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Fuel Availability and Java Households Cooking Fuel Choices: Evidence from Indonesia's LPG Subsidy Policy

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Abstract: In 2007, Indonesia launched a 3 kg Liquified Petroleum Gas (LPG) cylinder for poor households, and micro-enterprises were started on Java island to reduce the burden of fuel subsidies. In its implementation, the subsidized LPG may also be used by non-target households, which has implications for the government's fiscal burden. To avoid this, it is necessary to understand household behavior towards non-subsidized LPG choices. Household income and fuel availability determine the choice of household cooking fuel types. However, existing studies have not seen the relationship between subsidized and non-subsidized LPG as a household cooking fuel. Using rich data from the March 2018 National Socio-Economic Survey (Susenas) and the Ministry of Energy and Mineral Resources (KESDM) information, this study examined the relationship between income, subsidized LPG quota as a representation of the availability of subsidized fuel, and non-subsidized LPG choices as household cooking fuel in Java in 2018. The Multinomial Logit model's estimation results found that an increase in income and a decrease in subsidized LPG quotas were correlated with an increase in the opportunity to choose non-subsidized LPG as household cooking fuel in Java in 2018. Furthermore, this study revealed that the largest subsidized LPG users were non-poor households.
Keywords: Fuel Subsidy Policy; Household Behavior; Cooking Fuel Choice; Fuel Supply
JEL Classification: D04, D12, D90, H310

Introduction

Many developing countries offer fuel subsidies in the sense of providing affordable and sustainable energy sources. However, these subsidies impact increasing the government's fiscal burden (Bril-Mascarenhas & Post, 2015). Something similar happened in Indonesia. The increase in fiscal burden due to the increase in world oil prices in 2007 prompted the government to convert kerosene subsidies to Liquified Petroleum Gas (LPG), resulting in a new 3 Kg LPG cylinder. Based on regulation[1], the government provided this new LPG variant for poor households and microenterprises. The conversion of kerosene subsidy to LPG made government spending more efficient. With an estimated success of 90%

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[1] Presidential Regulation No. 104/2007, concerning the Provision of Distribution and Pricing of 3 kg LPG cylinder and KESDM Regulation No. 26/2009 concerning LPG Provision and Distribution, states that the target of subsidized LPG is poor households (households with an income of IDR 1,500,000 , - or can show a poor certificate) and micro business.

conversion, this program potentially saved the government budget of 10.81 trillion rupiahs per year (KESDM, 2007).

In this program, the government regulated the price and the quantity of subsidized LPG supply. In its supply policy, the government limited 3 kg LPG cylinders per region, known as subsidized LPG quota, each year. The government set subsidized LPG quotas for each region, estimated by the number of initial conversion package deliveries and an estimated ratio of fuel needs per household based on the previous year's volume. Moreover, the government provided free cooking appliances for targeted households and micro-enterprises, consisting of 3 kg LPG cylinders, stoves, and equipment as a first step in the conversion program. The package delivery took place in phases between 2007 and 2015 started in Java island, then at the end of 2018, covering all Indonesian provinces except East Nusa Tenggara, Maluku, North Maluku, Papua, and West Papua.

In ten years, the conversion program has been able to change the behavior of household fuel use. Data from the Central Bureau of Statistics (BPS) in 2007-2016 showed that the percentage of households using gas/LPG as cooking fuel increased by 61.81%. The LPG quantity consumption annually increased by an average of 595,000 tons (KESDM, 2018), and kerosene consumption decreased by 92% (Thoday et al., 2018).

