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Dynamic Relationship of Macro Variables and Liquefied Petroleum Gas Subsidy Transformation Program

Eddy Prabowo[1]*; Harianto[2]; Bambang Juanda[3]; Dikky Indrawan[4]

[1,2,4]School of Business, IPB University
Jln. Pajajaran, Jawa Barat 16128, Indonesia
[3]Department of Economics, IPB University
Jln. Raya Dramaga, Jawa Barat 16680, Indonesia
[1]eddyprabowo@apps.ipb.ac.id; [2]harianto.ipb@gmail.com;
[3]bbjuanda@gmail.com; [4]rdikky@apps.ipb.ac.id

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ABSTRACT

Most Indonesians rely on liquefied petroleum gas as one of their primary sources of energy. Liquefied petroleum gas is classified into subsidized and non-subsidized. Subsidized liquefied petroleum gas is primarily used by low-income households, small businesses, as well as poor fishermen and farmers for cooking. However, no exit strategy has been established to overcome the increase in government spending on subsidized kerosene introduced in 2008. The problem is that macro variables may influence liquefied petroleum gas economic prices. The research aimed to identify the relationship between macro variables that might affect liquefied petroleum gas economic prices. It applied a quantitative method with Vector Auto Regression (VAR) and Vector Error Correction Model (VECM). The results demonstrate that inflation rate have a significant impact on the economic price of liquefied petroleum gas. Then, gross domestic product, inflation rate, and world gas price have positive correlations to the economic prices in liquefied petroleum gas. Meanwhile, currency exchange and world oil price have negative coefficients. The regression model indicates that a rise in inflation increases market prices in liquefied petroleum gas. Furthermore, the increased subsidized fuel means more poor people cannot afford liquefied petroleum gas. It is because high inflation reduces purchasing and potentially increases the number of poor people.

Keywords: macro variables, liquefied petroleum gas (LPG), subsidy transformation program

INTRODUCTION

Liquefied petroleum gas is subsidized for most Indonesians, classified as low-income households, small businesses, as well as poor fishermen and farmers. According to data from the Indonesian Central Bureau of Statistics 2021, the number of poor people in September 2020 was estimated to be 27,55 million. Meanwhile, the number of poor people in East Asia and the Pacific region was 271 million in 2019 before Covid-19 (World Bank, 2020). This number may rise due to the pandemic's impact. The pandemic has caused many economic sectors to reduce or halt their activities, resulting in unemployment and layoffs (Mugaloglu et al., 2021; Nasir et al., 2018; Nasir et al., 2019). Furthermore, Covid-19 is linked to oil prices, whose supply remains constant, while the demand decreases due to the sluggishness of economic and industrial sectors (Iyke, 2020; Mugaloglu et al., 2021).

The existence of many poor people in Indonesia forces the government to spend money on subsidies in the energy sector, such as liquefied petroleum gas. As a result, the subsidy budget grows yearly, straining the state budget for other more productive sectors. Furthermore, only a few poor people benefit from this subsidy, especially the economically well-off group (Andadari et al., 2014). Therefore, it implies a need for energy transformation in liquefied petroleum gas to ensure that the subsidy of liquefied petroleum gas reaches poor people (Prabowo et al., 2022). Moreover, liquefied petroleum gas is advantageous in clean energy for cooking fuel and relatively less costly to provide affordable fuel-efficient transportation (Gould & Urpelainen, 2018). Liquefied petroleum gas is also used in vehicles to reduce emissions from fossil fuels (Choi et al., 2020; Kivevele et al., 2020).

Macroeconomics, fiscal policy, social and political situation, and energy pricing are among the factors affecting the energy subsidy reformation. Energy subsidy reformation has become an important goal for most countries, especially developing countries. The reformation not only removes the subsidy but also considers long-term energy sustainability development (Rentschler & Bazilian, 2017; Zhao et al., 2019). For example, removing subsidies in Ecuador negatively impacts vulnerable households in getting energy and makes this reformation difficult politically. Furthermore, the subsidy removal of liquefied petroleum gas without compensation is regressive as most poor people utilize the liquefied petroleum gas as a basic need (Schaffitzel et al., 2020). Hence, external power, such as the Paris Agreement, strongly advises countries to protect the climate by removing the fossil energy subsidy and implementing decarbonization. However, it creates pro and contra for developing countries as most poor people spur social and political resistance (Perry, 2020).

Policymakers should understand that balancing between the government energy subsidy, international oil price, and price behavior is essential for designing the policy. The regression time series determines the relation between the energy subsidy, international oil price, and pricing behavior. The energy price and the international oil price significantly affect the pricing behavior. However, the Consumer Price Index (CPI) is more sensitive and affected by oil price fluctuation than the producer price index. The consumer price index is an instrument to measure the inflation in a country due to the increase in the prices of goods and services consumed in that country (Husaini et al., 2019).

Research in the big ten countries with energy consumption in the world, China, United States of America, Russia, India, Japan, Canada, Germany, Brazil, France, dan South Korea, shows that economic growth has a positive relationship with energy consumption. On the other hand, the weak effect of economic growth on energy consumption occurs in a lower quantile in China, India, Germany, and France. Moreover, the weak effect of economic growth on energy consumption also occurs in the highest quantile income in the United States of America, Canada, Brazil, and South Korea. It happens because these countries are efficient in energy utilization (Shahbaz, Zakaria, et al., 2018). Similar previous research in Ireland and the Netherlands using regression time series also shows the relationship between economic growth and energy consumption (Shahbaz, Lahiani, et al., 2018).

