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Demand for Energy Goods in South Kalimantan: The Application of The Censored QUAIDS Model

Ahmadi Murjani[1]

[1]*BPS-Statistics of South Kalimantan Province*

Abstract

The energy subsidy reform in Indonesia is still being implemented amidst many obstacles. The policy that is taken by the government certainly needs many inputs to produce a well-planned energy subsidy reform policy. One of the inputs is the elasticity of demand for the selected energy goods. Income and price elasticity of demand are two common numbers utilized in the policy simulation. With a long timeline of the energy subsidy reform episodes, the values of such elasticities are needed to be recalculated to accommodate the dynamics of the policy. This paper aims to estimate the income and price elasticity of demand for some energy goods in Indonesia such as electricity, gasoline, diesel oil, kerosene, and LPG. After employing the censored QUAIDS model implemented in the South Kalimantan province of Indonesia, this paper arrived at conclusion. First, among all selected energy goods, gasoline, diesel oil, and kerosene are classified as luxury goods whereas electricity and LPG are necessity goods. Second, only kerosene is found price elastic among other energy goods.

Keywords Elasticity; Energy Goods; Demand; QUAIDSCE; South Kalimantan

INTRODUCTION

To date, the energy subsidy reform in Indonesia is still in progress. Based on the Indonesian Ministry of Finance (*Laporan Keuangan Pemerintah Pusat Tahun 2020* (Audited)), the subsidized energy goods in Indonesia comprise Automotive Diesel Oil (ADO), Kerosene, Liquid Petroleum Gas (LPG), and electricity. The subsidy for gasoline (Research Octane Number/RON 88) has been dismantled in 2015 by taking the momentum of the declining trend of world oil prices (Murjani, 2020). However, in March 2022, the distribution of the unsubsidized-gasoline RON 88 has been stopped and the government of Indonesia started to subsidize the gasoline RON 90 (so-called Pertalite). This is based on the Decree of the Indonesian Ministerial of Energy and Mineral Resources (2022) that replaces the assignment for gasoline RON 88 with gasoline RON 90. Eventually, a new episode of the energy subsidy has been started.

Rising world oil prices as a result of the Russia-Ukraine conflict in 2022 have affected the fuel prices in Indonesia. As a result, the government of Indonesia has set the higher RON of gasoline prices higher and maintained the price of RON 90 gasoline by subsidization.

The Kerosene-to-LPG conversion process is also in progress. The government gradually reduces the subsidy for kerosene. From 2019 to 2020, the kerosene subsidy declined from around 2.9 trillion IDR to 1.2 trillion IDR. For electricity, the pricing scheme is according to the Regulation of Indonesian Ministerial of Energy and Mineral Resources Number 3, 2020. In 2020, due to the Covid-19 pandemic, the poor households received the free charge of electricity (for the 450VA households) and a 50% discount for the 900VA household (Indonesian Ministry of Finance, 2021).

It is evident that the government of Indonesia on one side deals with the Covid-19 pandemic, other shocks (i.e., geopolitical conflict), and the budgetary adjustments; on the other side, needs to continue the energy subsidy reform amidst this turmoil. The inputs for the further possible energy reform are necessary. This paper provides the research on the income and price elasticity of demand for the selected energy goods particularly the subsidized energy goods by taking the year 2021 in the locus of South Kalimantan Province of Indonesia. This paper advances from others on the same topic in terms of the utilization of the most current data and econometrics modeling. The structure of this paper is the introduction, literature review,

✉Correspondence to: amurjani@bps.go.id

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research method, result and discussion, and conclusion.

LITERATURE REVIEW

The studies for the calculation of the income and price elasticity of demand for energy goods in the world are available yet not too extensive; moreover, the study cases in Indonesia are still limited. Table 1 provides some studies available in Indonesia.

Insert Table 1 in here

Table 1 shows the differences in the elasticities of demand, particularly in the price elasticity of demand. The utilizations of the DUV, AIDS, and QUAIDS models are very limited in Indonesia, especially on the energy demand system; although some studies in the energy context are also available from another locus outside Indonesia. This paper highlights its uniqueness compared to previous studies from two perspectives: (1) The process of the energy subsidy reform in Indonesia is very dynamic, and chosen period of examination affects the result; hence, this paper utilizes the most recent data available. (2) The censoring issue was not fully accounted for; although Renner et al. (2019) addressed it in their research, the chosen energy goods didn't include Diesel Oil/ADO, which is also subsidized by the government of Indonesia. Thus, this paper includes ADO in the demand system. Moreover, this paper accounts for censoring in the estimation stage to overcome the possible bias from occurrences of zero consumption in energy demand.[1] This paper utilizes the data in the locus of South Kalimantan province of Indonesia from the 2021 household survey.

