Ethanol Use and Gasoline Consumption in Thailand

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Abstract

This paper preliminarily evaluates the potential of Thailand to substitute ethanol as an alternative to gasoline consumption. Even though the government has given necessary measures to stimulate the expansion of ethanol blend fuel consumption, the level of high ethanol blend (E85) use is still low. This implies that most local vehicle owners in the country might not have perceptions about ethanol attributes of enhancing better environmental quality. Therefore, it might be unlikely to employ ethanol (a renewable energy) use as a crucial measure to reduce crude oil imports, to improve environmental quality and to maintain energy security.

Keywords: Gasoline, ethanol, flexible fuel vehicles, energy security, environmental quality improvement.
JEL Classification:Q20, Q40

1. Introduction

Many economies try to reduce pure gasoline consumption by promoting the uses of ethanol and other bio-fuels. The main advantages of substituting bio-fuels for pure gasoline consumption are energy security, reduction in carbon dioxide emissions, and air and water quality improvement. The U.S. Renewable Fuels Standard intends to increase ethanol use as an alternative to fuel consumption because ethanol is renewable energy. Anderson (2012) finds that ethanol is a gasoline substitute. Under high crude oil price episodes, the substitution effect can cause large increases in ethanol demand by the rest of the world. Therefore, the U.S. and Brazil can be the key ethanol exporting countries (Debnath et al., 2017). Previous study by Salvo and Huse (2011) offer a case study of how agriculture and energy markets link up at the very micro level. Brazil is a sizable economy to have developed the production of ethanol from sugar cane. As a result, the uptake of flexible-fuel vehicles (FFVs or hybrid vehicles) has been tremendous. Therefore, consumers can substitute ethanol for gasoline.

As flexible-fuel cars penetration grows, ethanol and gasoline become closer substitutes. Even though market power exists in fuel retail level, consumers have more choices for fuel consumption (Pessoa et al., 2019). Due to the growing concerns with the greenhouse gas (GHG) and the quest for oil independence, policies are designed to give an incentive to the purchase of fuel-efficient vehicles. Subsidies are given to the owners of hybrid and electric vehicles in the U.S. and Canada while sale taxes are reduced in China and Brazil. The Green Car Rebate (GCR) has been launched in Sweden. Huse and Lucida (2014) quantify the effects of the GCR program in Sweden. They find that the GCR increases the market share of green cars, mainly FFVs. However, the switching between gasoline and ethanol uses raises the cost of the program. Car scrappage (or cash-for-clunkers) is a program to stimulate car owners to purchase new cars, which are fuel-efficient. This program aims at encouraging consumers to retire older vehicles and purchase fuel-efficient new vehicles. Li et al. (2013) find that the huge spending from the program go to consumers who intend to purchase a new vehicle, but the gain in new car sales is temporary and the reduction in CO2 emission is not substantial.

To maintain a more sustainable transport sector, substantial technological changes are needed. Also, the more-green alternatives in the transport sector are required in order for policymakers to choose more efficient policy measures in the future. Andersson et al. (2020) evaluate how the self-reported fuel choice is influenced by the relative price and individual differences in norms and perceptions about environmental and quality attributes of ethanol. They find that ethanol price, perceptions about ethanol quality, age, and environmental attributes influence the willingness to choose ethanol as a gasoline substitute by the owners of FFVs in Sweden. Since the Swedish vehicle owners are heterogenous, the perceptions about environmental quality are different. A group of vehicle owners are choosing ethanol based on its better environmental quality while some car owners take into account the debate about motor damages from ethanol use.

The ethanol blend fuel has been used in Thailand since the late 1970s. This paper is a preliminary evaluation of the success of ethanol use as an alternative of gasoline consumption in the transport sector of the country.

