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REVISITING THE INFLATIONARY IMPACT OF FUEL SUBSIDIES: INSIGHTS FROM INDONESIA'S EXPOSURE TO GLOBAL OIL PRICE AND EXCHANGE RATE RISKS

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ABSTRACT

Research Originality — Existing studies on fuel subsidies and inflation largely focus on short-run effects or examine subsidy policies and external factors separately, with limited integration of global oil prices and exchange rates within a long-run framework, particularly in Indonesia. In addition, the transmission mechanisms through which fuel subsidy policies affect inflation remain insufficiently explored. This study addresses these gaps by conducting an integrated analysis of fuel subsidy policies and external macroeconomic pressures in both short- and long-run dynamics, while explicitly distinguishing between fuel subsidy expenditure and subsidized fuel prices as separate policy channels using a VECM approach.
Research Objectives — This study aims to analyze the influence of fuel subsidy policy on inflation and the differences in short-term adjustment dynamics and long-term equilibrium in the domestic price system in Indonesia.
Research Methods — This study utilizes a Vector Error Correction Model (VECM) using monthly data from 2006 to 2024. The study also incorporates various variables related to fuel subsidy allocation, subsidized fuel price, world oil price, rupiah/US dollar exchange rate, and Consumer Price Index (CPI). VECM is a model that can be used to check for long-run cointegration relationships between various variables. It also estimates the speed of adjustment to equilibrium in the short-run. Hence, VECM is an appropriate model for analyzing the dynamic relationship between various factors in determining inflation.
Empirical Results — The results of the present investigation revealed the presence of long-run cointegration among fuel subsidies, global oil prices, exchange rates, and inflation. It was revealed that in the long-run, an increase in world oil prices as well as the depreciation of the exchange rate have a positive impact on inflation. In the short run, it was revealed that an increase in the price of subsidized fuel has a positive impact on inflation. Furthermore, throughout the entire investigation period, it was revealed that inflation has a strong level of persistence.
Implications — The findings indicate the need for gradual fuel subsidy reforms in coordination with fiscal policy and exchange rate stabilization to minimize inflationary pressures and maintain household purchasing power amid global volatility. The study also contributes to the literature on fiscal and energy economics in developing countries by showing that the impact of subsidies needs to be understood within the framework of the dynamic interaction between energy pricing policies, external risks, and macroeconomic stability, rather than just being seen as a partial policy.

Keywords: Exchange Rate; Fiscal Policy; Fuel Subsidy; Global Oil Prices; Inflation

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INTRODUCTION

As a macroeconomic indicator, inflation plays a critical role in the stability of the economy and the welfare of the population. In Indonesia, fuel subsidy policies have been widely used to stabilize the economy and control inflation (Hassani et al., 2018). Fuel subsidies, considering the population and high energy consumption, form a critical part of the Indonesian economic policy to ensure the purchasing power of the population remains stable and away from the impacts of global energy price fluctuations (Badli et al., 2020).

