not float LPG because LPG price might effected people's cost of living, SMEs and industries that had already switched from initial fuel to LPG. The government actually aimed to subsidy to poor households but they peg overall price, so private firms got excess profit form this low price. As a result, government decided to set industry price level different from households and again, few years later they saw that automobile sector got excess benefit from the policy and it is costly for government to hold them. That is why LPG has three different price levels (table 1.1).

The LPG price mainly comprises of four main elements. Firstly, ex-refinery price normally refers to average cost of production but LPG price is an exceptional case. The ex-refinery price of LPG is directly regulated by government, which the price here is in fact much lower than the actual cost of production. The real LPG ex-refinery price has decreased over time in compare with other petroleum prices that fluctuate and increase as shown in figure 1.5. Secondly, taxes and VAT are kept in the same way as other products except the municipal tax that is slightly varied among provinces. Thirdly, oil fund is a kind of tax that the government takes from every petroleum products in order to subsidize and stabilize domestic petroleum price during fluctuated period. Even though, LPG also pays the oil fund but it is a main expense of the fund, which account for around 92% of the total expenses (table1.2). Lastly, marketing margin is a different between wholesale price and retail price. In other word, it is a profit that retailers or gas stations get from selling the gas.

Therefore, if the market margin is low, the gas station has low incentive to provide good services to customers, which may lead to security problems.

LPG Price Quoted on 2 November 2013						
Unit:Baht/ kilogram	Low income	Cooking	Automobile	Industry		
Ex-Refinery	10.4330	10.4330	10.4330	10.4330		
Tax	2.1700	2.1700	2.1700	2.1700		
Municipal Tax	0.2170	0.2170	0.2170	0.2170		
Oil Fund1	0.8663	0.8663	0.8663	0.8663		
Conservative Fund	0.0000	0.0000	0.0000	0.0000		
Wholesale Price	<u>13.6863</u>	<u>13.6863</u>	<u>13.6863</u>	<u>13.6863</u>		
VAT	0.9580	0.9580	0.9580	0.9580		
Oil Fund 2	-	1.4019	3.0374	11.2200		
Marketing Margin	3.2566	3.2566	3.2566	3.2566		
VAT	0.2280	0.3261	0.4406	1.0134		
Retail Price	18.13	19.63	21.38	30.13		

Table 1.1: Price structure of LPG quoted on 2 November 2013⁵

Figure 1.5 Ex-Refinery Price of Petroleum Products During 2000 – 2013 (Baht per liter)⁶



⁶ Data are provided by Energy Policy and Planning Office(EPPO), Ministry of Energy (Source : http://www.eppo.go.th/info/2petroleum_stat.htm)

⁵ LPG prices are reported on 2 November 2013 by Bureau of Petroleum and Petrochemical Policy, Energy Policy and Planning Office(EPPO), Ministry of Energy (Source : http://www.eppo.go.th/retail_prices.html)

	Million Baht per Day				
Petroleum Product	Income	Expense (% of total Expense)			
Benzene 95	17.43				
Gasohol 95	24.69				
Gasohol 91	8.53				
Gasohol E20	-	4.45 (4%)			
Gasohol E85	-	5.22 (4.5%)			
Diesel	73.3				
Fuel oil	0.35				
LPG	-	102.17 (91.5%)			
Total	124.3	111.84			

Table1.2: Oil Fund Income and Expense Reported on 2 August 2013 (Million Baht per day-)⁷

4) LPG Policy

Government has controlled LPG price since 50 years ago and severely subsidized during oil crisis. During first oil crisis, domestic petroleum prices were fluctuated and reached a peak. This shock would mostly affect to imported petroleum product, so LPG price were hit by little. Consequently, industries switched form their initial fuel to LPG so that LPG demand skyrocketed. After the first oil shock, world LPG price also reached to another level but government cannot float domestic price to match it. This price control policy would not cause such a severe problem unless LPG demand went over domestic production capacity. Domestic LPG price is three times lower than the world price, so subsidy to import costs a lot to government budget. Moreover, the policy aims to help to the poor but since LPG is widely used, subsidy benefit distributes to all over the country. Industries and private firms have enjoyed this benefit much more than the poor and it is considered costly to government budget. Theoretically, best way to eliminate this burden

⁷ Oil fund income and expenses are reported by Energy Fund Administration Institute (Public Organization) (EFAI). (Source : http://www.efai.or.th/fin_oilfund.html)

would be fully floating but sudden floating price may shock economy, so government has to process the policy by small step.