2. Demand for Pure Gasoline

Recent increasing of ethanol-blended gasoline consumption should exert the impact on pure gasoline with the octane of 95 (ULG 95). To assess the impact of ethanol-blended gasoline consumption on pure gasoline demand in Thailand, the standard demand expressed in Eq. (1) is estimated.

$$LQ_{1t} = \alpha_0 + \alpha_1 D_t + \beta_1 LP_{1t} + \beta_2 LP_{2t} + \beta_3 LGDP_t + e_t \qquad (1)$$

where LQ_1 is the log of pure gasoline demand, LP_1 is the log of real gasoline price, LP_2 is the log of real price of 20% ethanol-blended gasoline (E20), *LGDP* is the log of real GDP, and *D* is the dummy variable, capturing the impact of COVID 19 on pure gasoline demand. The coefficients in Eq. (1) can be explained as follows: $\alpha_1$is the impact of level shift in the pure gasoline demand, β_1 is the price elasticity, β_2 is the cross-price elasticity, and β_3 is the income elasticity.

Quarterly data from 2015Q1 to 2021Q4 are used to estimate the demand for gasoline.[1]Using the unit root test with an unknown structural break to examine whether all series are first-difference stationary, the results are shown in Table 1.

[1]Real GDP is obtained from the Office of National Economic and Social Development Board, and the quantity and prices are obtained from the Ministry of Energy website. The consumer price index (CPI)

Table 1. Unit root test.

Variable	Test statistic
ΔLQ_1	-7.011 [0] (<0.01)
ΔLP_1	-5.220 [0] (<0.01)
ΔLP_2	-6.536 [0] (<0.01)
$\Delta LGDP$	-14.533 [0] (<0.01)

Note: The number in the bracket is the optimal lag, and the number in parenthesis is the p-value of accepting the null hypothesis of unit root.

The results in Table 1 show that first differences of all series are stationary because the null hypothesis of unit root is rejected at the 1% level of significance. In other words, each series is integrated of order 1. Therefore, the series are suitable for cointegration tests.

The bounds testing for cointegration of Pesaran et al. (2001) is employed by choosing a parsimonious autoregressive distributed lag (ARDL) model. The chosen ARDL(1,1,1,1) model is free of serial correlation (the serial correlation LM test gives the F-statistic = 2.205 with p-value = 0.153). The computed F-statistic of 0.731 is much smaller than the lower-bound critical value at the 5% level of significance. This indicates that there is no level relationship between LQ_1 and the independent variables as specified in Eq. (1). The level relationship of the variables is shown in Table 2.

Table 2. Level relationship between high-octane gasoline consumption and the independent variables

Panel A. Level relationship
$LQ_{1t} = 9.150{*} - 0.417{***} D_t + 2.130 LP_{1t} - 1.775 LP_{2t} - 0.802 LGDP_t + e_t$
$Adj.R^2 = 0.783, F = 25.404$
Panel B. Residual-based test for cointegration
ADF statistic of the residual series = -0.919 (lag of the augmented term = 3)

Note: ***, **, and * indicate significance at the 1%, 5% and 10%, respectively.

Also, it is found that the variables are not cointegrated using Engle and Granger (1987) residual-based test. The residual-based test for cointegration can be performed using Eq. (2).

$$\Delta e_t = \rho e_{t-1} + \sum_{j=1}^{k} a_j \Delta e_{t-j} + u_t \qquad (2)$$

The estimated ADF statistic (ρ) of the residual series in Table 2 is much smaller than the critical value. Therefore, the null hypothesis of no cointegration cannot be rejected. Because the variables are not cointegrated, the standard Granger causality test is performed to examine the short-run causal relationship. The results are reported in Table 3.

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is obtained from the Ministry of Finance. All series are seasonally adjusted. Nominal gasoline and E20 prices are deflated by CPI.

Table 3. Granger causality

Null hypothesis	F-statistic	p-Value
ΔLP_1 does not cause ΔLQ_1	1.815	0.191
ΔLP_2 does not cause ΔLQ_1	0.299	0.590
ΔLQ does not cause ΔLQ_1	3.485*	0.075

Note: The optimal lag is 1. * indicates significance at the 10% level.

