Effect of petroleum product prices on Thailand’s economic growth

Kwanruetai Boonyasana
Rajamangala University of Technology Phra Nakhon (RMUTP),
The National Defence College (NDC) Alumni Think Tank,
Thailand
Email: kwanruetai.b@rmutp.ac.th
Email: kwanruetai@live.com

Abstract: Thailand has long been familiar with price control for petroleum products of economic or social importance. This paper applies the model of Garen et al. (2011) to investigate whether increases in petroleum product prices can reduce real gross domestic product (GDP). Time series analysis of data for the 24 quarters from 2009 to 2014 is used to determine real GDP. Two models use an autoregressive conditional heteroskedasticity process with regard to GARCH(1, 1) and EGARCH, and employ lagged variables to incorporate feedback over time. Price increases for both gasoline with 85% ethanol (E85) and unleaded regular gasoline with research octane number of 91 (UGR91) appear to have a positive effect on real GDP. This might be a result of government subsidies and taxes, including the effect of oil companies’ income on real GDP. Contrastingly, low sulphur diesel (LSD) price increases appear to have a negative effect on real GDP.

Keywords: petroleum product; price; economic growth; Thailand; exponential generalised autoregressive conditional heteroskedastic; EGARCH; generalised autoregressive conditional heteroskedasticity; GARCH(1, 1).


Biographical notes: Kwanruetai Boonyasana is an Economics Lecturer at the Faculty of Business Administration of RMUTP and a savant at NDC Alumni Think Tank. Her research includes energy economics, international trade and environmental sustainability. She received her PhD in Economics from the University of Leicester, UK in 2013, in addition to the Best Presentation Award from the Festival of Postgraduate Research in 2011. During her PhD studies, she was provided funding by the International Association for Energy Economics to attend conferences and present her papers. Her current research relates to energy economics and is funded by the Thai Government.

This paper is a revised and expanded version of a paper entitled ‘Effect of petroleum product prices on Thailand’s economic growth’ presented at SIBR-Thammasat 2015 Conference, Emerald Hotel, Bangkok, Thailand, 6 June 2015.
Effect of petroleum product prices on Thailand’s economic growth

1 Introduction

Thailand, with net exports of around 160,000 barrels per day in 2012, is a net exporter of petroleum products (Energy Policy and Planning Office, 2013). Even so, the Thai Ministry of Energy reports that the country is facing a problem due to limited reserves of oil and natural gas, with estimated reserves-to-production ratios of 3.5 years for oil and 12.5 years for natural gas. In relation to petroleum products, approximately 80% of Thailand’s crude oil needs (600,000 barrels per day) are imported, with the remainder produced domestically (150,000 barrels per day). The petroleum products resulting from domestically refined oil include gasoline, diesel, kerosene, aviation fuel and fuel oil (International Energy Agency, 2012).

The most widely used petroleum product in Thailand is diesel (50%), followed by liquid petroleum gas (LPG) (17%), then gasoline and aviation fuel (16%), with fuel oil and kerosene making up less than five% of total consumption. Diesel plays an important part in transport and agriculture accounting for more than 40% of all energy consumption, while LPG is utilised for industry, transport and residential needs, as well as for small businesses like street vendors, with gasoline mainly employed in the transport sector (Thai Ministry of Energy, 2012).

Since the early 2000s, ethanol and biodiesel have contributed towards solving Thailand’s problem of large demand coupled with limitation of energy resources. Ethanol is largely derived from sugarcane and cassava, while biodiesel is produced from palm oil (US Department of Agriculture, 2010). Given Thailand’s status as an upper-middle income country, the prevalence of traditional biomass energy sources such as wood, charcoal and rice husk is quite high, accounting for roughly 20% of total domestic production of primary energy (Thai Ministry of Energy, 2012). In 2005, biomass was responsible for 60% of total energy consumption for the residential sector, with usage exceeding 11 million tonnes (ASIAN Institute of Technology, 2010).