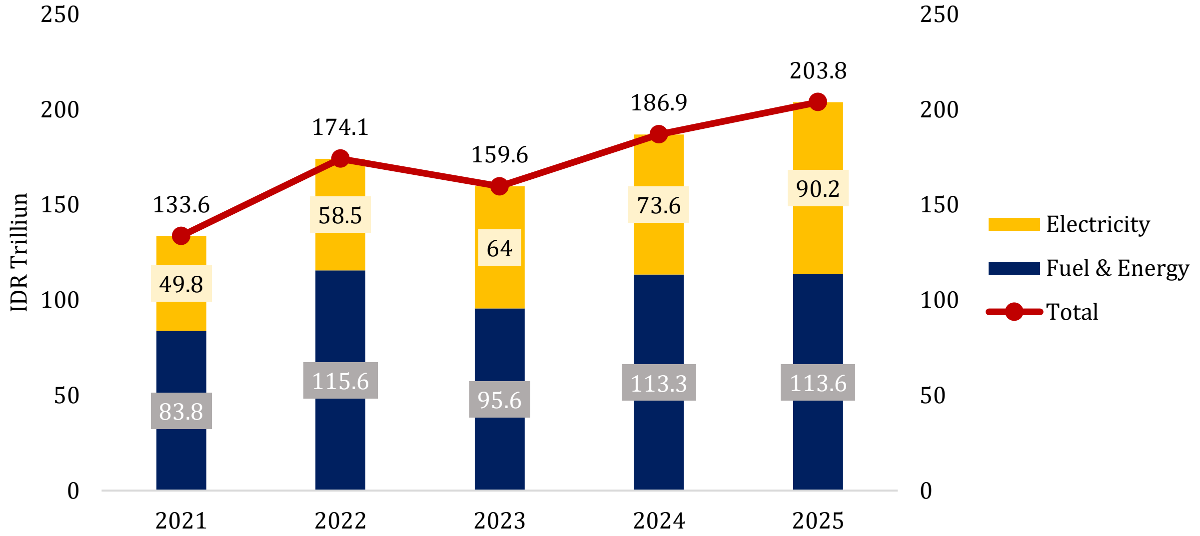
However, the effectiveness of this fuel subsidy policy in maintaining stability in Indonesia's inflation rate remains a contentious issue. On one hand, fuel subsidies help to keep fuel prices stable, and on the other, they have a high fiscal cost and could lead to distortions in the market (Inegbedion et al., 2020; Kofarbai et al., 2024).

Between 2006 and 2024, the Indonesian government introduced various policies on fuel subsidies in response to fluctuations in global oil price movements. The highest fuel subsidy expenditure was in 2022, when the Indonesian government spent Rp 502.4 trillion on fuel subsidies, driven by the increase in world oil price movements, which was caused by the pandemic and geopolitical tensions (Zakeri et al., 2022). Previously, the sharp 65% drop in oil prices during the Russia-Saudi Arabia price war in 2020, followed by a post-pandemic surge in demand from major economies in 2021, demonstrated that the global energy market is highly dynamic and can reverse direction quickly. This evidence suggests that exogenous factors play a major role (Stevens, 2021). Subsequently, there was price volatility, which led to uncertainty among investors and, consequently, a capital outflow. This led to a significant depreciation of the rupiah currency, especially as observed in March 2020, where there was a depreciation of 18% in a single month, leading to an exchange rate of approximately 16,800 Rupiah per dollar. This is evidence of the ineffectiveness of fuel subsidy policies in addressing inflation and supports the argument that exogenous commodity price shocks not only affect fuel prices but also put pressure on exchange rates (Hattantyo et al., 2023).

APPLICATIONS FOR PRACTICE

- The energy pricing policy acts as the major transmission channel for the impact of the macroeconomic shocks on the price stability.
- The fuel subsidies cannot serve as a reliable instrument for price stabilization, given that their effectiveness also is fundamentally shaped by the state of fiscal and external sector conditions.
- Future studies may adopt non-linear modeling frameworks and incorporate monetary policy variables and inflationary expectations to yield a more comprehensive understanding of energy price shocks transmission to inflation rate.

Figure 1 Indonesian Government Subsidies Expenditure 2021-2025 (IDR trillion)



Source: Processed by the authors

Figure 1 shows that fuel and energy subsidies were the dominant structure in Indonesia's energy subsidy structure from 2021 to 2025, with fuel and energy subsidies remaining the largest component in Indonesia's energy subsidy structure. In 2022, subsidy allocation increased due to the rise in crude oil prices in the world market, slightly decreased in 2023, and increased again in 2024 and 2025, reaching a peak of IDR 203.8 trillion in total subsidy allocation. However, despite the fluctuations in subsidy allocation in Indonesia, the fuel subsidy component remained at a high level and was more or less stable, reflecting Indonesia's reliance on fuel subsidies as a major tool in managing domestic price stability.