Another problem was the volume of subsidized LPG distribution increased, while the volume of non-subsidized LPG distribution decreased during 2010-2016, as shown in Figure 1. Meanwhile, based on BPS data for 2007-2018, the number of poor people as the target of subsidies fell annually by an average of one million residents. This contradiction might arise due to excessive consumption of subsidized LPG by target households, as there were no restrictions on the amount of subsidized LPG that could be consumed. It is in line with research stating that fuel subsidies are inefficient due to excessive consumption (Davis, 2014). Another possibility is the existence of non-target households that also use subsidized LPG. It is in accordance with research by Arze del Granado, Coady, and Gillingham (2012); Laan and Beaton (2010), which revealed that higher-income households got more benefit from subsidies.
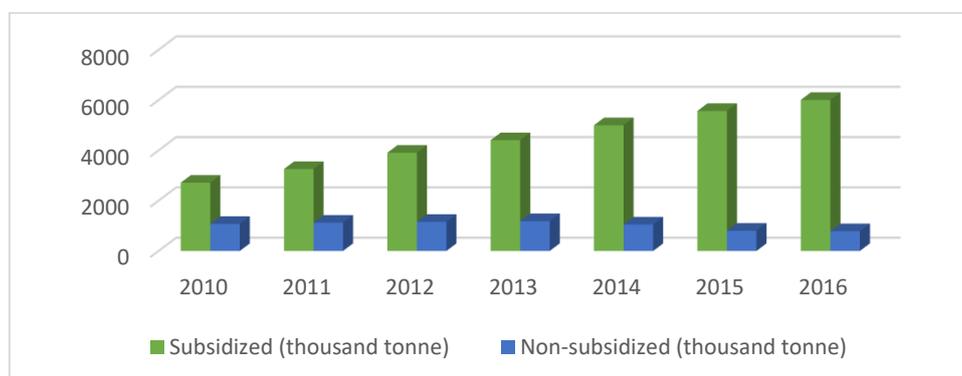

Figure 1 Distribution volume of subsidized and non-subsidized LPG from 2010 to 2016.
Source: KESDM, data processed.

Based on the literature, household income and fuel availability have an influence on household fuel choices (Cohn, 1980; Dubin & McFadden, 1984; Hosier & Dowd, 1987). Empirical evidence has shown that there was different behavior concept regarding cooking fuel usage within households. The energy ladder concept proposes that households tend to switch their fuels with others, which are more sophisticated (Mensah & Adu, 2015) and appear to be more costly because of the increase in their purchasing power (Guesalaga & Marshall, 2008). This concept assumes that the initial fuel is inferior compared to its replacement (Alem et al., 2016; Gupta & Köhlin, 2006; Hosier & Dowd, 1987). Therefore, households will only use one type of fuel for cooking.

However, another concept states that due to an increase in income, households tend to use some kinds of fuel without replacing the previously used fuel. This concept sees the multi-fuel behavior as a strategy to address market instability, savings, and efforts to sustain tradition (Bisu, Kuhe, & Iortyer, 2016; Van der Kroon, Brouwer, & van Beukering, 2013; Masera, Saatkamp, & Kammen, 2000). The multi-fuel usage concept further considers households' external factors other than income (Van der Kroon et al., 2013). One of the external factors is the fuel supply that can be represented by fuel availability (Ang, Choong, & Ng, 2015; Kowsari & Zerriffi, 2011). It is in line with the idea that when price or supply change, the consumer will adjust the choice of consumption to save expenses (Hursh, 1980; Hursh & Roma, 2013; Lancaster, 1966).

Further, the equal reliable availability of primary and alternative fuels encourages households to use only one fuel type (Hosier & Dowd, 1987). However, if one of the fuel's availabilities is limited, households choose to use some kinds of fuel for cooking, called multi-fuel behavior. Limitations in fuel supply can lead to a shortage that implies a price hike (Gupta & Köhlin, 2006), increasing cost and time to get it (Heltberg, 2005).

Andadari, Mulder, and Rietveld (2014) have studied Indonesian households' cooking preferences and behaviors. However, the analysis did not classify LPG as an option of cooking fuel into subsidized and non-subsidized LPG, and the research sample was limited to only 550 households in Central Java. To fill in this knowledge gap, this study examined the correlation of income and subsidized LPG availability with household behavior on choosing LPG variant as cooking fuel using multinomial logit model in Java Indonesia. As is well known, subsidized and non-subsidized LPG is available in the Java area[2], and most of the Indonesian population is centered in Java. This research gives a novelty as new contribution for the previous literatures where this study aims to determine the behavior of households using LPG variants, especially subsidized LPG as cooking fuel because it has implications for increasing the government's fiscal burden. The realization of LPG subsidies continues to exceed the available budget ceiling. Based on data from the Ministry of Energy and Mineral Resources for 2010-2018, the budget burden for LPG subsidies has increased by an average of 6.45 trillion rupiah per year[3].