The results in Table 3 reveal that high-octane gasoline consumption is not affected by its own price, the price of substitution product (E20). However, it is negatively affected by real GDP in the short-run only at the 10% level of significance.

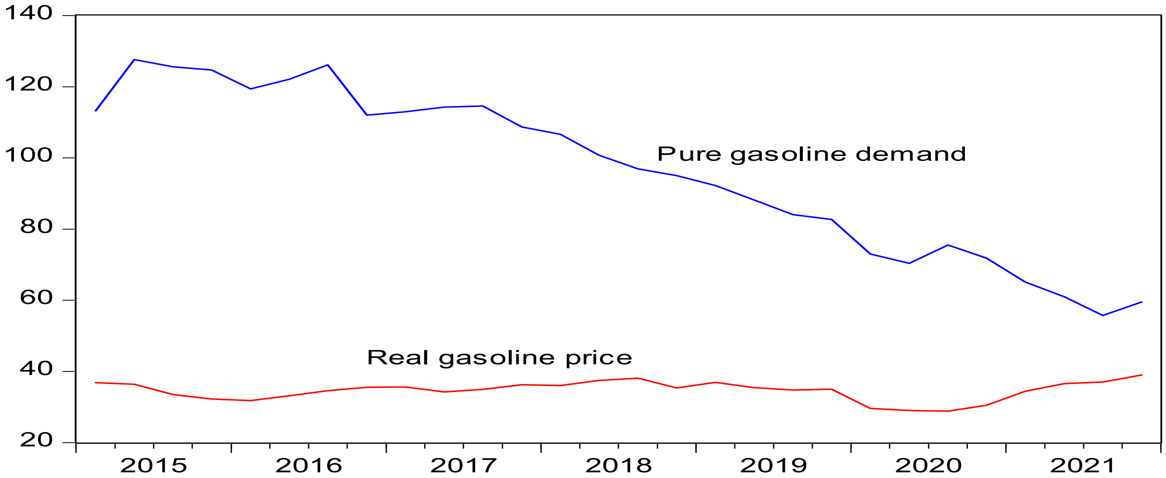

Figure. 1 Relationship between gasoline consumption and real gasoline price

The results from cointegration tests imply that the demand for high-octane gasoline cannot be modeled. Since the composition of vehicles in the market has changed and the price incentives for ethanol blended gasoline are offered by the government, the consumption of high-octane gasoline substantially declines even though its real price is quite stable (Figure.1). Foster and Bloyd (2016) evaluate Thailand's alternative energy development plan. The country has continued to support the use of alternative transport fuels. The national targets are for increasing the uses of low carbon and renewable energy. Alternative transport fuels are ethanol, biodiesel, pyrolysis oil, and compressed biogas. Among four general areas in the alternative energy development plan (2015-2036), the area pertaining to ethanol use is the promotion of ethanol blended gasoline called gasohol. The Thai government has given the price incentives to support for increased gasohol use. The level of fuel subsidies is higher for the higher blends of ethanol fuels, E20 and E85. The government measures can alter vehicle production and imports by focusing on flexible fuel cars.

3. Transport Vehicles and Fuel Consumption

Fuel consumption in Thailand depends on the driving pattern and the driving speed of vehicles. Lower speed driving tends to increase fuel consumption (Sirithian et al. 2022). Therefore, the types of transport vehicles can affect fuel consumption.

The country's energy policy also alters the structure of fuel prices, which in turn has influenced fuel consumption. The 2004 report from Energy Policy and Planning Office (EPPO), the Ministry of Finance reveals that the Oil Fund was established in 1979. This fund collected the monetary reserve to stabilize retail prices of domestic petroleum products when the world crude oil price tended to fluctuate. The price ceiling was set when global petroleum price substantially increased. Furthermore, domestic petroleum products were taxed at different rates and the tax revenue added the fund's monetary reserve. The reserve was used to subsidize liquefied petroleum gas and other natural gas prices, and some ethanol-blended products (E20 and E85).