Theoretically, fuel price hikes will cause cost-push inflation because fuel is a basic input in almost all production and distribution processes in the economy. When fuel prices rise, the cost of transporting goods will increase, and businesses will experience an increase in their marginal and total costs (Macia et al., 2024). Fuel subsidies aim to address market failures and redistribute income. However, a poorly targeted scheme risks misallocation of resources and market inefficiency (Tao et al., 2020). Various empirical studies have yielded varying findings regarding this phenomenon. Several previous studies have been conducted on the impact of energy subsidies on the economy. The study by Akhmad et al. (2023) revealed that increases in prices of domestic fuels, influenced by global oil price factors, strongly impact inflation and poverty levels in a country. Badli et al. (2020) found inefficiencies and price distortions in the fuel subsidy regime in Indonesia. Other studies, such as those by Mundaca (2017) and Yen et al. (2023), found that energy subsidies favor the richer segments of society, potentially exacerbating inequality in a country.

While there has been a significant number of studies on the impact of fuel subsidies on inflation, a number of analyses are limited in that they only consider the short-run impact or fail to include the impact of external factors such as world oil prices and exchange rates in a long-run model. In this study, we investigate the impact of fuel subsidy policies on inflation in the short and long runs, taking into account the impact of external factors such as world oil prices and exchange rates in a long-run model from 2006 to 2024, employing a Vector Error Correction Model (VECM) approach, given its ability to capture the dynamics of the adjustment process toward equilibrium in the long-run model. In addition, the study examines the effectiveness of government expenditure on fuel subsidies and the impact of the prices of subsidized fuels on the Consumer Price Index (CPI) in a country, while at the same time highlighting the impact of external factors on the effectiveness of national subsidy policies in controlling inflation in a country.

Based on identified theoretical, empirical, and knowledge gaps in relation to the subject matter, the objectives of the study can be identified as follows: To empirically examine the short-run and long-run relationship between fuel subsidy policies and inflation in Indonesia. To analyse the transmission mechanism through which fuel subsidy policies influence inflation in Indonesia and its implications for the subsidy burden. To assess how fuel subsidy outlays and other external factors like world oil prices and exchange rates have relative importance in relation to inflation in Indonesia. The novelty and contribution of the study can be identified as follows. The study aims to analyse the process through which fuel subsidy policies influence inflation in Indonesia in terms of direct and indirect effects through world oil prices and exchange rates. The study aims to assess how subsidy allocation and subsidized fuel prices have relative importance in relation to price stabilization in Indonesia.

LITERATURE REVIEW

The purchasing power of households also contributes to price stability in the economy. However, according to Mohammed et al. (2020), the policies of fuel subsidy exhibit "trade-offs," where price stability in the short run is achieved at the expense of long-run resource allocation efficiency. This phenomenon can be seen in the context of cost-push inflation, which is "an increase in the price level of goods in the economy caused by an increase in the cost of production." (Adekunle & Oseni, 2021; Takami, 2015)

This is because fuel is an essential element in the production process of different sectors of the economy, including the transportation industry and the consumer industry. (Zhao & Li, 2019) Hence, the withdrawal of the subsidy policy is likely to lead to an increase in the price of fuel, which in turn may trigger inflation because of the higher cost of production. However, the policy may also lead to fiscal unsustainability because of the growing burden on the government budget, as examined by Khalid (2022).

In the long term, untargeted subsidies can distort economic incentives, create dependency, and limit fiscal room for investments in sectors with higher growth potential, such as education and infrastructure (Sharma & Lomror, 2022). This, in essence, reiterates the point made in the previous paragraphs that, although fuel subsidies can have an inflationary impact in the short term, there is a need to reevaluate the long-run effectiveness of fuel subsidies in stabilizing inflation. Based on the experience of Indonesia, as analyzed in Murjani (2022), fuel subsidy reforms are commonly followed by temporary inflationary surges. However, the magnitude of these inflationary surges depends on the magnitude of subsidy reforms, the types of compensations, and the policies undertaken. With respect to inflationary trends in developing economies, there are signs of inflation being increasingly determined by factors beyond the control of local governments. According to the research undertaken by Ha et al. (2019), inflation is less likely to be determined by local demand and supply shocks; rather, there is a substantial impact from global factors. With respect to global macroeconomic factors, movements in global oil prices and exchange rates are seen as having substantial effects on inflation. According to Sumantri & Fadli (2022), movements in global oil prices have substantial effects on inflation since these directly impact local production through cost-push inflation triggered by sharp increases in the prices of imported goods Nanovsky (2019).