Economic growth and inflation have a long-term positive relationship, according to studies conducted in India, Bangladesh, Pakistan, and Sri Lanka (Aggarwal et al., 2020; Devpura & Narayan, 2020; Kuehl, 2021). Moderate inflation is beneficial to growth, but rapid economic growth impacts inflation. Conversely, the absence of inflation indicates economic stagnation or decline because prices are unchanged, weakening the industrial sector (Bui, 2020). In Indonesia, inflation was low from 2008 to 2014, with no discernible impact on economic growth (Nasir et al., 2018; Purnomo et al., 2020).

Oil prices, exchange rates, and inflation positively and significantly impact economic growth (Yii et al., 2017). For example, oil price shocks in Nigeria negatively and significantly impact economic growth but have a marginally positive impact on inflation and exchange rates (Alenoghena, 2020). Nigeria also uses liquefied petroleum gas for the future energy system by reducing the import of gasoline. However, due to the limitation of the domestic refinery, the liquefied petroleum gas still needs to be imported from other countries (Emodi et al., 2017). Therefore, fluctuations in oil prices are caused by the supply and demand mechanism. In this case, a decrease in oil prices increases the demand, and vice versa (Arifah et al., 2020). Price fluctuations are also caused by competition among the world's oil-producing countries. Similarly, fluctuations in currency exchange rates, particularly the US Dollar, significantly impact exporting countries and global oil consumption (Febrianti et al., 2021; Kim & Jung, 2018).

Petroleum is the Indonesian government's primary macroeconomic assumption, meaning oil price fluctuations impact the country's economic stability. The fluctuations positively impact economic growth, inflation, and unemployment (Purnomo et al., 2020). In comparison, global oil price shocks negatively impact economic growth, weaken currency exchange rates, and increase inflation and interest rates (Jayanti et al., 2021). It shows that oil price fluctuations are one of the most concerning variables for Indonesians (Asmara et al., 2016).

World oil prices increase the export value of producing countries and the production costs of importers. Indonesia is a major importer of liquefied petroleum gas, making it highly reliant on oil prices. A rise in oil prices increases the cost of liquefied petroleum gas imported from oil refineries. Inflation occurs when the volume of liquefied petroleum gas decreases due to high costs while the product demand exceeds the supply. So, the price of domestic goods is higher than imports due to inflation. Then, increased domestic prices reduce competitiveness in the international market. Subsequently, domestic competitiveness deteriorates, reducing the trade balance due to a fall in the value of exports and a rise in the value of imports. In addition, import value increases demand for domestic currency relative to foreign currencies. As a result, it causes the domestic currency's exchange rate to fall (Purnomo et al., 2020).

Oil price fluctuations impact a country's economy as an exporter and importer. A rise in oil prices forces domestic manufacturing industries to use oil-based fuel to reduce output. This issue occurs because increased oil prices raise production costs, causing industrial companies to make production adjustments. In line with this, the drop in output impacts the country's economic growth (Badli et al., 2020; Ramyar & Kianfar, 2019; Renner et al., 2019; Valenti et al., 2020). There are recommendations for the Indonesian government to implement a closed system for providing subsidized liquefied petroleum gas to improve supervision and provide certainty about the target of subsidies (Jakob et al., 2019; Meng et al., 2020; Santika et al., 2020).

Previous research in China shows that eliminating subsidies reduces energy demand significantly while negatively impacting macroeconomic variables. Compensation policies can be implemented for other, more productive activities due to the elimination of subsidies (Liu et al., 2021). Another example is Cameroon's economic growth is boosted by increased consumption of liquefied petroleum gas. However, implementing energy efficiency by reducing consumption of liquefied petroleum gas is not an option. The government must provide subsidies to its people and encourage an increase in consumption and a national storage program (Tamba, 2020). Liquefied petroleum gas can be used as a bridge of energy to reduce emissions while South Asian countries transition from nonrenewable to renewable energy consumption (Murshed, 2021).

The Georgian government provides electricity and gas subsidies to veterans and poor people, especially in the winter. These subsidies alleviate poverty and ensure equitable welfare distribution, especially for households with high expenditures. However, the subsidy exceeds the basic needs of households, making state subsidies increase. Welfare-related subsidies are quite successful in Georgia. However, other benefits are constrained by a large budget to affect low-income families. Reorienting the subsidy program to maximize compensation will benefit the recipients and the government by identifying the target recipients in need (Mateut, 2018; Pirveli et al., 2020).

Previous research in Bangladesh shows that removing direct subsidies on electricity and indirect subsidies on natural gas positively increases economic growth and gross domestic product (Timilsina & Pargal, 2020). Most recent years, developing countries have been struggling with heavy energy subsidies. In addition, the adverse economic situation makes the government of some developing countries plan to remove the subsidy without considering the social and political disturbance risk. The dual fuel pricing policy in the market can be an alternative solution (Majidpour, 2022).

Prior to 1973, most Brazilians, particularly poor people in rural areas, cooked with firewood. The Brazilian government introduced subsidy of liquefied petroleum gas to replace firewood between 1973 and 1990 until they were discontinued in 2000. As a result, the use of firewood decreased by 65% between 1973 and 2000. However, after the subsidy of liquefied petroleum gas was removed, the Brazilian people returned to cooking with firewood. The elimination of the liquefied petroleum gas subsidy resulted in a 17% increase in retail prices and a 5% decrease in consumption of liquefied petroleum gas. Hence, there is a relationship between Brazilian's liquefied petroleum gas economic price and inflation. When liquefied petroleum gas is used at its economical price, inflation rises accordingly. Then, the Brazilian government uses a voucher system to allow poor people to purchase liquefied petroleum gas, but it is ineffective (Coelho & Goldemberg, 2013).In addition, the Brazilian government put in place an integrated system in the form of a family allowance program. This program is essentially a direct income transfer program for extremely poor (Coelho et al., 2018).