RESEARCH METHOD

Data

This paper utilizes the National Socioeconomic Survey (SUSENAS) from the March 2021 wave survey. For the chosen locus, which is the South Kalimantan province of Indonesia, the total number of samples is 8,239 households. From SUSENAS data, some variables are extracted such as total monthly expenditure (IDR), monthly expenditure for energy goods (electricity, gasoline, ADO, kerosene, and LPG), total quantity consumed for energy goods, household size, rural-urban areas, age, education, and gender. Age, education, and gender refer to the household's head. For the price, it will use the unit value approach, which is dividing total expenditure by total quantity. For the zero price, the price is assumed same for households living in the same neighborhood; thus, the median value of the price is used.[2]

Econometrics Modelling

This paper utilizes the QUAIDS model (Banks et al., 1997) as a modification of the classical AIDS model developed by Deaton and Muellbauer (1980) to calculate the income and price elasticity of demand for energy goods. The QUAIDS model can be written in the specification as follow (Caro et al., 2021a):

$$w_i^h = \alpha_i + \sum_{j=1}^{J} \gamma_{ij} \, ln \, p_j^h + \beta_i \{ln \, y^h - ln \, a(p)\} + \lambda_i \frac{\{\ln y^h - \ln a(p)\}^2}{b(p)} + \sum_{k=1}^{K} \eta_{ik} z_{hk} + u_i^h$$

$$h = 1, \dots, H; i, j = 1, \dots, J; k = 1, \dots, K \qquad (1)$$

Where,

w_i^h : Budget share of the i^{th} energy good obtained from the expenditure of the i^{th} energy good divided by total energy goods expenditures.

$\alpha_i, \beta_i, \gamma_{ij}, \eta_{ik}, \lambda_i$: Parameters in the demand system.

p_j^h : Price of the j^{th} energy good faced by household h.

y^h : Total expenditure of energy goods of household h in the demand system.

$a(p), b(p)$: Price aggregators defined as

$$ln \, a(p) = \alpha_0 + \sum_{j=1}^{J} \alpha_{ij} ln \, p_j^h + \sum_j \sum_k \eta_{ik} z_{hk} \, ln \, p_j^h + 0.5 \sum_i \sum_j \eta_{ij} \, ln \, p_i^h \, ln \, p_j^h.$$

$$b(p) = \exp \left(\sum_{j=1}^{J} \beta_i ln \, p_j^h \right).$$

u_i^h : error terms.

H, J, K : Number of households, categories, and shifters.

Some regressors are incorporated into Equation (1) through α_i which is:

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[1] The censored model hasn't been addressed by Poi (2012) and Lecocq & Robin (2015). This paper employs Caro et al. (2021b) STATA module.

[2] Murjani (2020) elaborated the determination of median price starting from census block, regency, and province.

$$\alpha_i = \alpha_i^* + \sum_{k=1}^{m} \alpha_{ik}^* d_k \quad (2)$$

Where,

α_i^* : The intercept of the i^{th} energy good.

α_{ik}^* : The coefficient of the i^{th} energy good for k^{th} demographic variable.

d_k :The value of k^{th} demographic variable.

The demographic variables utilized in this paper comprise household size, urban or rural areas of the living place, income groups classification (bottom 40% and top 60%), age of household head, education of household head (holding a college degree and not), and gender of the household's head (male and female).

The QUAIDS model in this paper imposes some restrictions in Equation (1) such as:

Adding up: $\sum_{i=1}^{J} \alpha_i = 1$, $\sum_{i=1}^{J} \beta_i = 0$, $\sum_{i=1}^{J} \eta_{ik} = 0, \sum_{i=1}^{J} \lambda_i = 0$, Homogeneity: $\sum_{j=1}^{J} \gamma_{ij} = 0$, and Symmetry: $\gamma_{ij} = \gamma_{ji}$.