Thai government has planed to fully float the LPG price since 1999 but the plan has a slow progress since it affects to most Thai people that link with political sphere. On the other hand, they also realized that the subsidy is too expensive and get bigger and bigger every year, so they decided to take the first step to increase the price to match the GSP cost, which is equal to 24.82 baht per kilogram. The policy will be effective in only household and automotive sector and increase by 0.5 baht per kilogram per month, while industry sector has already paid more than this price. The households have to pay more 6 baht per kilogram for the gas and automobile users pay more 3 baht per kilogram for the gas. The policy has started since 1 September 2013 and will effect to automotive price in 1 March 2014.

B. Motivation

As I have mentioned earlier that government need to reduce their budget burden on subsidies and gradually rebalance LPG market to its natural equilibrium, so they decided to implement new LPG policy. The policy says that LPG price used by households and Automobile sector will have to rise to match domestic cost. However, increase in price will definitely affect loss on consumer surplus and this consumer surplus loss from the policy is an important motivation for this research. Therefore, the research aims to measure change in social welfare from LPG policy in automotive sector. The welfare change will by estimated by change in consumer surplus from the policy.

II. Theoretical Framework and Literature Review

A. Theoretical Framework

The scope of study is LPG demand function during 1994 -2013 and LPG policy analysis in social welfare perspective. The demand estimation normally assumes downward slope demand curve, which a change in price will affect change in quantity demanded. In this research, the LPG demand function in Thailand historically composes of price of LPG, price of substitute for LPG, which is price of benzene octane 95(ULG 95) and dummy variable of controlling and floating LPG policy. (chanisa,1997). However, the research has developed from the past model by adding gross domestic product (GDP), which expects to have a positive impact on LPG consumption. Moreover, the models also add more prices of substitute for LPG, which are price of benzene octane 91(ULG 91) and price of diesel since there are more vehicles that initially use ULG 91 and diesel but change to LPG in order to cut their cost.

Social welfare that is affected by the policy will be measured in term of Marshallian's theory of consumer surplus. Assume downward slope demand curve, consumer surplus will be an area under demand curve but above equilibrium price. Thus, the policy said to increase the price from initial price level; therefore, the consumer surplus will be expected to decrease.

However, the policy that the research aims to estimate will be affective in the future, so the LPG consumption will be a forecasted amount. Empirically, the LPG demand forecasting used linear trend forecasting, which the quantity demanded will be changed by a certain amount for a period of time. The forecasting method definitely carries on an error but it is simply useful and creditable in a certain confident interval.

B. Literature Review

The research aims to measure an impact of LPG policy in automobile sector of Thailand, which is related to demand estimation, LPG pricing policy and social welfare measurement. Empirical studies for the research will definitely involve with the past studies of LPG demand in Thailand. Unfortunately, there are few studies that is directly related, so the researcher expand the scope of empirical studies to gasoline demand estimation because it is useful to refer to demand estimation techniques in related field. Moreover, the research's purpose is a LPG policy measurement; therefore, studies of Thailand LPG policy are also important.

1) Past LPG demand study in Thailand

Thailand LPG consumption in 1997 can be separated into three main sectors, which are households, industries and automobile. The study of the demand for LPG therefore has to be separated. For example, in household sector, factors included in the model are number of households and per capita income, while in automobile sector; the variables included possible price of substitutes (Chanisa,1997). The estimation method is simply OLS for time series data. The empirical result shows that price elasticity of demand for LPG in household sector is inelastic, while industry sector and automotive sector are elastic.

2) Gasoline Demand Estimation

In a field of energy economic, studies of energy demand elasticity are significantly important. Although, it does not directly relate to the research, it is quite useful to review its approach. Gasoline demand elasticity has been studied in many countries. The results are inconclusive but its approach is quite interesting. Cointegration and error collection are relatively famous technique to separate between short run and long run elasticity of gasoline as well as other petroleum products. Cointegration technique is relatively recent econometric tool used for estimating long-run relationship between variables. Once cointegration was found, error collection model will be estimated in order to see a short-run effect. (Alves, 2003; Eltony and Al Mutairi, 1995; Ramanathan, 1999) The variables that mostly include in regression model are quantity, price and income are converted into real value. However, when the time period of study cover a period of economic shock or recession, economic variables, such as inflation and interest rate might have an impact on demand. Therefore it also should be included in regression models. (Hughes,2006)