In Thailand, the major part of total energy consumption is made up of petroleum products, and since the great majority of petroleum is imported, the country is highly vulnerable to price changes in international markets (International Institute for Sustainable Development, 2015). Because of the effect of the price of energy on economic growth, Thailand has long been familiar with price control for petroleum products through taxes, subsidies and oil fund levies. This practice has resulted in more affordability for consumers as well as reduced impact from fluctuations in world energy prices.

The intention of the Thai Government is to see the majority of fuel prices at a level where the cost of supply is reflected in the retail price. However, since subsidy withdrawal involves consequences for the public, it can pose difficulties. Assurance will need to be given that subsidy benefits, such as energy access for the poor, can be made available through other measures. Furthermore, any such price changes would consequently affect the level and structure of final demand (Symons et al., 1994). Because these policies can impact the cost of energy, a quantitative evaluation of the effect of petroleum product prices on economic growth is vital.

This paper investigates whether increases in petroleum product prices reduce economic growth. The results may prove important for Thailand’s policy makers by indicating which energy price increases have most effect on real gross domestic product (GDP).
2 Literature review

The essential element of Keynesian economics promotes the idea of using GDP to measure the economic performance of a whole country or region. Economic growth reflects an increase in real GDP which translates as an increase in the value of goods and services produced in an economy. The rate of economic growth is a measure of the annual percentage increase in real GDP, and this rate is determined by a number of factors usually divided into two groups – demand and supply. The influence of demand side factors on growth of aggregate demand (AD) is presented as the equation\[ AD = C + I + G + X – M \]where a rise in consumption (C), investment (I), government spending (G) and net exports [export (X) – import (M)] can lead to higher AD and higher economic growth.

Figure 1 Conceptual framework (see online version for colours)

Figure 1, which provides a conceptual framework of this paper, shows that the Thai Government grants authorisation to the tax, subsidy and oil fund levies authority to adjust petroleum product prices charged between related parties. This government measure can control the effect of petroleum product prices on inflation and interest rates which may have a negative influence on consumption and investment. Both are the main drivers of GDP growth, as put forward by Keynes (1936).

The relationship between energy and economic activity with regard to production and employment was investigated by Garen et al. (2011). Their findings confirm the expected negative relationship of energy prices with gross state product growth and levels. However, in comparison to electricity and natural gas prices, crude oil prices are shown to have more of an effect on production growth. Van de Ven and Fouquet (2014), using data on the UK over the last 300 years, the paper identifies supply, aggregate demand and residual shocks to energy prices and estimates their changing influence on energy prices and GDP.

The literature reveals the conflicting nature of the empirical results which can even vary for the same country. They cannot be regarded as conclusive because of the different econometric methodologies and sample sizes applied.
3 Methods and procedures

This paper explores the effect on Thailand’s GDP of petroleum product prices with regard to gasoline with 85% ethanol (E85), unleaded regular gasoline with research octane number of 91 (UGR91), high speed diesel (HSD), low sulphur diesel (LSD) and LPG for cooking. The purpose of the study is to investigate the impact of such petroleum product price increases on economic growth.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>2,808,404.00</td>
<td>2,863,933.00</td>
<td>3,313,714.00</td>
<td>2,105,688.00</td>
<td>375,341.40</td>
<td>-0.30</td>
<td>1.77</td>
</tr>
<tr>
<td>UGR91</td>
<td>20.39</td>
<td>21.66</td>
<td>26.18</td>
<td>11.15</td>
<td>4.02</td>
<td>-0.63</td>
<td>2.45</td>
</tr>
<tr>
<td>E85</td>
<td>22.61</td>
<td>22.30</td>
<td>25.83</td>
<td>19.81</td>
<td>1.79</td>
<td>0.17</td>
<td>1.95</td>
</tr>
<tr>
<td>HSD</td>
<td>22.88</td>
<td>24.99</td>
<td>27.68</td>
<td>16.58</td>
<td>4.25</td>
<td>-0.49</td>
<td>1.49</td>
</tr>
<tr>
<td>LSD</td>
<td>21.99</td>
<td>24.23</td>
<td>26.53</td>
<td>15.94</td>
<td>4.05</td>
<td>-0.49</td>
<td>1.47</td>
</tr>
<tr>
<td>LPG</td>
<td>10.44</td>
<td>10.49</td>
<td>11.28</td>
<td>9.80</td>
<td>0.42</td>
<td>0.22</td>
<td>2.42</td>
</tr>
</tbody>
</table>