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[2] The availability of LPG in Java varies more than outside Java, as the private sector also provides non-subsidized LPG for households in addition to Pertamina as state-owned enterprise given the assignment to distribute subsidized LPG to the public.
[3] Source of data of the Directorate General of Budget of the Ministry of Finance (Performance Report of the State General Treasurer, Financial Notes and Budget of the State Revenue and Expenditure, Central Government Financial Reports

Research Method

The household fuel demand theory assumes that households determine cooking fuel based on rational considerations. Households have a preference among several fuel choices and choose them by maximizing the utilities. Household income, fuel price, and fuel availability have an impact on household fuel choices (Cohn, 1980; Dubin & McFadden, 1984; Hosier & Dowd, 1987). Besides, other household characteristics may contribute to the household preference for cooking fuel choices, such as microenterprise ownership, household size, region, education, and gender. The utility function can be written as,

$$U_{ij} = \beta'X_{ij} + \varepsilon_j, \ \ j = (1,2,3) \tag{1}$$

where U_{ij} is a household utility with a choice of j fuel, β' is the coefficients, X_{ij} is exogenous variables influencing the choice of one fuel over another, and ε_j is the model error.

If a household chose one of the three choices fuel j, the choice opportunity could be estimated using the Multinomial Logit (MNL) model. This model is suitable for the study of discrete choices with more than two choices. In principle, the logit model is a nonlinear regression model both in parameters and variables. Therefore, it is more appropriate to use Maximum Likelihood analysis techniques than Ordinary Least Square (OLS) (Allard, & Murphy, 1975). The probability for each cooking fuel choice category was calculated using the following equation,

$$P(Y = j | x) = \frac{\exp(\beta_j'X_i)}{\sum_{j=1}^{3} \exp(\beta_j'X_i)} \tag{2}$$

where P $(Y = j \mid x)$ is the opportunity to choose j fuel over the basis fuel.

The cooking fuel choices consisted of subsidized LPG, non-subsidized LPG, or a combination of subsidized and non-subsidized LPG (mixed). These variables were made by constructing multilevel variables from questions concerning main cooking fuel and above 3 Kg LPG cylinder ownership questions. The cooking fuel variable was a dummy, categorically worth 1 for subsidized LPG as the main fuel and not having above 3 Kg LPG cylinder, 2 for non-subsidized LPG as the main fuel, and 3 for a combination of subsidized and non-subsidized LPG with 3 kg LPG as the main fuel and having above 3 Kg LPG cylinder. Due to data limitations, households that used non-subsidized LPG as the main fuel and had subsidized LPG cylinders could not be involved in this study.

Two main explanatory variables in this study were household income and subsidized LPG availability. To avoid reverse causality, household expenditure as a representation of income was reduced by LPG consumption expenditure. The second explanatory variable was subsidized LPG availability in the respondent area, represented by subsidizing LPG

2010-2018) processed by the Directorate General of Petroleum and Gas of the Ministry of Energy and Mineral Resources (KESDM).

quota data at the district level in 2018. The government set the subsidized LPG quota considering the targeted number and growth of subsidy recipients in each district each year, but over-quota could occur in realization. Increasing subsidized LPG quota was likely to increase households' probability of preferring subsidized LPG as households saved more money than using more costly non-subsidized LPG. Limited supply may lead households to refuse to choose it as their main fuel (Kowsari & Zerriffi, 2011), perhaps switching to more expensive alternative fuels (Inge, Jan, & Marti, 1997). In multi-fuel use behavior, households tend to consume both types of fuel, one of which is used as a reserve because of its uncertainty of supply (Bisu et al., 2016).

In addition to the two main explanatory variables, the study employed multiple household characteristics control variables to capture the influence of variables other than the main explanatory. Households prefer to choose from several cooking energy sources to maximize their utility (Ouedraogo, 2006). The study used control variables: micro-enterprises ownership, household size, residential area, house ownership, the person in charge (PIC) of the family education level, and PIC of the family's gender.

Demographic factors utilized the characteristics of the person in charge of the family (PIC). PIC, in general, is the household head who is authorized as a decision-maker (Posel, 2001). However, for male household heads who are married and their wives live in the same residence, the wife plays the PIC role because, in cooking activities or fulfilling household needs, the wife plays a role as a decision-maker (David, 1994). Table 1 displays all definitions of variable research.