As we known that problem of study of demand equation occur when the collected data of quantity demand and price come from shift in both demand and supply, resulting in biased estimation of the parameters. In order to deal with this problem, assign for instrumental variables (IV) and two stages least square (2SLS) has been studied. The instrumental variables should be the one that affect solely demand or supply. In a study of gasoline demand, to address suitable IVs are quite difficult. Using relative price of other refinery products or crude oil quality is one of possible options. (Dahl, 1991, Hughes, 2006).

3) LPG policy in Thailand

In case of Thailand, energy subsidies policy is still available namely "oil fund", which mainly aim to stabilize oil prices during volatility period. However, the oil fund expenditure spends on LPG subsidies the most. Since a long period of controlling LPG price, the price difference between LPG and others petroleum products become bigger, so LPG demand has been excessive and it costs more to the fund. Moreover, LPG pricing

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system in Thailand raises a question to policy makers if the way to price LPG is suitable in long term. (Pripol, 2010)

Thailand LPG price has been largely subsidy, which the price is fixed at ex-refinery price but it did not reflect the actual cost of both gas separating plant (GSP) cost and refinery cost. In fact, the suitable price should be firstly, reflect both costs plus suitable taxes. Secondly, the price level should not much cheaper than others fuels that may cause a substantial substitution effect. Thirdly, it should not be permanently fixed but government can sometimes intervene the price during fluctuation period. Lastly, government should compensate to specific group of peoples, specifically the poorest group of people. One way to define the suitable price level is to assign weighted average price method. The paper also provide the suggested price level using weighted average price method, which the price is around 24 baht per kilogram and this price is similar to government's calculation. (Pripol, 2012)

In conclusion, empirical study of LPG demand in Thailand shows that price elasticity of demand for LPG is inelastic in household sector but elastic in industry and automobile sector. The demands were also expected to increase over time. The demand estimation method, which is suitable for the research is ordinary least square method together with co-integration method because the methods that are explained above dealing with market price and quantity but the market situation dose not work in this research. Therefore, simple OLS is sufficient for this case but to check the long run cointegration will support more credible results.

III. Research Methodology

A. Data

The target of the study is an overall **Automobile sector in Thailand** during 1994 - 2013. The sector has been chosen because it can represent the impact of government policy on such important sector of the country. Time series data are provided by Ministry of Energy, which are legally published. The data facilitate researcher to analyze an impact of price change over time. More details are provided in the following tables.

Table 3.1	: De	scriptive	Statistic	of	Variables
1 4010 5.1	$\cdot Dc$	scriptive	Statistic	01	v al lables

Variables	Unit	Mean	Median	Maximum	Minimum	S.E.
Quantity demand of LPG	Million liter per quarter	182.53	107.71	719.61	34.48	152.45
LPG Price	Baht per liter	8.4	8.42	9.78	7.05	0.76
GDP	Billion Baht per quarter	1700.5	1472	2997	871	607.73
Price of Benzene Octane 95	Baht per liter	22.1	20.17	34.88	13.13	6.99
Price of Benzene Octane 91	Baht per liter	20.6	18.92	33.34	12.70	6.03
Price of Diesel	Baht per liter	17.8	16.64	30.54	10	5.16

B. Method

The research is mainly use econometric approach and mathematical calculation but descriptive approach is also fairly important. A main propose of this study is to identify LPG demand function and then calculate a change in consumer surplus. Therefore, there are two main steps to find a result, which are identifying demand function and to calculating consumer surplus.

1) Identifying LPG Demand Function

The econometric of approach here deals with time-series data, so checking stationary of the data is a basic requirement. In this research, I used Augmented Dickey fuller and found that the price and quantity of LPG are not stationary, so it has to be transformed to first differences form and log of first differences form. Then, the researcher also checks for long-run cointegration of the equations. Once the long-run cointegration relationship was found, ordinary least square (OLS) method will be applied.

Normally, OLS method cannot be applied for demand estimation since time series demand curve is a link between the points that demand cross with supply for each period of time, which occurs in market equilibrium situation or price and quantity demanded are endogenous variables. However, the OLS can be applied in this case since the LPG price in Thailand is directly regulated by the government, so any price movement in this case does not occur in market equilibrium. In other word, the LPG price is an exogenous variable for this estimation.