For the censored observation, it follows Shonkwiler and Yen (1999) method, the latent budget share w_i^{*h} is related to the observed budget share where $w_i^h = b_i^h w_i^{*h}$. b_i^h is a binary variable that has a value equal to 1 for non-zero expenditure and 0 otherwise. The unconditional expected value of the system from Equation (1) can be expressed as $w_i^{*h} = \Phi(z_h'\theta_i) w_i^h + \delta_i \phi(z_h'\theta_i) + \varepsilon_i$, where Φ and ϕ are the standard normal variable of cumulative and density distribution function. The steps for estimating the censored observations are as follows. (1) Estimating a univariate probit equation $b_i^h = z_h'\theta_i \ \forall\, i$, where z_h is a vector of regressors containing prices and demographic variables. (2) $\Phi(z_h'\hat{\theta}_i)$ and $\phi(z_h'\hat{\theta}_i)$ are calculated and inserted in the second stage so that:

$$w_i^{*h} = \Phi(z_h'\hat{\theta}_i) w_i^h + \delta_i \phi(z_h'\hat{\theta}_i) + \varepsilon_i \quad (3)$$

To obtain the income and price elasticity by incorporating Equation (3) into Equation (1), the differentiation of Equation (1) w.r.t y and p produces:

$$\mu_i = \beta_i + 2\lambda_i \frac{\{\ln y - \ln a(p)\}}{b(p)} \quad (4)$$

$$\mu_{ij} = \gamma_{ij} - \mu_i(\alpha_j + \sum_j \gamma_{ij} \ln p_j^h) - \lambda_i \beta_j \frac{\{\ln y - \ln a(p)\}^2}{b(p)} \quad (5)$$

The expenditure and uncompensated elasticities are expressed respectively as:

$$e_i = 1 + \frac{1}{w_i^*}\left\{\Phi_i \mu_{ij} + \theta_{i,\ln(p_j)} \phi_i [w_i - \delta_i(z'\theta_i)]\right\} \quad (6)$$

$$e_{ij}^u = -\delta_{ij} + \frac{1}{w_i^*}\left\{\Phi_i \mu_{ij} + \theta_{i,\ln(p_j)} \phi_i [w_i - \delta_i(z'\theta_i)]\right\} \quad (7)$$

Where, δ_{ij} is Kronecker delta that has a value equal to 1 when $i = j$, otherwise the value is 0. It is important to note that when $\Phi_i \to 1$ and $\phi_i \to 0$, the elasticities from Equations (6) and (7) converge into standard QUAIDS.

RESULT AND DISCUSSION

Energy Expenditure Elasticities (Income Elasticities of Demand)

Expenditure elasticity of demand (or in other terms income elasticity of demand) exhibits the percentage changes of quantity goods demanded by a percent change in income. Hence, the good is classified as a normal good if the income elasticity is positive and less than 1. Further, the good is classified as a luxury good if it has a positive income elasticity and more than 1. For a negative income elasticity, the good is considered an inferior good. Table 2 shows the energy expenditure elasticities for electricity, gasoline, ADO, kerosene, and LPG.

Insert Table 2 in here

Table 2 exhibits some findings regarding the classification of the energy goods, and this is highly related to the dynamics in the energy subsidy reform in Indonesia. Murjani (2020) found that in 2012 the income elasticities of demand for subsidized energy goods in Indonesia are positive and more than unity only for gasoline and ADO (the rest was positive and less than 1). The result is similar to the result of Table 2 except for kerosene being classified as a luxury good in 2021. The data from the Indonesian Ministry of Finance shows that the kerosene subsidy keeps declining inferring that the unsubsidized kerosene is consumed more by households. Moreover, the fuel for cooking now is dominated by LPG and as from Table 2 classified as a normal good. For electricity, it is considered a normal good since the value of income elasticity is less than 1.

Uncompensated Price Elasticities of Demand (PED)

The good is considered price elastic if it has the PED (in an absolute value) more than 1.

On the other hand, a good that has a PED of less than 1 is considered price inelastic. The estimation result for PED by using the Censored QUAIDS specification can be seen in Table 3.

Insert Table 3 in here

It is seen in Table 3 that only Kerosene has a PED of more than 1 whereas the other energy goods have a PED of less than 1. This finding can be elaborated in two ways. First, kerosene has a substitution good which is LPG, this makes the value of the price elasticity of demand for kerosene is price elastic. Specifically, a 1% increase in kerosene price will make the quantity of demanded kerosene decrease by 1.198%, and vice versa. The possible substitution good for kerosene, which is LPG, is also important to highlight. Based on the calculation in this research, the cross-price uncompensated PED for kerosene to LPG equals 0.001, meaning that a 1% increase in kerosene price will make the quantity demanded LPG increase by 0.001% inferring that LPG is a substitution good for kerosene.