3.1 Data

In this empirical study, the dataset for Thailand is provided by the 24 quarters from 2009 to 2014, and includes GDP provided by the Office of The National Economic and Social Development Board, and petroleum product prices made available by the Energy Policy and Planning Office, Ministry of Energy, Thailand. The Office of Trade Economics, Ministry of Commerce, provides consumer price index (CPI) (2011 = 100) which is used to adjust GDP and petroleum product prices, thereby removing the effect of inflation. This paper employs real GDP of the previous year as a controllable variable. To overcome the problem of different measurement scales between dependent variable and independent variables, the natural logarithms of all variables are taken.

Figure 2 Prices of petroleum products in Thailand relative to the GDP deflator (2011 = 100) (see online version for colours)

Source: Energy Policy and Planning Office (EPPO), Thailand
A time series regression model is suitable for evaluating the effect of petroleum product prices on Thailand’s GDP. However, in general, there exists a problem of potential for confounding in short time series regression, which can reduce estimation efficiency. Therefore, care must be taken to properly account for trend and seasonality. However, Figure 2 indicates no seasonal effect. All petroleum product prices appear similar, except LPG for cooking which is a stationary time series, and might be attributable to government subsidies.

Figure 3 displays GDP deflator (2011 = 100) which is the dependent variable in this study. Because of short time series data availability, the data have exponential trending, hence non-stationarity. However, if long time series data are available, these data can have stationarity by visual analysis.

Figure 3  Real GDP of Thailand from 2009 to 2014 (see online version for colours)

Source: Office of the National Economic and Social Development Board, Thailand

3.2 Statistical analysis

3.2.1 Unit root test

Before time series analysis is conducted, the Augmented Dickey-Fuller (ADF) unit root test is employed to check for stationarity (Dickey and Fuller, 1979). From Table 2, the ADF unit root test results offer evidence of non-stationarity for some variables. This suggests that taking first differences of all variables is recommended to avoid the non-stationary process.

Table 2  Unit root test results

<table>
<thead>
<tr>
<th></th>
<th>Constant term</th>
<th></th>
<th>Constant term plus trend</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st diff</td>
<td>Conclusion</td>
<td>Level</td>
</tr>
<tr>
<td>ln GDP</td>
<td>–1.44</td>
<td>–5.67***</td>
<td>l(1)</td>
<td>–3.09</td>
</tr>
<tr>
<td>ln UGR91</td>
<td>–3.40**</td>
<td></td>
<td>l(0)</td>
<td>–2.20</td>
</tr>
<tr>
<td>ln E85</td>
<td>–2.51</td>
<td>–4.74***</td>
<td>l(1)</td>
<td>–2.81</td>
</tr>
<tr>
<td>ln HSD</td>
<td>–3.39**</td>
<td></td>
<td>l(0)</td>
<td>–1.36</td>
</tr>
<tr>
<td>ln LSD</td>
<td>–3.41**</td>
<td></td>
<td>l(0)</td>
<td>–1.34</td>
</tr>
<tr>
<td>ln LPG</td>
<td>–1.06</td>
<td>–6.85***</td>
<td>l(1)</td>
<td>–2.43</td>
</tr>
</tbody>
</table>

Note: *** and ** illustrate significance at 1% and 5% levels respectively.
3.2.2 Correlation test

This analysis employs the Pearson correlation test to check for multicollinearity, where high correlation exists between two or more independent variables (Blalock, 1963). The results show high correlation (0.99) between HSD and LSD. To avoid this multicollinearity problem, the analysis constructs two models of petroleum product price functions – Model 1 involving HSD and Model 2 involving LSD.