Countries in North Africa and the Middle East are in the progress of consideration of phasing out the energy subsidy. For example, the energy subsidy removal in Egypt has an impact in the short and long term. In the short term, energy subsidy removal causes poor people to suffer from getting energy and decreases economic growth. Meanwhile, in the long term, the removal can be a positive impact, depending on policy measures (Breisinger et al., 2019). Energy subsidy reformation is often linked with profit and loss by changing energy pricing and service cost (Coxhead & Grainger, 2018).

Demand elasticity is a condition where a change in the demand for a good or service changes the price (Mankiw, 2004). For example, a product or service is elastic or luxurious when a 10% increase in price reduces demand by 25%. Conversely, the product or service is inelastic when a 10% increase in price results in a 5% decrease in demand. Since liquefied petroleum gas is one of the basic needs for some Indonesians, a price increase may not make people stop buying the commodity. On the contrary, people are likely to reduce the frequency of purchases. Hence, liquefied petroleum gas is an inelastic product.

Energy consumption and electricity have played an essential role in the energy reform in China. Previous research shows that the demand for residential electricity is inelastic to the price. It means the increase in electricity prices does not stop people from consuming electricity. Instead, people tend to reduce their electricity utilization (Lin & Wang, 2020). In the case of smuggling fuel elasticity in Iran, it shows that the ratio of the foreign and domestic fuel prices has a significant relationship with the fuel demand elasticity. Therefore, it is consistent with the research hypothesis that an increase in domestic fuel price reduces the fuel smuggling demand (Ghoddusi et al., 2018, 2022).

Figure 1 shows the inelastic curve of subsidized liquefied petroleum gas. The demand line of liquefied petroleum gas is drawn from the top left to the bottom right (D1). Then, the provision of subsidies moves the supply line to the right from S1 to (S1+Subsidy). It means that subsidizing products by lowering production costs increases supply. Conversely, eliminating subsidies causes the supply line to shift to the left and quantity from Q2 to Q1. Liquefied petroleum gas is an example of a product subsidized by the government. Pertamina is an Indonesian oil and gas company providing liquefied petroleum gas. The company receives this product subsidy, making the consumer price lower than the market price (Gobel et al., 2021).

Jules Dupuit first applied the theory of price discrimination and product differentiation in 1804-1866. Dupuit investigated the effects of price discrimination on output and economic well-being. The theory was based on the monopoly profit maximization principle. However, monopoly or market power alone was insufficient to discriminate unless combined with market separation (Ekelund, 1970).

When two or more similar products are sold at different prices based on their marginal costs, it refers to price discrimination (Alese, 2008). It adds a third condition prohibiting resale, permitting price discrimination. In this case, price discrimination is a natural consequence of monopoly theory. Sellers receive incentives when goods are sold at prices higher than their marginal cost. In the process, buyers pay more than the production price for each additional unit of goods.

Moreover, lowering consumer prices is unprofitable, but lowering prices for some consumers may be profitable. Selling products to marginal consumers is difficult. It is because consumers must be sorted out using a strategy based on age criteria.

Companies that want to sell products at varied prices to different consumers must develop strategies to ensure that discounted goods or products are not resold. Several criteria have been identified to prevent resale. First, the nature of some products, such as services and electricity, cannot be resold. Second, tariffs, taxes, and transportation costs bar consumers from reselling. For example, publishers sell books at varied prices in different countries. In this case, transportation costs are included in the selling price, preventing consumers from reselling. Third, a company can legally limit resale. For instance, computer manufacturers frequently offer educational discounts and contract terms that limit resale. Fourth, companies modify products, such as software for student editions, to have limited resale ability because they differ from the standard version (Carlton & Perloff, 1981).

A traditional form of price discrimination is divided into three parts. First, first-degree price discrimination is when each product unit is sold at different prices. The products are sold at the maximum price payable by consumers. Second, second-level price discrimination in the product is sold by the seller. Third, buyers are charged different prices depending on the number of product units purchased by consumers, such as discounted goods. Each buyer pays a constant amount for each unit purchased, such as discounted student books or on different days (Pigou, 1920).

One proposed plan is to set a single market price for liquefied petroleum gas to curb subsidy leakage. However, achieving this goal requires thoroughly examining the macroeconomic variables that can influence economic prices of liquefied petroleum gas (Badli et al., 2020; Nasir et al., 2018, 2019). Therefore, the research applies the Vector Auto Regression (VAR) and Vector Error Correction Model (VECM) methods