Second, having that most the energy goods have inelastic PEDs, the energy subsidy reform (i.e., price increases of energy goods due to subsidy cuts) should be done carefully and gradually. For kerosene, on the other hand, the reform can be continued by keep reducing the subsidy and continuing the kerosene-to-LPG conversion program. The energy subsidy reform that is implemented in form of subsidy cuts resulting in an increased price of the energy goods should be done at a right time with precisely selected goods. This is to avoid unwanted inflationary impact and increasing poverty due to declining in real income as well as increasing poverty line.

CONCLUSION

The energy subsidy reform in Indonesia is still being implemented with various obstacles in its timeline. Some research investigated the income and price elasticity of demand for energy goods in the world, but only a few have been done in Indonesia. The price elasticity of demand is a common indicator to utilize in the policy reform simulation, and energy good is no exception. This paper investigates the price and income elasticity of demand for selected energy goods in the South Kalimantan province of Indonesia using the 2021 survey data to review the current situation of energy goods in Indonesia.

The issue of the censored observation in the household survey data, the situation when the household doesn't consume the goods at the survey time, has been a concern in the demand system study. This paper aims to overcome the issue by utilizing a censored QUAIDS model that is relatively new in the energy demand system, especially in Indonesia. This paper found some finding as follow.

First, the income (or expenditure) elasticities of demand for selected energy goods have a value of more than 1 for gasoline, ADO, and kerosene. These goods are categorized as luxury goods. Kerosene, that known for the goods for low-income households, has changed a lot since the LPG utilization dominates the source of cooking fuel. Kerosene is now harder to find, and it is found normally at an unsubsidized price. For electricity and LPG, those have a value of the income elasticity of demand by less than 1; so, those are categorized as normal/necessity goods. Second, the price elasticities of demand for all selected energy goods are negative and less than 1 (price inelastic) except for kerosene which has a negative value of more than 1 (price elastic). Further, LPG is a substitution good for kerosene.

For recommendation, this paper highlights the importance of examining the elasticities of the subsidized energy goods before implementing the subsidy reform. Many of the energy goods have inelastic demand, meaning that the increasing prices due to the reform will make the households reduce their consumption by less than the percentage increase of the price. A well-planned energy subsidy reform will avoid a higher poverty rate as the possible effect of the subsidy cuts. Lastly, the government should keep the supply of subsidized energy goods stable to avoid scarcity that can lead to inflation.

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List of Tables

Table 1. Previous Studies of Demand for Energy Goods in Indonesia

Author	Region	Method	Year	Result
Olivia & Gibson (2008)	Java	Deaton Unit Value (DUV)	1999	Electricity is the only price elastic energy goods
Bhakti (2011)	Java	Almost-Ideal Demand System (AIDS)	2007-2010	All the energy goods examined are price elastic
Murjani (2017)	Tabalong Regency, South Kalimantan	AIDS and Quadratic-AIDS (QUAIDS)	2016	All the energy goods examined are price inelastic
Renner et al. (2019)	Indonesia	QUAIDS	2009-2013	Gasoline and LPG are the only price elastic energy goods for the lowest and highest decile of the income group
Murjani (2020)	Indonesia	AIDS-ILLS	1999 and 2012	All the energy goods examined are price elastic

Source: Murjani (2021).

Table 2. Energy Expenditure Elasticities in South Kalimantan using Censored QUAIDS Model, 2021

Energy Goods	e_i	Standard Error	Classification
Electricity	0.513	0.050	Normal/Necessity
Gasoline	2.070	0.030	Luxury
ADO	1.400	0.017	Luxury
Kerosene	1.031	0.030	Luxury
LPG	0.898	0.012	Normal/Necessity

Source: Author's estimation.

Table 3. Own-Priced Uncompensated PED of Energy Goods in South Kalimantan using Censored QUAIDS Model, 2021

Energy Goods	e_{ij}	Standard Error	Classification
Electricity	-0.803	0.079	Price Inelastic
Gasoline	-0.910	0.059	Price Inelastic
ADO	-0.934	0.017	Price Inelastic
Kerosene	-1.198	0.021	Price Elastic
LPG	-0.843	0.008	Price Inelastic

Source: Author's estimation.