Table 1 Definition of Research Variables

Variable	Definition	Source
Dependent		
Cooking fuel	LPG as dummy variable used for cooking fuel, 1 for subsidized LPG, 2 for non-subsidized LPG, 3 for subsidized LPG and non-subsidized (mixed)	Statistics Indonesia
Variable of interest		
Income	Monthly household expenditure without LPG consumption in hundred thousand rupiahs	Statistics Indonesia
Subsidized LPG Quota	The quota of subsidized LPG per 1000 tons	Ministry of Energy and Mineral Resources (KESDM)
Control		
Microenterprises ownership	Dummy variable; ownership of micro-enterprises by households has a value of 1 if at least one household member work in the informal sector, with work field in the processing industry, accommodation provision, food and drink provision, and 0 if others.	Statistics Indonesia
Household size	The number of household members	Statistics Indonesia
Region	Dummy variable of a residential area that is worth 1 if living in urban areas, and 0 if rural areas.	Statistics Indonesia
Dwelling ownership	Dummy variable of dwelling ownership that is worth 1 if household lives in a house they owned, and 0 for others.	Statistics Indonesia
Education	PIC's years of schooling	Statistics Indonesia
Gender	Dummy variable of PIC's gender, 1 if PJRT male and 0 if female.	Statistics Indonesia

The study used cross-sectional data that combined microdata from Susenas BPS in March 2018 and KESDM data in 2018. Susenas is one household level and individual survey to obtain Indonesian people's socio-economic conditions, which has been taking hold every year since 2015 in March and September. The results of the March 2018 Susenas were selected as samples because they contained LPG variant usage information as cooking fuel, and the data could present estimated results up to the district level (BPS, 2017). Otherwise, it also corresponded to the data available from KESDM.

The KESDM data included subsidized LPG quota information at each Indonesian district in 2018. The data used as the main explanatory variable to represent fuel characteristics in the respondent residential area influenced LPG variant choice as cooking fuel.

There were 295,155 household samples, which matched based on district codes, after combining Susenas and KESDM data. Next, sample selection was in two stages. First, selecting household samples using LPG as the main fuel for cooking left 199,410 households. The final steps were selecting household samples living in areas that already had subsidized LPG agents in the Java area, leaving 77,445 households ready for analysis.

Result and Discussion

Descriptive Statistics

Tables 2 to Table 5 present the descriptive statistics and analysis of research variables. Based on March 2018 Susenas results, LPG was the cooking fuel of most households in Java, with subsidized LPG as the largest variant with 88.08%, non-subsidized with 7.08%, and mixed LPG with 4,84%.

Table 2 exhibits a descriptive analysis of research variables tabulated with the economic status of households categorized as poor, susceptible, and non-poor[4]. The data showed that the largest subsidized LPG users were non-poor households compared to susceptible and poor households; likewise, with the use of mixed LPG. It could happen because there were no exclusions other than poor households on the use of subsidized LPG so that poor, susceptible, and non-poor households could access it freely as long as LPG subsidies were available.

Moreover, the data revealed that 0.33% of non-subsidized LPG users and 0.85% of mixed LPG users were poor households. It might be related to the inadequate availability of subsidized LPG in the respondent's residential area, while there was more non-subsidized LPG. It is in line with the literature that a reliable supply is a factor influencing fuel choice as the main fuel (Hosier & Dowd, 1987).

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[4] Households are classified as poor if the amount of monthly per capita household expenditure is below the district/city poverty line. Susceptible households are households with total per capita household expenditure in the range of 1.5 times the district/city poverty line. Non-poor households are if the amount of monthly per capita household expenditure is above 1.5 times the district/city poverty line.

Table 2 Cross Tabulation of LPG Variant Uses Based on Economic Status in 2018

Household Economic Status	LPG Variant			
	Subsidized	Non-subsidized	Mixed LPG	Total
Poor	3843	18	32	3893
	(5.63%)	(0.33%)	(0.85%)	(5.03%)
Susceptible	11316	74	182	11572
	(16.59%)	(1.35%)	(4.85%)	(14.94%)
Non-poor	53060	5394	3536	61990
	(77.78%)	(98.32%)	(94.29%)	(81.03%)
Total	68219	5486	3750	77455
	(100%)	(100%)	(100%)	(100%)

Source: Data processed.