2) Calculating a change in consumer surplus from the policy.

As I have already mentioned before that the policy will affect automotive sector in 1 March 2014, so to estimate change in consumer surplus from the policy has to deal with a forecasted value of LPG consumption. The forecasting methodology is a linear trend forecasting. Figure 3.1 shows empirical LPG consumption plotting with forecasted value. The data forecasted is on quarterly basis. The forecasting equation is;

$$Q = \alpha + \beta t$$

Q is a quantity demanded for LPG

t Quarter

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After β is estimated from the forecasting equation, a change in consumer surplus can be calculated. In this forecasting, the result will be on quarterly basis, so change in consumer surplus will be calculate for separated period. However, the policy will affect in 1 March 2014, which is the last month of first quarter (Q1) of year and price of LPG will reach the targeted price in 1 October 2014, which is the first month of the fourth quarter (Q4) of year. Therefore, the forecasted quantity demanded for these two months would be its quarterly consumption divided by three and change in consumer surplus for these periods are also separately calculated.

Figure 3.1 Empirical LPG Consumption and Forecasting Consumption Using Linear Trend Forecasting Method During 1994-2016 (Million liter per quarter)⁸



Four models are estimated to find price elasticity of demand for LPG in automotive sector. Since the data are not stationary, Variables have been transformed to first different form in first two models and to natural logarithm of first different form for the last two models. Importantly, models assume that coefficients of variables, α and β , in period t and period t-1 are equal. Therefore, α and β can be implied to coefficients of one period demand function.

⁸ Empirical LPG consumptions are reported on 1994 to 2013 by Energy Policy and Planning office, Ministry of Energy. The forecasting line is estimated using linear trend forecasting method.

1.)
$$Q_{t} - Q_{t-1} = \alpha + \beta_{1}(LPG_{t} - LPG_{t-1}) + \beta_{2}(Y_{t} - Y_{t-1}) + \mu$$
,
2.) $Q_{t} - Q_{t-1} = \alpha + \beta_{1}(LPG_{t} - LPG_{t-1}) + \beta_{2}(ULP95_{t} - ULG95_{t-1}) + \beta_{3}(ULG91_{t} - ULG91_{t-1}) + \beta_{4}(HSD_{t} - HSD_{t-1}) + \beta_{5}(Y_{t} - Y_{t-1}) + \mu$,
3.) $\ln(Q_{t}) - \ln(Q_{t-1}) = \alpha + \beta_{1}(lnLPG_{t} - lnLPG_{t-1}) + \beta_{2}(lnY_{t} - lnY_{t-1}) + T + \mu$,
4.) $\ln(Q_{t}) - \ln(Q_{t-1}) = \alpha + \beta_{1}(\ln LPG_{t} - lnLPG_{t-1}) + \beta_{2}(lnULG95_{t} - lnULG95_{t-1}) + \beta_{3}(lnULG91_{t} - lnULG91_{t-1}) + \beta_{4}(lnHSD_{t} - lnHSD_{t-1}) + \beta_{5}(lnY_{t} - lnY_{t-1}) + \mu$

Table 3.2: Operation Definition of Variables

Abbreviation	Variables	Expected Sign
Qt - Qt-1	First different of quantity demanded	Dependent variable
	for LPG	
$In(Q_t)-In(Q_{t-1})$	Natural log of first different of quantity	Dependent variable
	demanded for LPG	
LPGt - LPGt - 1	First different of real price of LPG	Negative
$lnLPG_t - lnLPG_{t-1}$	Natural log of first different of real	Negative
	price of LPG	
Yt - Y _{t-1}	First different of real gross domestic	Positive
	product	
$lnY_t - lnY_{t-1}$	Natural log of first different of real	Positive
	gross domestic product	
ULG95t - ULG95t - 1	First different of real price of benzene	Positive
	octane 95	
lnULG95t	Natural log of first different of real	Positive
— <i>lnULG</i> 95 <i>t</i> – 1	price of benzene octane 95	
ULG91t - ULG91t - 1	First different of real price of benzene	Positive
	octane 91	
lnULG91t	Natural log of first different of real	Positive
- lnULG91t - 1	price of benzene octane 91	
HSDt - HSDt - 1	First different of real price of high	Positive
	speed diesel	
lnHSDt – lnHSDt – 1	Natural log of first different of real	Positive
	price of high speed diesel	

Hypothesis Testing

1) $H_0 : \beta_1 = 0$ $H_a : \beta_1 \neq 0$

2) Accept H₀ when P-value is greater than 0.05 (t > 1.645, at 95% significance level).