3.2.3 Testing for serial correlation

Consistency of results requires no serial correlation in the error terms (Green, 2008), which is tested by means of the Durbin-Watson statistic. After running the regression, the Durbin-Watson statistic results indicate serial correlation may be present. For dealing with the problem of serial correlation, this paper adopts the method of adding lagged values of the variables. Following this, Durbin’s alternative test for autocorrelation and the Breusch-Godfrey test show that there is no serial correlation for both models.

3.3 Empirical models

This paper employs time series analysis to construct two models of real GDP. The explanatory variables are UGR91, E85, HSD, LSD and LPG for cooking, with all variables relative to the GDP deflator (2011 = 100). This approach shows the effects of petroleum product prices on real GDP. Using $\Delta$ as a difference operator, the models are presented as follows.

- **Model 1**

\[
\Delta \ln (GDP_t) = \alpha + \beta_1 \Delta \ln (GDP_{t-1}) + \beta_2 \Delta \ln (GDP_{t-2}) \]
\[
+ \beta_3 \Delta \ln (UGR91_{t-1}) + \beta_4 \Delta \ln (E85_t) + \beta_5 \Delta \ln (E85_{t-1})
\]
\[
+ \beta_6 \Delta \ln (HSD_t) + \beta_7 \Delta \ln (HSD_{t-1}) + \beta_8 \Delta \ln (LPG_t)
\]
\[
+ \beta_9 \Delta \ln (LPG_{t-1}) + \varepsilon_t
\]

- **Model 2**

\[
\Delta \ln (GDP_t) = \alpha + \beta_1 \Delta \ln (GDP_{t-1}) + \beta_2 \Delta \ln (GDP_{t-2}) + \beta_3 \Delta \ln (UGR91_t)
\]
\[
+ \beta_4 \Delta \ln (UGR91_{t-1}) + \beta_5 \Delta \ln (E85_t) + \beta_6 \Delta \ln (E85_{t-1})
\]
\[
+ \beta_7 \Delta \ln (LSD_t) + \beta_8 \Delta \ln (LSD_{t-1}) + \beta_9 \Delta \ln (LPG_t)
\]
\[
+ \beta_{10} \Delta \ln (LPG_{t-1}) + \varepsilon_t
\]

where $t$ denotes years, $\alpha$ is a constant term, $\varepsilon_t$ is the error term, and the lagged variables account for the autoregressive effects of the previous years.

This analysis constructs two models of petroleum product price functions, the difference being that Model 1 involves HSD and Model 2 involves LSD, with both models using lagged variables to control for serial correlation. Heteroskedasticity is avoided by using the generalised autoregressive conditional heteroskedasticity [GARCH(1, 1)] model by Bollerslev (1986, 2009) and the exponential generalised autoregressive conditional heteroskedastic (EGARCH) model by Nelson (1991).
4 Empirical results

This study investigates whether petroleum product price increases can reduce GDP, and compares the effects of such price increases for a variety of petroleum products with a view to determining the best solution to Thailand’s future energy requirements. Estimation for time series data determines real GDP functions, using quarterly data from 2009 to 2014.