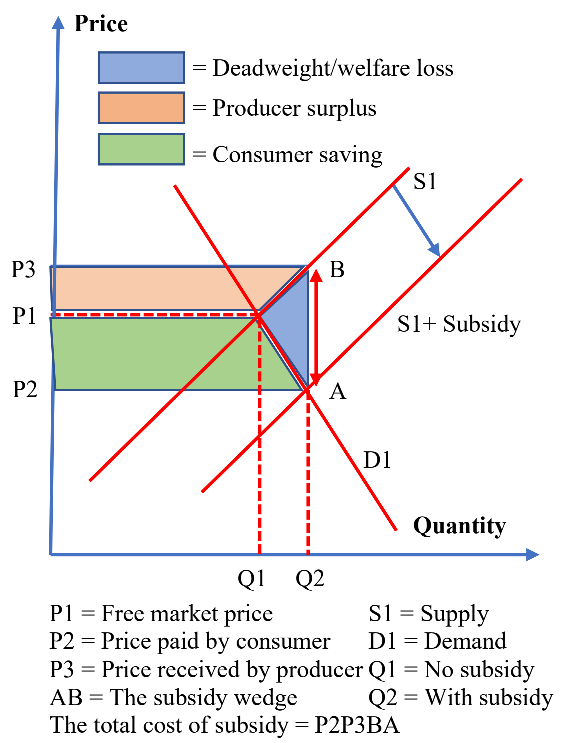


Figure 1 Inelastic Curve of the Relationship between Subsidy Price and Quantity

to determine the relationship between macroeconomic variables that may influence liquefied petroleum gas economic prices.

METHODS

The research applies a quantitative method, employing a time series regression model in VAR and VECM. This method is commonly used in multivariate time series economic studies (Basuki & Prawoto, 2019; Firdaus et al., 2020). In 1980, Christopher Shims proposed the VAR method as a promising macro-econometric framework (Sims, 2002). Data description, forecasting, structural inference, and policy analysis are all part of VAR analysis. In addition, forecasting, impulse response function, forecast error variance decomposition, and Granger causality test are all employed.

Forecasting is the future prediction based on current and historical data. The Granger causality test is used to determine the causal relationship between variables. Furthermore, forecast error variance decomposition predicts the percentage variance contribution of each variable to changes in a specific variable. The impulse response function plots current and future responses for each variable as a result of previous changes or shocks to that variable (Firdaus et al., 2020).

The multivariate VAR model has several advantages over traditional econometric models. It avoids biased parameters by excluding relevant variables. The model detects the relationship between variables by making them endogenous. It is also free from economic theory limitations, such as spurious variables, because it works on data. Then, it includes all variables simultaneously in the analysis (Firdaus et al., 2020).

The VAR model is employed when time series data are used, the relationship between variables is unknown, the data are large enough, and assumptions are met. In the unit root test, it is assumed that the time series data must be stationary. When the time series data are not stationary at the data level, a unit root test is run on the first difference. When the first difference is stationary, the cointegration test at the level is performed. Then, when time series data are cointegrated at the data level, the vector error correction model is the best method (Basuki & Prawoto, 2019; Firdaus et al., 2020). A general VAR equation model is shown in Equation (1). It shows Y_t as vector size dimension $(n \times 1)$ with n variable in the VAR model, c as vector intercept size $(n \times 1)$, Ai as coefficient matrix/parameter size $(n \times n)$ for $i=1, 2, 3, \ldots, n$, and ε_t as error vector size $(n \times 1)$.

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_n Y_{t-n} + \varepsilon_t \quad (1)$$

$$LPG_t = \emptyset_0 + \sum_{t=1}^{n} \emptyset_{1t} LPG_{t-n} + \sum_{t=1}^{n} \emptyset_{2t} GAS_{t-n} + \sum_{t=1}^{n} \emptyset_{3t} OIL_{t-n} + \sum_{t=1}^{n} \emptyset_{4t} INF_{t-n} + \sum_{t=1}^{n} \emptyset_{5t} PDB_{t-n} + \sum_{t=1}^{n} \emptyset_{6t} KUR_{t-n} + \mu_{nt} \quad (2)$$

Then, Equation (2) shows dynamic regression. It includes LPG_t as the economical price (benchmark price) of Indonesian liquefied petroleum gas at time t, GAS_{t-n} as the price of liquefied natural gas at a time $(t-n)$ depending on the optimal lag length, and OIL_{t-n} as the price of oil type of West Texas Intermediate (WTI) at a time $(t-n)$, depending on the optimal lag length. Then, it also has INF_{t-n} as the inflation at a time $(t-n)$, depending on the optimal lag length, PDB_{t-n} as the economic growth at time $(t-n)$, depending on the optimal lag length, KUR_{t-n} as the currency exchange rate at the time $(t-n)$ depends on the optimal lag length, μ_{nt} as the error vector at time t (white noise), ϕ_0 as the intercept vector, and ϕ_1-ϕ_6 as the size matrix coefficient $(n \times n)$ for each $i = 1, 2, 3, \ldots, n$.

Table 1 shows the variables, types, and data sources, and time range used in the research. The variables used are global gas prices, oil prices, inflation rates, currency exchange rates, gross domestic product, and economic prices of liquefied petroleum gas. The quarterly and yearly data are interpolated into monthly data ranging from 2010−2020, implying that each variable has 132 data sets. The time series data must be tested to determine its stationarity when estimating an economic model.

Stationary data do not contain unit roots, while non-stationary data have a constant mean, variance, and covariance over time (Lütkepohl & Krätzig, 2009). Furthermore, when there is no significant change in the data, it is considered stationary. Regardless of the time or variance of the fluctuations, the data oscillates around a constant mean value. The stationarity test is required because non-stationary data produces spurious regression. The R^2 and t-statistic values show a significant effect but no economic significance. Furthermore, the least-square estimate is inconsistent (Lütkepohl & Krätzig, 2009). Then, a unit root test is used to perform a stationarity test. The methods for performing a unit root test include the Dickey-Fuller (DF), the Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests. The research uses the ADF method with hypothesis $H_0{:}\phi = 1$ (there is a unit root, or the data are not stationary) and $H_1{:}|\phi|<1$ (no unit root or data stationary). When the calculated ADF test statistic is less than the critical value table of 5%, or when the probability value is less than the residual value in the output, H_0 is rejected, indicating that the data are stationary.