Figure 2 displays the use of LPG variants based on ten income groups represented by monthly household expenditure per capita for a more detailed analysis. Based on the data, 0.64% of non-subsidized LPG users were found in the group of households with the lowest 10% income, and 2.43 % were mixed LPG users.
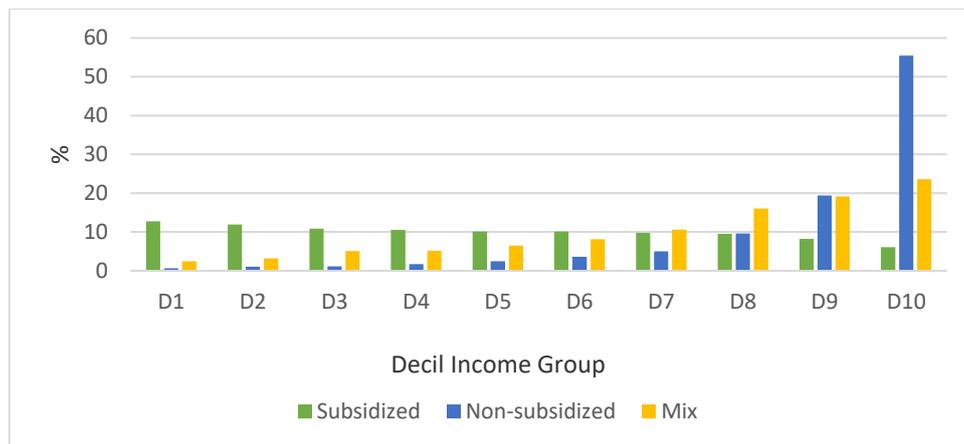

Figure 2 LPG Variant Uses Based on Income Group 2018.
Source: Data processed.

Subsidized LPG users were found to be in each decile of income groups with the largest percentage in the fourth decile, but it continued to decline for each income group above it. It might occur because the subsidized LPG distribution system could not prevent non-target households from accessing it. Moreover, existing regulations did not impose sanctions on non-target households using subsidized LPG, so it was difficult to avoid the opportunistic behavior of non-target households.

Furthermore, the data disclosed an increasing percentage of mixed LPG users in the higher income group. Based on the literature, the multi-fuel behavior is one of the household's efforts to overcome their main fuel supply constraints (Bisu et al., 2016; Van der Kroon et al., 2013). Looking at the phenomenon of using mixed LPG in Indonesia, it could be a household's precautionary effort if subsidized LPG was scarce at any time because the government distributed subsidized LPG to each region limited by an annual quota.

Based on Table 3, it reveals that only 10.54% of subsidized LPG users were poor micro-enterprises households. Poor households with microenterprises did not use non-subsidized LPG, but there were still 9.38% mixed users. It might occur as a precaution if, at any time, subsidized LPG was more difficult to obtain.

Table 3 LPG Variant Uses in Poor Households Based on Micro-Enterprises Ownership 2018

Microenterprises Ownership	Poor Household			
	Subsidized	Non-subsidized	Mixed LPG	Total
No	3,438	18	29	3,385
	(89.46%)	(100%)	(90.63%)	(89.52%)
Yes	405	-	3	408
	(10.54%)	(- %)	(9.38%)	(10.48%)
Total	3,843	18	32	3,893
	(100%)	(100%)	(100%)	(100%)

Source: Data processed.

Table 4 exposes that in susceptible households as subsidized LPG users, only 12.80% had micro-enterprises. Though it did not break the regulations as micro-entrepreneurs were the main consumers of subsidized LPG, it is better for household's personal cooking needs to use non-subsidized LPG. However, there were 16.48% of susceptible micro-enterprises households using mixed LPG. It might happen if households used subsidized LPG to do business, while non-subsidized LPG was used for domestic cooking.

Table 4 LPG Variant Uses in Susceptible Households Based on Micro-Enterprises Ownership 2018

Microenterprises Ownership	Susceptible Household			
	Subsidized	Non-subsidized	Mixed LPG	Total
No	9,867	72	152	10,091
	(87.20%)	(97.30%)	(83.52%)	(90.18%)
Yes	1,449	2	30	1,481
	(12.80%)	(2.70%)	(16.48%)	(9.82%)
Total	11,316	74	182	11,572
	(100%)	(100%)	(100%)	(100%)

Source: Data processed.

The descriptive analysis based on Table 5 shows that 89% of non-poor households using subsidized LPG actually did not have micro-enterprises, and only 11% had micro-enterprises. Similarly, the main consumers of mixed LPG were non-poor households with no micro-enterprises. It might occur because the distribution system could not exclude non-target households from access to subsidized LPG. Additionally, existing regulations did not place restrictions on non-target households who used subsidized LPG. It was difficult to avoid opportunistic behavior of non-target households so that most non-target households enjoyed LPG subsidies.