The role of the exchange rate is also evident as a factor that significantly affects this process. For instance, nations like Indonesia that are heavily reliant on imports of capital goods and energy are vulnerable to currency depreciation and its consequent inflationary pressures (Lubis & Karim, 2021). Martyshev et al. (2024)

established that currency depreciation increases local import prices and therefore affects final consumer prices. Such risks can be further increased due to various external factors, such as fluctuations in global capital flows and tightening monetary policy in developed countries, as explained by Ozcelebi et al. (2021). According to Yabu & Kimolo (2020), this kind of global economic dynamic often triggers inflationary pressures that are difficult to control only through conventional policies. For a country like Indonesia, which is still heavily dependent on energy imports and a variety of basic consumer goods, global economic factors are one of the main determinants of domestic inflation expectations. Taylor & Barbosa-Filho (2021) also emphasize the importance of considering global economic factors in analyzing inflation expectations in developing countries such as Indonesia. This argument suggests that domestic price stabilization cannot be effectively achieved without policies that are responsive and adaptive to changing global economic conditions. Numerous studies have also highlighted the complex relationship between fuel subsidies, inflation, and economic well-being in various developing countries. In the Nigerian context, for example, Raifu & Afolabi (2024) used the Dynamic Simulated Autoregressive Distributed Lag (DS-ARDL) model to analyze the heterogeneous impact of fuel subsidy removal on inflation. According to the study, urban and rural areas have differential responses to the degree of fuel price adjustments. In another study on Nigeria, Alexander (2024) has used a Vector Autoregressive (VAR) model to examine the effects of fuel subsidy abolition on inflation. According to the study, there has been an enhanced inflationary impact of domestic fuel prices that persists for about a year. In both studies, it has been highlighted that there needs to be coordination between the government and the central bank to mitigate the effects of inflation (Alexander, 2024; Raifu & Afolabi, 2024). This finding indicates that inflationary pressure is not equally influenced by subsidy policies and is rather subject to local economic structures and capacities for mitigating welfare disruption risks.

In Indonesia, similar concerns have been addressed and analyzed in various research works. Akhmad et al. (2023) showed evidence of increasing fuel prices leading not only to inflation but also to poverty and unemployment. Using a distributed autoregressive lag model, Murjani (2022) showed evidence of significant effects of energy subsidies on domestic prices, both in the short and long term, thus calling for policymakers' attention towards price stability and fiscal sustainability. However, Okorie & Wesseh Jr. (2024) showed evidence of the need for policymakers to design and implement strategic transfer programs targeting firms and households to reduce the effects of subsidy policies, ensuring household welfare is maintained and the government reduces its burden.

In addition to inflationary pressure, Shittu et al. (2024) showed evidence of the effects of energy subsidy policies, along with good governance, leading not only to improved electricity access but also to more favorable economic outcomes. Using institutional quality as a mediating variable, these findings highlight its significance in improving subsidy policies. However, eliminating subsidy policies, especially for liquefied petroleum gas, could lead to a situation where people would opt for traditional sources of energy, thus compromising energy consumption standards and potentially leading to higher greenhouse gas emissions than anticipated, according to Greve & Lay (2023).

METHODS

This study adopts a quantitative research methodology. The research design will be conducted using monthly series data from 2006 to 2024. The research will examine the impact of fuel subsidy allocation and subsidized fuel prices as variables of Indonesia's fuel subsidy policy, together with global oil prices and exchange rates as variables to represent external factors that affect inflation as measured by the Consumer Price Index (CPI). The secondary data used in this research will be obtained from reliable sources, including the Indonesian Ministry of Energy and Mineral Resources, Statistics Indonesia (BPS), and financial market data from Investing Indonesia. The monthly series of data will be used to represent the different phases of fuel subsidy policy changes in Indonesia, fluctuations in the global oil market, and periods of exchange rate volatility. The long-term analysis will be used to create a model that elucidates the effects of external factors and fuel subsidy policy on inflation in the Indonesian economy as a developing economy.