Lag lengths are determined using the Final

Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information (HQ). When these criteria are met, the optimal lag is chosen. However, these criteria frequently produce contradictory results. For example, in a small sample, the AIC and Final Prediction Error (FPE) criteria explain the optimal lag better than the SC and HQ criteria and vice versa. The lag check determines parameter estimates for the vector autoregressive model and the optimal lag length for the following analysis. In the VAR model, the lag length represents the degrees of freedom. When the optimal lag entered is too short, the model dynamics may not be fully explained. On the other hand, a too-long optimal lag leads to inefficient estimation due to reduced freedom, particularly for models with small samples. It means that the optimal lag must be determined before estimating the VAR. The best model has the lowest AIC value (Basuki & Prawoto, 2019; Lütkepohl & Krätzig, 2009).

A stability test is performed after determining the optimal lag length. It is performed to ensure that the VAR model's impulse response function and forecast error variance decomposition analyses are long-term valid. The VAR model is stable when all of the roots of the characteristic polynomial functions of all variables have a modulus value of less than one or are in the unit circle (Basuki & Prawoto, 2019; Firdaus et al., 2020).

Next, a cointegration test is performed to determine a long-term balance or similarity of movement and stability of the relationship between the variables. The cointegration test uses Johansen's method to test several cointegration vectors. When the previous stationarity test shows that all variables are integrated into the first difference, cointegration between variables must be tested to determine the appropriate analysis method. In this case, the VECM method is used when cointegration occurs because VAR can change each variable in log form. All variables whose values are not fractions or percentages are converted to log form. The coefficient model is represented by this log figure as an elasticity number. However, the VAR method can still be used when the cointegration test fails (Basuki & Prawoto, 2019; Firdaus et al., 2020).

The causality test determines the possibility of an endogenous variable being treated as an exogenous variable due to a lack of understanding of the interdependence of variables. For example, when there are two variables, A and B, it is necessary to determine the possibility of A causing B and vice versa or the existence of a relationship between the two. Variable A influences B by indicating how much the current period's value of B is explained by the previous period's values of B and A. The causality test can be performed using the Granger error correction model causality. Since all variables in the VAR or VECM model are endogenous, each variable can affect other variables in the system. Therefore, the Granger causality test is based on F-Statistics values and other probabilities (Basuki & Prawoto, 2019; Firdaus et al., 2020). The hypotheses tested are $H_0 = \theta_{1p}$ or $\gamma_{2p} = 0$ (θ variable does not affect γ variable and vice versa), $H_1 = \theta_{1p}$ or $\gamma_{2p} \neq 0$ (θ variable affects γ variable and vice versa). Then, H_0 is rejected when the p-value is less than one, indicating an influence from one variable to the other.

The Impulse Response Function (IRF) is used to calculate the response of a variable to a one-standard-deviation shock from the variable or other variables. IRF analysis can also predict the present and future shock responses. The analysis is an excellent feature because each coefficient in the VAR equation is not always easy to interpret. In addition, Forecast Error Variance Decomposition (FEVD) is used to calculate the contribution percentage of a variable's variance caused by changes in other variables. The analysis examines a variable's square prediction

Table 1 Variables and Data Sources

Variables	Source data	Type of data	Time Range
World natural gas price	http://www.eia.gov/dnav/ng/hist/rngwhhdm.htm	Monthly	2010-2020
World WTI oil prices	https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M	Monthly	2010-2020
Inflation	https://www.bi.go.id/id/statistik/indikator/data-inflasi.aspx	Monthly	2010-2020
Currency exchange rate	https://www.investing.com/currencies/usd-idr-historical-data	Monthly	2010-2020
Gross domestic product	https://www.bps.go.id/indicator/11/65/12/-seri-2010-pdb-seri-2010.html	Quarterly	2010-2020
LPG economic price	Ministry of Finance (Kementerian Keuangan)	Yearly	2010-2020

error percentage caused by shocks to the variable and other variables. In this case, a greater percentage of a variable's shock contribution to other variables means that the variable is more sensitive to changes in other variables (Basuki & Prawoto, 2019; Firdaus et al., 2020).

RESULTS AND DISCUSSIONS

The results of regression time series using VAR or VECM after running some tests are as follows. The stationary test shows that liquefied petroleum gas economic price, world gas price, world oil price, currency exchange, inflation rate, and gross domestic product are not stationary at the data level. Therefore, the unit root test must be exercised at the first difference. Then, the model can proceed to conduct stability tests.

Table 2 shows the first difference in stationary test results for all variables. The stability test results show that all variables are less than 1,00, with a maximum value of 0,997. It indicates that the VAR meets the stability criteria. The optimal lag length must be determined when the estimates produce a valid model output. The model's dynamics may not fully explain when the lag length is too short. On the contrary, a too-long optimal lag has too long results in an inefficient estimation due to the reduced freedom for small sample models. The lag length criteria selection result shows that the optimal lag test from Likelihood Ratio (LR), FPE, AIC, Schwarz Criterion (SC), and Hannan Quinn (HQ) is at lag 2, with the largest adjusted R^2 value, as shown in Table 3 and Table 4.

Next, the cointegration test is performed to determine the ability of non-stationary variables at the data level to meet the cointegration requirements that all variables must be stationary at the first difference. The data stationary at the first difference must be tested for cointegration to determine its existence between variables. Furthermore, a cointegration test is performed to determine whether the studied variables are balanced over time. The long-term balance is whether the same movement and stability of the relationship between variables exist.