Table 5 LPG Variant Use in Non-poor Households Based on Micro-Enterprises Ownership 2018

Microenterprises Ownership	Non-poor Household			
	Subsidized	**Non-subsidized**	**Mixed LPG**	**Total**
No	47,222	5,115	3,167	55,504
	(89.00%)	(94.83%)	(89.56%)	(89.54%)
Yes	5,838	279	369	6,486
	(11.00%)	(5.17%)	(10.44%)	(10.46%)
Total	53,060	5,394	3,536	61,990
	(100%)	(100%)	(100%)	(100%)

Source: Data processed.

The Probability for Choosing an LPG Variant as Cooking Fuel

Based on Table 6, income as the main household factor negatively correlated with subsidized and mixed LPG choice instead of non-subsidized. With each income rose by one hundred thousand rupiahs, household probability had 0.97 times to choose subsidized LPG over non-subsidized LPG and 0.99 times probability of choosing a mixed LPG over non-subsidized LPG.

This result indicated that subsidized LPG was inferior to non-subsidized products because households preferred non-subsidized LPG as purchasing power increased over subsidies. It is consistent with research revealing that higher incomes were correlated with the choice of more modern and relatively more expensive fuels if the initial fuel was considered to be inferior (Bisu et al., 2016; Inge et al., 1997; Kowsari & Zerriffi, 2011; Van der Kroon et al., 2013; Masera et al., 2000, Sudaryanto, 2019).

Besides, the estimated results showed that statistically, subsidized LPG quota as a representation of fuel availability correlated significantly with the choice of subsidized and mixed LPG compared to non-subsidized LPG. An increase in subsidized LPG quota was positively correlated with increased opportunities for subsidized LPG choices compared to non-subsidized choices. For each additional one thousand tons subsidized LPG quota, households had the probability to choose subsidized LPG over non-subsidized LPG one time. It aligns with the literature, which states that increasing fuel supply increases fuel accessibility and reliability to be used as the main fuel for cooking (Mensah & Adu, 2015). The abundance of fuel available makes it easy for every household to access it (Hosier & Dowd, 1987).

However, the estimated results revealed a different relationship between the subsidized LPG quota and mixed LPG choice compared to non-subsidized. Each subsidized LPG quota increased by 1000 tons; households had a probability of choosing mixed LPG by 0.99 times over non-subsidized LPG. It suggested that increasing subsidized LPG availability resulted in fuel replacement behavior and did not result in mixed-fuel behavior. It implied that both subsidized and non-subsidized LPG supplies were reliable as the main cooking fuel.

Despite this, further research is essential to evaluate the subsidized LPG quota policy to encourage households, especially those non-targeted households, to choose non-

subsidized LPG. Improvements need to be made to the subsidized LPG distribution system to provide tighter restrictions or barriers for non-target households to access subsidized LPG.

Table 6 Results of Multinomial Logit Regression Estimation of LPG Variant Choices as Cooking Fuel in Indonesia 2018

Variable	Coef.	Relative Risk Ratio
	(1)	*(2)*
Subsidized LPG		
Household income	-0.0269	0.9734
	(0.00039) ***	(0.00039) ***
Subsidized LPG quota	0.0009	1.0009
	(0.00053) *	(0.00053) *
Dummy of microenterprises ownership (1=Yes)	0.5324	1.7029
	(0.06920) ***	(0.11784) ***
Household size	0.3106	1.3643
	(0.01320) ***	(0.01801) ***
Dummy of residential region (1=urban)	-1.0171	0.3616
	(0.05431) ***	(0.01964) ***
Household responsibility education	-0.1578	0.8540
	(0.00433) ***	(0.00370) ***
Dummy of household PIC gender	-1.0394	0.3537
(1=men)	(0.08264) ***	(0.02923) ***
Non-subsidized LPG		
Mixed LPG		
Household income	-0.0060	0.9920
	(0.00041) ***	(0.00040) ***
Subsidiezed LPG quota	-0.0039	0.9961
	(0,00073) ***	(0.00073) ***
Dummy of microenterprises ownership (1=Yes)	0.5758	1.7786
	(0.08392) ***	(0.14926) ***
Household size	0.2102	1.2339
	(0.01665) ***	(0.02055) ***
Dummy of residential region (1=urban)	-0.6027	0.5473
	(0.06713) ***	(0.03674) ***
Household responsibility education	-0.0655	0.9366
	(0.00564) ***	(0.00528)***
Dummy of household PIC gender	-0.6897	0.5017
(1=men)	(0.11541)***	(0.05790)***
N	77,455	
Mc Fadden pseudo R²	**0.2215**	

Note: * p <0.10; ** p <0.05; *** p <0.010; () standard error.
Source: Data processed.