The Energy Conservation Fund established in 1992 provided financial assistance to promote activities engaging in energy conservation, energy efficiency, development and use of renewable energy. This fund collected monetary reserve from all petroleum products. The 2016 EPPO report indicated that the Thai government had set up the Energy Efficiency Development Plan aiming at energy efficiency improvement and economical use or reduced expenditures on energy by households, transport and energy sectors. The government had taken into account the problems concerning energy prices, international competition for energy resources, environmental impacts and climate change stemming from energy production and utilization. After the 2007 Asia-Pacific Economic Cooperation (APEC) summit, the government had set up the 20-year Energy Efficiency Plan (2011-2030). This plan provided the national policy framework and guidelines on energy conservation implementation in the long run.

The government energy policies exert an impact on the structure of the prices of fuel types, namely pure gasoline and gasoline blend prices. Figure 2 show the ratio of pure gasoline price and the price of20% ethanol blend (E20).

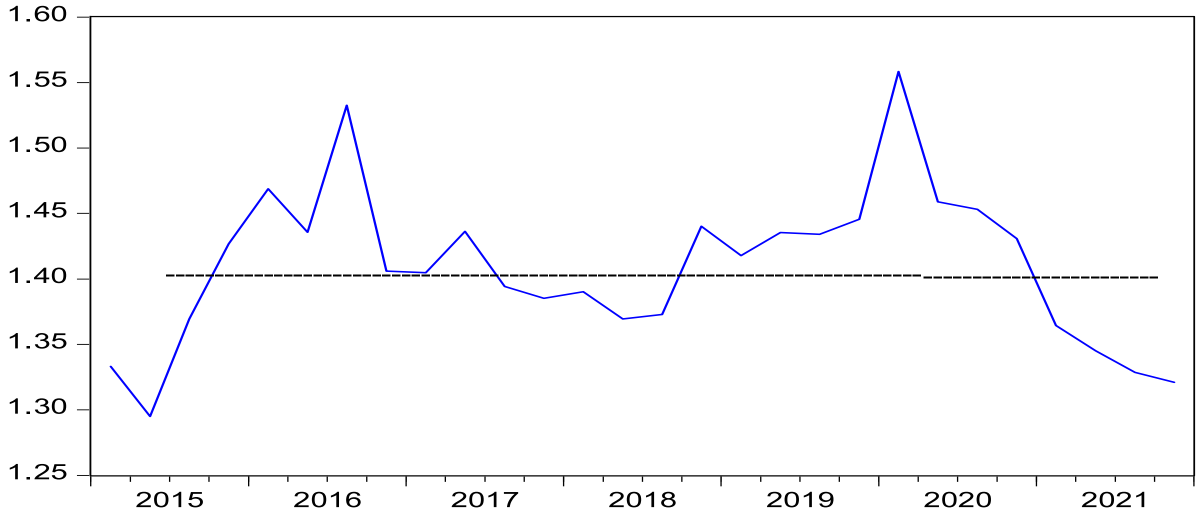

Figure 2. The ratio of pure gasoline and E20 prices (2015Q1-2021Q4)

The ratio of pure gasoline and E20 prices are above 1 for the entire period with some fluctuations. The average of this ratio is 1.4. Since the price of E20 is below the price of pure gasoline, ethanol blend fuel has become a cheaper source of octane in the transport sector.