 β_1 is equal to zero means that change in price of LPG would not significantly affect quantity demanded of LPG. In other word, price elasticity of demand for LPG is inelastic.

IV. Result and discussion

This section divides into two parts. The first part discusses about the demand function of LPG and the second part will show the result of consumer surplus calculation.

A. Regressing Result

During process of estimating the demand, both auto-correlation problem and Heteroskedasticity problem occur, so HAC robust standard error will be used to tackle the problems. From table 4.1, a sign of LPG price is negative following the expectation; however, LPG coefficients of all models are not significant, which means that H₀ cannot be rejected at 95% confident interval. In other word, price elasticity of demand for LPG is inelastic.

The coefficients of gross domestic product are positive and significant in model 3 and 4, which means that when the economy expands, LPG consumption will also increase. Model 3 and model 4 better represent LPG demand function in comparing with the first two models because the p-value(F) of regression of these two models are less than 0.05, which mean that the independent variables can significantly explain the dependent variable. However, when comparing model 3 and model 4, the model 4 is better because when adding variables of price of substitute for LPG, not only the adjusted R square increase, p-value (F) is less but the coefficients of price of benzene 91 is also significant. This means that when price of benzene octane 91 increase, quantity demanded for LPG also increases. In other word, benzene 91 is a substituted product for LPG.

Table 4.1 : Regression result of LPG demand function. Quantity demanded of LPG is an dependent variable, using $\alpha = 5\%$. N = 73

	Model 1		Model 2		Model 3		Model 4	
Regressor	Coefficient		Coefficient		Coefficient		Coefficient	
	(S.E.)	P-value	(S.E.)	P-value	(S.E.)	P-value	(S.E.)	P-value
Constant	2.33 (1.21)	0.06	2.28 (1.25)	0.07	-0.04 (0.02)	0.09	0.02 (0.01)	0.22
LPG	-6.27 (3.93)	0.11	-2.51 (2.26)	2.27	-0.52 (0.27)	0.053	-0.35 (0.19)	0.06
GDP	0.02 (0.02)	0.30	0.02 (0.02)	0.16	0.71 (0.23)	0.003**	0.51 (0.21)	0.01**
ULG 95			-8.26 (5.49)	0.14			-1.2 (0.58)	0.04**
ULG 91			9.42 (5.17)	0.07			1.44 (0.51)	0.006**
HSD			-0.07 (0.43)	0.87			0.04 (0.08)	0.58
					0.001			
Time Trend					(0.0004)	0.007**		
Adjusted								
R-squared	0.08	3	0.21		0.13		0.25	
P-value(F)	0.17	7	0.07	1	0.00	[0.001	1

** means the coefficient is significant at 95% confident interval.

In conclusion, model 4 is the fittest model that can represent LPG demand function in automotive sector because of reasons that I have already mentioned above; however, other models also follow the theoretical expectation. The coefficient of LPG price is not significant at 95% confident interval, so the price elasticity of demand for LPG is inelastic, which illustrate in vertical line

B. Consumer Surplus Result

In the second part will show the consumer surplus (CS) calculation. In this part will start with the forecasting result of LPG consumption using linear trend forecasting method.

$$Q = -52.5916 + 6.02878t$$
(30.11) (0.75)

Q is a quantity demand for LPG and t is a time period. Coefficient of t means that when time past by 1 period, demand for LPG will increase by 6.02 million liters (S.E.).

The policy will hit the automotive price in 1 March 2014, which is the last month of the first quarter of next year and the price will reach to the target price in 1 October 2014, which is the first month of last quarter of next year.