Besides the main variables, some control variables statistically contributed to the household's preference on choosing subsidized and mixed LPG over non-subsidized LPG significantly. Ownership of micro-enterprises contributed positively to households' preferences choosing to subsidized LPG over non-subsidized and choosing a mixed over non-subsidized. It was because micro-enterprise owners were legally entitled to use subsidized LPG.

The household members' number contributed positively to the household's preference to choose subsidized LPG over non-subsidized and choose a mixed over non-subsidized.

Larger households tend to choose subsidized or mixed LPG over non-subsidized to save their expenses (Barnes, Krutilla, & Hyde, 2005; Heltberg, 2005). As household members increased, the burden of providing more food increased. More ingredients made food cook longer, so more energy was needed.

However, the residential area contributed negatively to households' preferences to choose subsidized or mixed LPG instead of non-subsidized. Urban households tended to prefer non-subsidized LPG compared to rural households. It might be due to the comparatively improved quality of urban infrastructure in promoting diverse fuel delivery compared to rural areas (Barnes et al., 2005; Heltberg, 2005), rendering the urban market's LPG choices more extensive. It is easier to find non-subsidized LPG retailers or bases because there are no constraints on infrastructure quality, such as roads or closer distances to gas filling stations or large non-subsidized LPG agents.

PIC education contributed negatively to the choice of subsidized or mixed LPG instead of non-subsidized LPG. Education reflects one's knowledge in addition to representing the economic status. Formal education is one place to get knowledge. Higher education level provides the potential for increased awareness of LPG subsidies for poor households (Fernandes, 2018), which will be even more burdensome for the government if consumed by non-target households.

Lastly, estimation results showed that PIC gender had a statistically significant negative contribution with households' preference in subsidized LPG choosing over non-subsidized and mixed non-subsidized. It aligns with studies showing that women tend to prefer cheap goods as an expense-saving shopping effort (Otnes & McGrath, 2001). Therefore, male households PIC preferred using non-subsidized LPG instead of subsidized and mixed.

Marginal Effect in the Selection of LPG as Cooking Fuel

Table 7 presents the marginal effects of each main and control variable. If household income rose by one hundred thousand rupiahs, the opportunity to choose subsidized LPG fell by 0.15%, the opportunity to choose non-subsidized LPG grew 0.08%, and the opportunity to choose mixed LPG increased by 0.07%. It is consistent with the descriptive statistics described that as income groups increased, subsidized LPG users decreased, while non-subsidized and mixed users increased.

Increased income increased the probability of choosing non-subsidized LPG as the main fuel for cooking. Increasing household income would increase purchasing power and economic status. The improved economic status would affect household consumption patterns. Households gradually reduced the use of inferior goods and going to consume luxury goods. Research in Indonesia by Olivia and Gibson (2008) said that non-subsidized LPG is a luxury item. A non-subsidized LPG cylinder's price is more expensive than a subsidized LPG given free of charge to the target household at the beginning of the conversion. Therefore, although the study was carried out before the conversion program, this assumption can still be used. Given the high initial costs, more sophisticated

fuels tend to be more expensive for households (Gupta & Köhlin, 2006; Masera et al., 2000).

Table 7 Multinomial Logit Regression Estimation Results for LPG Variant Use as Cooking Fuel in Indonesia 2018

Variable	LPG variant		
	Subsidized **(1)**	**Non-subsidized** **(2)**	**Mix** **(3)**
Household income	-0.00154	0.00080	0.00074
	(0.00003) ***	(0.00002) ***	(0.00002) ***
Subsidized LPG quota	0.00022	-0.00002	-0.00019
	(0.00003) ***	(0.00002) ***	(0.00002) ***
Dummy of microenterprises ownership (1=Yes)	0.01121	-0.01363	0.00242
	(0.00283) **	(0.00145) ***	(0.00237) ***
Household size	0.01311	-0.00942	-0.00369
	(0.00069) ***	(0.00042) ***	(0.00237) ***
Dummy of residential region (1=urban)	-0.04211	0.02724	0.01487
	(0.00203) ***	(0.00125) ***	(0.00159) ***
Household responsibility education	-0.00829	0.00473	0.00356
	(0.00023) ***	(0.00013) ***	(0.00017) ***
Dummy of household responsibility gender(1=men)	-0.06245	0.04889	0.01356
	(0.00723) ***	(0.00567) **	(0.00464) ***
N		77,445	

Note: * p <0.10; ** p <0.05; *** p <0.010; () standard error.
Source: Data processed.