Table 2 Stationary Test Result at First Difference

Variable	**T-Statistics**	**MacKinnom Critical Value**		**Probability**
		1%	**5%**	
Liquefied petroleum gas economic price (LPG)	-4,289625	-3,481623	-2,88393	0,0007***
World gas price (GAS)	-11,60095	-3,481217	-2,883753	0,0000***
World oil price (OIL)	-7,966798	-3,481623	-2,88393	0,0000***
Currency exchange (KUR)	-12,53992	-3,481217	-2,883753	0,0000***
Inflation rate (INF)	-8,548339	-3,481623	-2,88393	0,0000***
Gross domestic product (PDB)	-5,120216	-3,481217	-2,883753	0,0000**

Notes: ***, ** = stationary level at 1% and 5%, respectively.

Table 3 Optimal Lag Length Result

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	1017,803	NA	1,91e-15	-16,86339	-16,72402	-16,80679
1	1113,332	179,9118	7,09e-16	-17,85553	-16,87991*	-17,45933*
2	1158,120	79,87203	6,15e-16*	-18,00200	-16,19013	-17,26619
3	1177,519	32,65557	8,21e-16	-17,72532	-15,07720	-16,64991
4	1209,452	50,55963	8,97e-16	-17,65753	-14,17316	-16,24251
5	1234,879	37,71681	1,11e-15	-17,48131	-13,16070	-15,72669
6	1282,833	66,33689	9,56e-16	-17,68055	-12,52369	-15,58633
7	1326,215	55,67304	9,12e-16	-17,80358	-11,81047	-15,36975
8	1346,413	23,90144	1,32e-15	-17,54022	-10,71086	-14,76678
9	1389,996	47,21517	1,33e-15	-17,66660	-10,00100	-14,55357
10	1474,783	83,37396*	7,10e-16	-18,47972	-9,977872	-15,02708
11	1532,224	50,73970	6,31e-16	-18,83707*	-9,498977	-15,04483

Notes: * = optimal lag length is 2.

Johansen's cointegration method is used to conduct the cointegration test. The integration test has two hypotheses supporting and refuting cointegration. Then, the VECM method is used in the next stage when cointegration occurs.

The cointegration test results demonstrate that one cointegrated equation from trace test statistics is significant. The maximum eigenvalue at r = 0 is less than the critical value. The result suggests that the movements of the macroeconomic variables have a long-term stable relationship. For the short-term relationship, all variables adjust to reach their long-run equilibrium. The VECM method is selected based on cointegration test results.

It is required to check that the p-value or probability is less than 5% (0,005) to test the H_0. When the p-value is less than 5%, H_0 is rejected. Meanwhile, if the p-value is the same or more than 5%, H_0 is accepted. The p-value of 5% is based upon practical reference for social science and business management, where a benchmark p-value of 5% can be adopted. Furthermore, the Granger causality test determines the presence of a unidirectional, reciprocal, or no relationship between two variables. The causality test is also conducted to determine the causal relationship between variables because each variable has the potential to become exogenous or endogenous. Table 5 shows the Granger causality result

Table 5 shows that the inflation rate affects the economic price of liquefied petroleum gas (0,0048). Liquefied petroleum gas affects inflation rate, but it is not significant (0,597). Then, effect of inflation rate on the economic price of liquefied petroleum gas is consistent with actual conditions. High inflation rate will occur when the liquefied petroleum gas price increases.

Next, world gas price, world oil price, currency exchange, and gross domestic product have a relationship with the economic price of liquefied petroleum gas and vice versa. However, they are

Table 4 Adjusted R^2 Results

	D(LPG)	**D(GAS)**	**D(OIL)**	**D(KUR)**	**D(INF)**	**D(PDB)**
Lag 1 Adjusted R^2	0,309608	0,005597	0,184445	0,022888	0,042737	0,454404
Lag 2 Adjusted R^2	0,431614	0,035607	0,235616	0,066186	0,059330	0,441802

Notes: The value of lag 2 adjusted R^2 for D(LPG) is 0,431614 and lag 1 adjusted R^2 for D(LPG) is 0,309608. Therefore, lag 2 is selected as the optimal lag length. It shows liquefied petroleum gas economic price (LPG), world gas price (GAS), world oil price (OIL), currency exchange (KUR), inflation rate (INF), and gross domestic product (PDB).

Table 5 Granger Causality Results

Null Hypothesis	**Observed**	**F-Statistic**	**Probability**
World gas price (GAS) does not Granger Cause liquefied petroleum gas economic price (LPG)	130	1,47054	0,2337
Liquefied petroleum gas economic price (LPG) does not Granger Cause world gas price (GAS)		1,91804	0,1512
World oil price (OIL) does not Granger Cause liquefied petroleum gas economic price (LPG)	130	2,71648	0,0700
Liquefied petroleum gas economic price (LPG) does not Granger Cause world oil price (OIL)		1,08793	0,3401
Currency exchange (KUR) does not Granger Cause liquefied petroleum gas economic price (LPG)	130	0,80992	0,4472
Liquefied petroleum gas economic price (LPG) does not Granger Cause currency exchange (KUR)		2,18722	0,1165
Inflation rate (INF) does not Granger Cause liquefied petroleum gas economic price (LPG)	130	5,56589	0,0048**
Liquefied petroleum gas economic price (LPG) does not Granger Cause Inflation rate (INF)		0,51801	0,5970
Gross domestic product (PDB) does not Granger Cause liquefied petroleum gas economic price (LPG)	130	0,15615	0,8556
Liquefied petroleum gas economic price (LPG) does not Granger Cause gross domestic product (PDB)		0,07938	0,9237

Notes: ** = p-value less than 5%. It means this inflation rate affects the liquefied petroleum gas.

insignificant. Liquefied petroleum gas affects the world oil price insignificantly (0,340). Similarly, world oil price also affects the liquefied petroleum gas, but it is not significant (0,070). The result differs from the actual condition in which the liquefied petroleum gas normally is affected by the world oil price as the liquefied petroleum gas product is extracted from the oil refineries. This non-significant result is possible due to the small composition of ethane and butane in the oil product, which results in the non-economic development of liquefied petroleum gas. If the world oil price increases, the liquefied petroleum gas price will also increase.