Table 3 Results of time series analysis for real GDP

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GARCH(1, 1)</td>
<td>EGARCH</td>
</tr>
<tr>
<td>Δ GDP&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.13 (0.35)</td>
<td>-0.28 (0.36)</td>
</tr>
<tr>
<td>Δ GDP&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>-0.32* (0.19)</td>
<td>-0.24 (0.26)</td>
</tr>
<tr>
<td>Δ ln (UGR91&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>0.44 (0.30)</td>
<td>0.56*** (0.19)</td>
</tr>
<tr>
<td>Δ ln (UGR91&lt;sub&gt;t-1&lt;/sub&gt;)</td>
<td>-0.21 (0.43)</td>
<td>-0.19 (0.39)</td>
</tr>
<tr>
<td>Δ ln (E85&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>0.43* (0.23)</td>
<td>0.37*** (0.11)</td>
</tr>
<tr>
<td>Δ ln (E85&lt;sub&gt;t-1&lt;/sub&gt;)</td>
<td>-0.13 (0.23)</td>
<td>-0.15 (0.10)</td>
</tr>
<tr>
<td>Δ ln (HSD&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>-0.34 (0.50)</td>
<td>-0.19 (0.22)</td>
</tr>
<tr>
<td>Δ ln (HSD&lt;sub&gt;t-1&lt;/sub&gt;)</td>
<td>0.46 (0.33)</td>
<td>0.37 (0.47)</td>
</tr>
<tr>
<td>Δ ln (LSD&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>-0.34 (0.47)</td>
<td></td>
</tr>
<tr>
<td>Δ ln (LSD&lt;sub&gt;t-1&lt;/sub&gt;)</td>
<td>(0.320)</td>
<td>0.44 (0.30)</td>
</tr>
<tr>
<td>Δ ln (LPG&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>0.50 (0.47)</td>
<td>0.15 (0.49)</td>
</tr>
<tr>
<td>Δ ln (LPG&lt;sub&gt;t-1&lt;/sub&gt;)</td>
<td>0.19 (0.47)</td>
<td>0.09 (0.52)</td>
</tr>
<tr>
<td>R-square</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>AIC</td>
<td>-3.12</td>
<td>-4.52</td>
</tr>
<tr>
<td>SIC</td>
<td>-2.42</td>
<td>-3.77</td>
</tr>
</tbody>
</table>

Notes: Standard errors in ( ). *** *, ** and * illustrate significance at 1%, 5% and 10% levels respectively. AIC and SIC indicate Akaike information criterion and Schwarz information criterion respectively.

From Table 3, the EGARCH model is selected to explain the findings because of giving the lower values of Akaike information criterion (AIC) and Schwarz information criterion (SIC). The results of Model 1 show that a rise of 1% in UGR91 price increases...
real GDP by about 0.56%, while a similar rise in the price of E85 is seen to increase real GDP by about 0.37%, with both results highly significant. For HSD and LPG, price increases show no effect on real GDP, holding everything else constant. Model 2 shows that most petroleum product price rises have effect on real GDP, except for LPG. Price increases for UGR91 appear to have more of an effect on real GDP than E85 price increases. A 1% increase in URG91 and E85 prices is estimated to significantly increase real GDP by about 0.57% and 0.36% respectively. In contrast, price increases for LSD appear to have a negative effect on real GDP of about 0.23%, holding everything else constant.

5 Discussion

In Thailand, policy makers are forced to focus on control of prices, through taxes and subsidies, for energy products that are economically or socially important. It appears this strategy has been successful for all kinds of petroleum products, except for LSD where price increase is shown to have a negative effect on real GDP. As a result, the Thai Government must confront the obligation of obtaining maximum benefit from energy industries with a view to economic growth, while remaining committed to an emission trading program. This paper’s findings further show that petroleum product price increases can have not only a negative effect, but also a positive effect on economic growth – possibly because of government tax and subsidy policies, including the impact of oil companies’ income on real GDP.

6 Conclusions

This paper examines the effect of increases in petroleum product prices with regard to unleaded regular gasoline with research octane number of 91 (UGR91), gasoline with 85% ethanol (E85), HSD, LSD and LPG for cooking, on real GDP in Thailand. The topic has relevance in the light of price control by way of taxes and subsidies influencing the cost of energy. For E85 and UGR91, price increases are seen to have a positive effect on economic growth. This finding may be partially attributable to influence of government subsidies and taxes, as well as impact of oil companies’ income on real GDP. For LSD, price increases show a negative effect on economic growth in accordance with expectation. The way forward for Thailand lies in achieving maximum benefit from energy industries while, at the same time, balancing economic growth with emission trading agreements at the optimal level.

Acknowledgements

The author is grateful to her good friend, Mr. Robin Neill, for his guidance and kind support. In addition, the author would like to thank RMUTP and NDC Alumni Think Tank.
References


Notes

1 With 1,306 billion cubic feet produced in 2011, natural gas is Thailand’s most abundant domestic energy resource ranking the country 24th in world gas production (Energy Information Administration, 2012).