The fuel service stations provide pure gasoline in order to serve the remaining older-model cars. For new model vehicles, the owners tend to use a 10% ethanol blend gasoline (E10) or gasohol 91 (a 10% ethanol blended gasoline with the octane of 91). The fuel service stations also offer high ethanol blend, which is E85.[2]

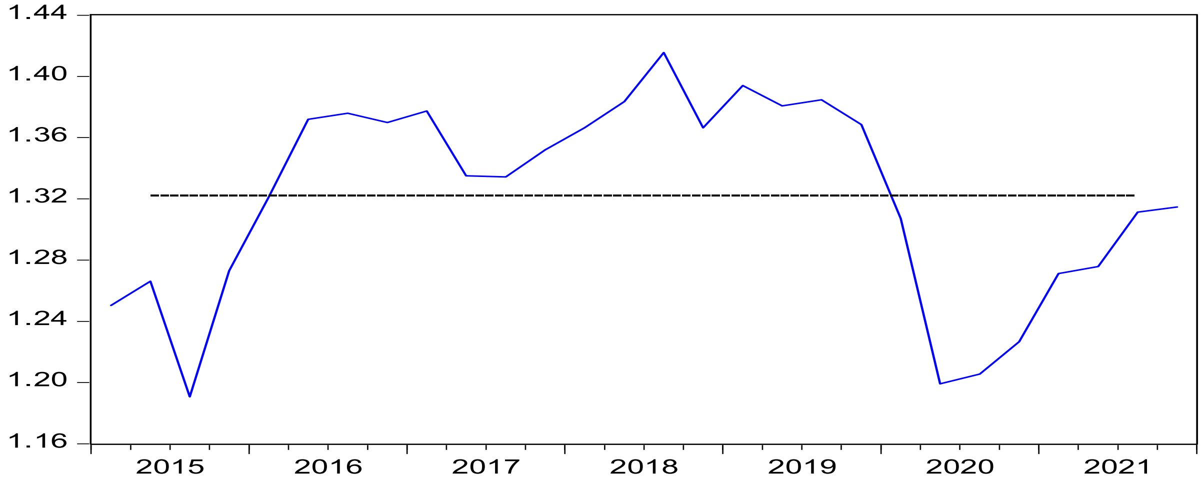

Figure 3. The ratio of E10 and E85 prices (2015Q1-2021Q4)

The ratio of E10 and E85 prices in Figure 3 is greater than 1 for the entire period with the average ratio of 1.32. The price of E85 is much lower than the price of E10 during 2016 and 2019 due to lower rate of excise tax.[3] Therefore, ethanol is a cheaper alternative of gasoline. Since E85 is an 85% ethanol blend, it is suitable for FFVs. Increasing consumption of E85 at a rapid rate can lead to increasing production of FFVs in the future. The Thai government measures (tax rebate and other incentives) to push for expanding production of FFVs deem necessary.

4. Future Ethanol Consumption

Even though a sufficient subsidy can keep the average ethanol price competitive, a large proportion of ethanol plants may shut down. Without blend mandates or flexible subsidy schemes, biofuels will lose competitiveness when crude oil prices are low or feedstock prices are expensive (Ghoddusi, 2017). However, these problems might be relevant for ethanol producers in Thailand in the future. There are two types of ethanol production in Thailand: sugarcane-based and cassava-based. Local ethanol distilleries have to compete with other industrial plants in acquiring sufficient raw materials, except for large distilleries that own sugarcane processing plants. Any intervention by the government in input allocation and price setting affect other industries, i.e., food and beverages, animal feeds and alcohol. Furthermore, farmers cannot receive their desired feedstock prices without the government subsidy.

According to the Department of Alternative Energy Development and Efficiency (DEDE), the Thai government targets to boost ethanol use around 3 million liters/day in 2015 to 9 million liters/day in 2021 through gasohol usage. However, the consumption of locally produced

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[2] In analyzing the demand for ethanol as a gasoline substitute in the U.S., Anderson (2012) treats E10 as gasoline and E85 as ethanol. The price ratio in Figure 3 depicts the similar analysis.

[3] Even though E10 is widely used internationally, the excise tax on E10 is much higher than the tax on higher ethanol blended fuel.

ethanol is only 3.71 million liters/day, even though the local ethanol installed production capacity is 5.97 million liters/day. Therefore, ethanol imports from large producers, such as the U.S., Brazil and China will not be necessary.