Liquefied petroleum gas affects the world gas price insignificantly (0,230). The world gas price also affects liquefied petroleum gas, but it is not significant (0,150). The result is different from the actual condition. The price of liquefied petroleum gas is affected by the world gas price due to the fact that the liquefied petroleum gas product is extracted from gas refineries. This effect will have consequences. If the world gas price increases, the liquefied petroleum gas price also increases.

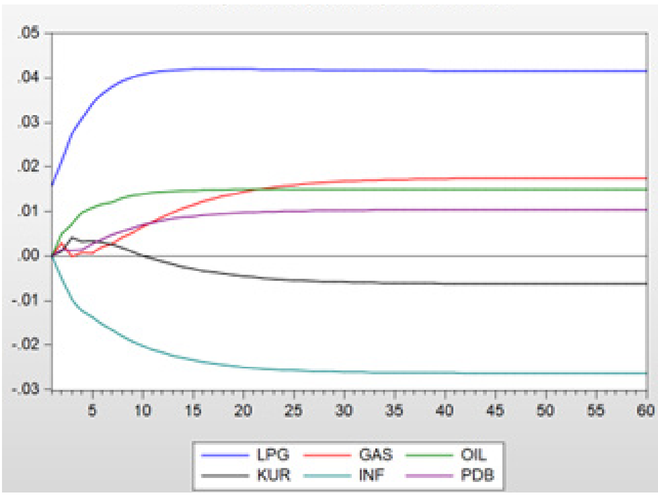
Currency exchange also affects the liquefied petroleum gas insignificantly (0,450). Similarly, liquefied petroleum gas also affects the currency exchange, but it is not significant (0,120). The result is different from the actual condition where the transaction of liquefied petroleum gas using the US Dollar currency. If the liquefied petroleum gas import price in the US Dollar increases, the Indonesian Rupiah also increases. However, this effect can happen when imported liquefied petroleum gas transactions use a futures contract. For example, on 5 March 2021, the Indonesian government signed the purchase contract for buying the liquefied petroleum gas from Abu Dhabi National Oil Company with a value of US$2 billion for four years (Yanwardhana, 2021). Therefore, the Indonesian currency will not significantly impact liquefied petroleum gas import prices within four years.

Gross domestic product also affects liquefied petroleum gas insignificantly (0,856). Then, liquefied petroleum gas also affects gross domestic product insignificantly too (0,924). The empirical data show the relation between gross domestic product and world oil price. Increasing world oil prices will cause a decrease in production. It means decreasing in gross domestic product because most industries use oil as fuel for their production.

The estimation results are expected to show short and long-term relationships between macroeconomic variables. The economic price of liquefied petroleum gas is the dependent variable, while others are independent. The short-term relationship results show six significant variables, including liquefied petroleum gas economic price at lag 1 and 2, world gas price at lag 1, world oil price at lag 2, currency exchange rate at lag 2, and inflation rate at lag 1. The adjustment from short to long-term is -0,0227%. The short-term estimation results show that the economic price of liquefied petroleum gas at lag 1 and 2 has a positive effect of 0,304% and 0,348%, respectively. However, the long-term results show that the global oil gas price has a negative effect of -0,026 at lag 1. Then, world oil price and currency exchange rates at lags 1 and 2 have a positive effect of 0,0505% and 0,299%, respectively. Last, the inflation rate at lag 1 has a negative effect of -0,008 in the short-term relationship.

The four variables in the long-term relationship are world gas prices, currency exchange rates, inflation rates, and gross domestic product. The short-term estimation results showed that world gas prices and currency exchange rates have a negative and positive effect of -0,691% and 1,547%, respectively. Moreover, the inflation rate and gross domestic product positively and negatively affect 0,066% and -1,762% on liquefied petroleum gas economic prices, respectively.

The impulse response function analysis explains shocks' short- and long-term impact on one variable. The impulse response function analysis also determines the duration of the effect on the response. The impulse response function can be depicted as a graph, with the horizontal and vertical axes representing the period in months and the percentage response. Figure 2 shows liquefied petroleum gas's responses to liquefied petroleum gas, world gas price, world oil price, exchange currency, inflation rate, and gross domestic product's shocks. The dynamic effect is seen when the variables are exposed to certain shocks of one standard error in each equation.