Furthermore, an increase in income also increased the chances of using mixed LPG. Increased purchasing power made it possible for households to buy both subsidized and non-subsidized LPG. However, LPG distribution of subsidies was limited according to the quota set for each district/city. Thus, to anticipate if subsidized LPG would be scarce at any time, households used mixed LPG. According to the literature, an increase in income contributed to the multi-fuel behavior to anticipate the scarcity of the main fuel (Bisu et al., 2016).

The estimated results uncovered that if the subsidized LPG quota increased by one thousand tons, the probability of choosing subsidized LPG rose by 0.02%, the probability to choose non-subsidized LPG fell by 0.002%, and the probability to choose a mixed decreased by 0.013%. In other words, this research revealed that increasing the availability of subsidized LPG would make it easier for households to access subsidized LPG. With the price difference, households preferred subsidized LPG to non-subsidized LPG for greater spending saving. This study's finding is much lower than (Mensah & Adu, 2015), estimating that the probability of choosing LPG over other kinds of fuels rose by 34,4% for the LPG's reliability supply in Ghana. It seems plausible since this study used the same kind of fuel at different prices, while (Mensah & Adu, 2015) used a different kind of fuel. Nevertheless, the results are consistent with empirical evidence, stating that fuel availability is an external driver of household fuel type choices (Alem et al., 2016; Bisu et al., 2016; Gupta & Köhlin, 2006; Mensah & Adu, 2015).

Conclusion

By introducing 3 kg LPG for poor households and micro-enterprises, the government initiated a conversion program of kerosene to LPG in 2007 to reduce the burden of subsidies. In its implementation, the use of subsidized LPG was possible for non-target households. To prevent the use of subsidized LPG by non-target households, households' behavior in choosing non-subsidized LPG, especially in Java, should be understood.

The research aimed to study the relationship between household's income, subsidized LPG availability and non-subsidized LPG choices in Java Indonesia as households cooking fuel. The Susenas and KESDM 2018 cross-sectional data were analyzed using the Multinomial Logit model. The data showed fewer non-subsidized LPG users than subsidized LPG users and a small proportion of subsidized and non-subsidized LPG users. Furthermore, this study revealed that the largest subsidized LPG users were non-poor households.

These study findings disclosed that Java households would choose non-subsidized LPG if their income increased, and subsidized LPG quotas decreased. Other household characteristics, such as micro-enterprise ownership, number of household members, residential area, education, and gender PIC family, also contributed to the Indonesian household preference in choosing non-subsidized LPG as cooking fuel.

Based on the study results, the government can follow some of the suggestions to encourage non-target households to use non-subsidized LPG. First, evaluating the determination of subsidized LPG quotas. Today, quota determination also uses estimates based on the volume realization amount in the previous year, considering the number of distributions of the initial conversion kit and the average ratio of fuel needs per household. Also, updating the number of program targets using information from the Susenas or Economic Census (SE). Susenas may present economic status data and the need for cooking fuel consumption per month for households in one region, while micro-enterprises may use SE data. Second, improving the governance of the subsidized LPG distribution in the community by implementing a closed subsidized LPG distribution system as laid down in KESDM Regulation No. 26/2009 concerning Provision and Distribution of LPG. Subsidized LPG is delivered to households and micro-enterprises at specific delivery points that have been determined by showing a control card selection.

Appendix

Table 8 Summary of Statistical Research Variables

Variable		Mean	SE	Min.	Max.
Cookung fuel	Multinomial	1.17	0.48	1	3
Income	IDR 100,000,-	43.81	44.49	1.83	1367.76
Subsidized LPG Quota	1000 Tons	40.80	29.10	0.65	152.59
Dummy micro-enterprises ownership (1=Yes)	-	0.11	0.31	0	1
HHsize	Person	3.66	1.49	1	17
Dummy residential region (1=Urban)	-	0.66	0.47	0	1
PIC's Education	Year	7.65	4.47	0	25
Dummy PIC's gender (1=Men)	-	0.06	0.24	0	1
Observation number	Households		77455		

Source: Data processed

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