The main problem that can hinder the expansion of ethanol use in the county is the low level of E85 consumption. In 2020, the use of E85 was less than 2.9% of all ethanol blends while the use of E20 was 75.9%, and the use of E20 was 21.2%.[4] Industry team of The Bank of Ayudhya (2021) predicts that ethanol industry is exposed to the risk arising from the growing popularity of hybrid and electrical vehicles. However, it can be argued that the country's production of electrical vehicles is currently in the early stage. The usage of ethanol can lead to the target of environmental quality improvement more rapidly. Biofuel mandate is important to car owners because it affects a cost-per-mile of drivers. For low ethanol blend mandate (E10), the volume of ethanol use will be much lower than high ethanol blend mandate (E85).

Pouliot and Babcock (2017) estimate the demand for E85 in U.S. two metropolitan areas. They find that owners of FFVs will consume a much larger volume of E85 if it is priced such that the cost-per-mile is 20% lower than that of E10. In the case of Thailand, the data on the cost per kilometer are not available. Even though the DEDE does not have the dataset of E85 vehicle models, the low level of E85 consumption indicates that there are few owners of FFVs in the country. Thai automobile producers have requested that engine size restrictions for cars running on E85 be lifted. Also, they have been worried that cars with larger engine sizes would not be able to compete with cheaper eco-cars (Leu, 2012). The availability of FFVs with different engine sizes is important to ethanol usage because FFV owners can switch using petrol, E10, E20 and E85. Furthermore, renewable fuel support by the public, investing in transportation expansion, and providing fuel retail infrastructure are crucial factors causing higher ethanol consumption (Du and Carriquiry, 2013). Most vehicle owners in Thailand might not have perceptions about ethanol attributes of enhancing better environmental quality. Therefore, the price incentives offered by the Thai government do not cause the consumption of E85 to expand.

5. Conclusions

This paper evaluates the potential of Thailand to substitute ethanol as an alternative to gasoline consumption. The success of this substitution will benefit the country in that energy security will be achieved, and carbon dioxide emission will be reduced. The estimation shows that the demand for pure gasoline cannot be modeled. However, gasoline consumption has decreased gradually and continuously during 2015 and 2021.The newer car models are designed to support the increased consumption of ethanol blends. The government has imposed some measures to stimulate ethanol consumption. Among four general areas in the alternative energy development plan (2015-2036), the area pertaining to ethanol use is the promotion of ethanol blended gasoline called gasohol. The Thai government has given the price incentives to support for increased the usage of ethanol blends. The level of fuel

[4] The low level of E85 consumption indicates that the country will depend on crude oil imports even though ethanol-blend fuel has been used. The data from the Energy Policy and Planning Office show that crude oil imports did not significantly decrease during 2015 and 2021. The imported crude oil was 50.8 billion of liters in 2015, and slightly decreased to 49.6 in 2016. The value of imported crude oil was 55.2 billion of liters in 2018 and 50.1 in 2021.

subsidies is higher for the higher blends of ethanol fuels, E20 and E85. As a result, the relative price of gasoline is higher than that of high ethanol blends. This suggests that ethanol blend is cheaper source of octane for vehicle owners. However, the low level of E85 consumption implies that renewable energy is not strongly supported by the public. The public might not have perception of environmental quality, but might care for engine damage caused by ethanol use. Furthermore, the number of FFVs that can use E85 might be too small compared to FFVs that run on E10 and E20. Also, the fuel retail infrastructure is not sufficiently provided for E85, i.e, only few gas stations have E85 pumps. As a result, local car manufacturers will not have enough incentives to produce E85 vehicles. It will take a long period of time or might be impossible to use renewable energy (ethanol) as a crucial alternative fuel to reduce crude oil imports, to improve environmental quality and to maintain energy security.

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