Note: GAS : world gas price
LPG : liquefied petroleum gas
OIL : world oil price
KUR : exchange currency rate
INF : inflation rate
PDB : gross domestic product

Figure 2 Response of Liquefied Petroleum Gas to Innovations using Cholesky (d.f. adjusted) Factors

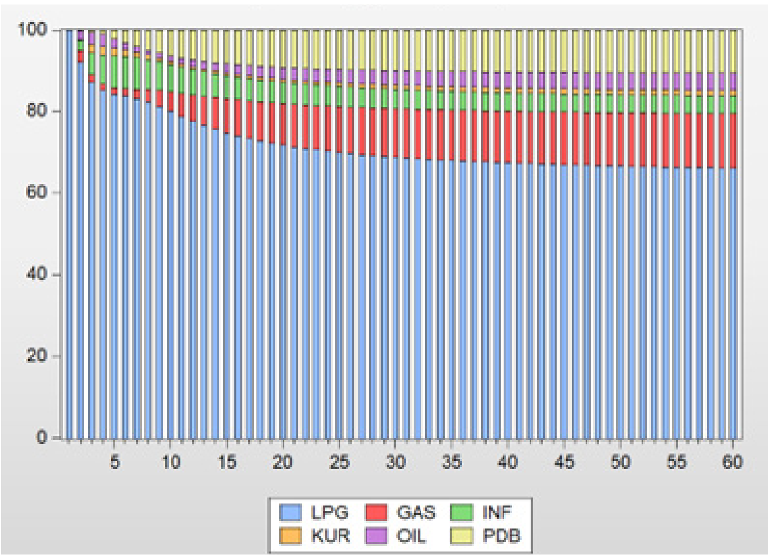
The impulse response function graph depicts the liquefied petroleum gas's responses to the previous shocks. The liquefied petroleum gas begins to respond to the shock positively until the 10th month. Then, it starts moving steadily in the 10th month and remains stable until the 60th month, with a response rate of 0,04%. Until the 5th month, the response of world gas price fluctuates and begins rising with a positive trend until the 25th month. Then, it rises steadily until the 60th month at a response rate of 0,02%. Furthermore, the response of world oil price increases positively until the 10th month. After that, world oil price also moves steadily from the 10th to the 60th month, with a response rate of less than 0,02%.

The response of the exchange currency rate increases with a positive trend until the 5th month, when it begins declining and reaches the horizontal axis in the 10th month. Then, it decreases with a negative trend until the 30th month. The exchange currency rate also steadily decreases until the 60th month at a response rate of -0,05%. Meanwhile, the response to the inflation rate decreases negatively until the 25th month. It remains stable from the 25th to the 60th month, with a response rate of -0,025%. On the other hand, the response of gross domestic product increases positively until the 4th month. Then, it increases positively from the 4th to the 20th month. It rises steadily from the 20th to the 60th month, with a response rate of 0,01%.

The research analyzes the role of each shock in explaining fluctuations in macroeconomic variables using FEVD or variance decomposition analysis. The analysis determines the contribution of variable shocks in the system to changes in certain variables. Figure 3 shows the graph of variance decomposition of liquefied petroleum gas on contribution to liquefied petroleum gas, world gas price, world oil price, exchange currency, inflation rate, and gross domestic product's shocks. The first economic price is determined by the liquefied petroleum gas in the first period, with the other variables not contributing. The role of other variables is seen in the second period, where world gas price, world oil price, exchange currency, inflation rate, and gross domestic product, and liquefied petroleum gas contribute to 1,11%, 3,20%, 0,15%, 3,30%, 0,23%, and 92% to the economical price, respectively.

CONCLUSIONS

The findings indicate that inflation rate influences economic prices of liquefied petroleum gas significantly. Other variables like world gas price, world oil price, exchange currency rate, and gross domestic product have a relationship with the liquefied petroleum gas economic price and vice versa, insignificantly. The liquefied petroleum gas economic price is basically the market price (benchmark price) instead of the subsidy price. The findings contribute to the government's decision when they plan to increase liquefied petroleum gas prices. In actual conditions, world oil price and world gas price affect the liquefied petroleum gas import price because the liquefied



Note: GAS : world gas price
LPG : liquefied petroleum gas
OIL : world oil price
KUR : exchange currency rate
INF : inflation rate
PDB : gross domestic product

Figure 3 Variance Decomposition Graph

petroleum gas product is one of the outputs of oil and gas refineries. Liquefied petroleum gas is mainly imported due to limited domestic natural sources and refinery capacity. Removing the subsidy of liquefied petroleum gas will result in significant inflation as most people use fuel and subsidized liquefied petroleum gas for their basic needs. High inflation will also increase the prices of other products. Therefore, the government should compensate the beneficiaries with a sufficient amount of compensation in the case of subsidy removal.

The research implications are for policymakers to implement the policy related to the subsidy removal of liquefied petroleum gas by providing compensation. Compensation of IDR52.000,00 for poor families per month, IDR155.000,00 per month for micro-entrepreneurship, and IDR206.000,00 per month for poor farmers and fishermen will keep poor people above the poverty line and increase economic activity. Next is the implication for the Indonesian government to look into liquefied petroleum gas substitutes and energy alternatives, such as producing Dimethyl Ether (DME) by utilizing low-carbon natural sources and electric stoves to ensure that the Indonesian government has sufficient energy security. This energy security has become critical as Indonesian liquefied petroleum gas depends on another country.

The research is limited only to five macroeconomic variables (world oil price, world gas price, inflation rate, exchange currency, and gross domestic product), which potentially affect the liquefied petroleum gas economic price. Moreover, the research does not study other factors that may affect the liquefied petroleum gas economics price. Examples are law enforcement, shipment of liquefied petroleum gas, land transportation, storage facilities, and refinery capacity.

The research is essential for future research as the research only considers five macro variables which may affect the liquefied petroleum gas economic price. It is a future research opportunity to have more macro variables studied. Furthermore, the research is part of subsidy energy reform. Therefore, it is a future opportunity to formulate a suitable model for better energy reform as it still does not have an exit strategy.

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