Table 4.2: Predicted change in consumer during March 2013 – October 2014

Total	1.86	1,995.33	(1,269.27)
Oct	0.1	253.94	(25.39)
Jul-sep	0.81	749.75	(607.75)
Apr-Jun	0.81	743.73	(602.42)
Mar	0.14	247.91	(34.71)
Year 2014	$\Delta P(\text{baht/liter})$	Expected Consumption (million liter)	ΔCS (million baht)

The table 4.1 shows calculations of change in consumer surplus during the policy. As I have already mentioned that the policy will first hit LPG price in 1 March 2014, which the price will be increased by 0.25 baht per kilogram or 0.14 baht per liter. The predicted consumption in March 2014 is equal to 247.91 million liters, which is the total consumption of this quarter (January 2014 – March 2014) divides by 3 and the consumer

surplus will therefore decrease by 34.71 million baht. The same way calculates in October 2014. The total consumer will be decreased by 1,269.27 million baht from the policy.

V. Conclusion and Suggestion

A. Conclusion

The research aims to measure effect of LPG policy to LPG consumption in automobile sector. The measurement of the policy is a change in consumer surplus. LPG demand function is estimated using OLS estimation method to calculate price elasticity of demand for LPG. Moreover, long run cointegration relationship is also observed.

Theoretically, the demand function should be a downward, vertical or horizontal curve. According to Marshallian theory of consumer surplus, when price increases, consumer surplus will decrease. Moreover, energy consumption will normally grow as economy expands.

Empirical study found that the LPG demand in automobile sector is highly elastic. However, this research found an opposite result. The results form regressions found that price elasticity of demand for LPG is inelastic, so the LPG demand curve here is a vertical line. This may be because the LPG price is quite low comparing with other fuel prices, so the price change would have small impact on demand. Moreover, relationship between economic growth and LPG consumption is positive and significant. Therefore, the regression results comply with the theory.

Impact of the policy to social welfare is measured in term of change in consumer surplus. The result shows that implementing LPG policy would decrease consumer surplus by 1,269.27 million baht.

This policy is a good policy in economist perspective and it can clearly reduce government expenditure. Even though, social welfare will expect to decreases from the policy but beside politic circumstance it will bring an LPG market to a right track. Obviously, the government cannot keep subsidies forever since all petroleum prices tend to increase and the subsidy amount also expand. Moreover, using oil fund to subsidy LPG seem to be unfair to other users. The oil fund is likely to an oil tax that all drivers have to pay for fuel consumption. The payments are different among various fuel types. Driver, whose car use gasohol octane 95 and diesel, contribute the most to the fund, while benzene octane 91 pay the highest tax. When the fund becomes negative, government tends to increase oil fund rate of benzene and gasohol, so it is unfair to spend the tax to benefit to a specific group of people. Furthermore, the regulated price has already distorted demand, LPG users have used to pay a cheap price for the gas, so they over consume the gas. In addition, since domestic price of LPG in Thailand is much cheaper than other countries. Therefore, there are illegal export LPG form Thailand to our neighbor countries and this would waste more tax spending for other countries. Hence, the policy is sufficient to lonerun benefit, however, government should consider other related policies to compensate a welfare lost and these will be explained more in a following policy suggestion section.

B. Policy suggestion

The section will discuss about possible policies that will yield the welfare loss from LPG policy. The LPG subsidies seem to be unfair for other fuel users because of reasons that I have already mentioned in the previous section. Increasing LPG price could reduce or at least slow down oil fund spending. Therefore, government should also reduce oil fund rate in other fuel price, so the price of other fuels will be cheaper. This policy does not only benefit to consumers but since LPG price becomes more expensive while other fuel prices are cheaper, so the gap between them will be narrower. Therefore, new consumers will be less likely to switch from their initial fuel to LPG; this will also slowdown the growth of LPG consumption. As a result, the consumption distortion will be less in the long run.

Moreover, the car related policies are also one of interesting options that will help to cover the loss. The car tax rebate and insurance payment are possible choices. Importantly, tackle traffic jam problem also helps in this case. Since Thailand has a severe traffic jam problem, so time spending on driving is so long as well as money spend on travelling. Therefore, if traffic congestion problem release, excessive spending on travelling will becomes less.

C. Suggestion for further studies.

Throughout the research, there are a number of limitations that can be improved. First of all, there is limitation to access information. Income per capita should substitute to gross domestic product variable because it is a better representative an ability of people to spend on LPG consumption. Moreover, there are more fuel types that are better substitution products for LPG but it has used since last few year, so it is excluded form this research because the available data are too short to have an impact. In addition, there is also a time limitation in this research. Dealing with various econometric problems takes time, so if heteroskedasticity and autocorrelation problems can be clearly solved, the regressing result should be more punctual.

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