This study uses Vector Autoregression (VAR) modeling as an econometric technique to analyze the dynamic relationships between the macroeconomic variables. In the VAR framework, all variables are treated as endogenous; for example, inflation can be affected by fuel prices; fuel prices can be affected by world oil prices and exchange rates, and so on. This means that the variables in the study are not truly exogenous. This approach also allows for the examination of two-way interactions without requiring explicit classification into dependent or independent variables in a rigid manner, as in other approaches such as simple linear regression, which risks ignoring the existence of two-way relationships. Formally, the unconstrained VAR(p) model in this study is expressed by the equation:

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \epsilon_t \ \dots (1)$$

where Y_t was a (k × 1) vector of endogenous variables at time t, consisting of Fuel Subsidy Expenditure (FSUB), Subsidized Fuel Price (SFP), Global Oil Price (GOP), Exchange Rate (EXC), and Consumer Price Index (CPI); c

was a (k × 1) vector of intercepts; A_i were (k × k) coefficient matrices for lags i = 1 to p; and ϵ_t was a vector of innovations assumed to be white noise.

In view of the non-stationary properties that are often associated with the time series of the macroeconomic variables, the study began with the unit root test with the objective of determining the order of integration of the variables. After establishing the cointegration of the variables, the VECM was applied for the analysis of the interrelationships of the variables. This approach allows for the identification of short-run effects in association with the long-run adjustment mechanism. The VECM model adopted for this study is specified as follows:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \mu + \epsilon_t \; \ldots (2)$$

where ΔY_t represented the vector of first differences; Π denoted the long-run impact matrix, which can be decomposed as $\Pi = \alpha\beta'$, with α representing the speed of adjustment coefficients and β representing the cointegrating vectors), Γ_i were short-run adjustment coefficient matrices capturing lagged differenced effects; μ was a vector of deterministic components (constant or trend); and ϵ_t was a vector of serially uncorrelated residuals.

The empirical analysis of this study follows a series of systematically arranged stages. First, the order of stationarity of the variables is examined by conducting unit root tests to determine the order of integration of the variables. Next, the lag order for the model is chosen by using the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC). After choosing the lag order, the cointegration of the variables is tested using the Johansen trace statistic and the maximum eigenvalue test to identify the long-run relationships between the variables. Once the presence of cointegration is established, a Vector Error Correction Model (VECM) is estimated to capture the short-run behavior of the variables along with the rate of adjustment to equilibrium.

Furthermore, Granger causality tests are performed in the context of the VECM to establish the direction of predictive relationships between the variables. Additionally, this study includes an Impulse Response Function (IRF) to investigate the dynamic response of the Consumer Price Index (CPI) and other macroeconomic variables to shocks in fuel subsidies, world oil prices, and exchange rates. The final part of the study includes the estimation of Variance Decomposition (VD) to quantify the contribution of each of the explanatory variables to the forecast error variance of the CPI for a specified period.

RESULT AND DISCUSSION

As presented in Table 1, the results of the Augmented Dickey-Fuller unit root test indicate that all the major variables under investigation, such as the Consumer Price Index (CPI), fuel subsidy expenditure (FSUB), subsidized fuel prices (SFP), world oil prices (GOP), and exchange rates (EXC), are non-stationary at their levels. However, after subjecting these variables to first differencing, they become stationary. This is supported by the highly negative t-statistic values obtained for each variable, which range from -11.33 to -15.52 and are far beyond the critical values at 1%, 5%, and 10% significance levels. Additionally, the p-values of 0.0000 for each variable confirm that the null hypothesis of a unit root can be rejected at each of these conventional significance levels.

Table 1 Unit Root Test Results for All Variables

Variable	Unit Root	ADF t-Statistics	Prob
FSUB	*First Difference*	-14.96884	0.0000
SFP	*First Difference*	-14.73541	0.0000
GOP	*First Difference*	-11.33484	0.0000
EXC	*First Difference*	-12.48907	0.0000
CPI	*First Difference*	-15.52165	0.0000

Source: Processed by the authors

These results suggest that each of these series is integrated of order one, denoted as I(1). This implies that each of these series possesses a stochastic process in its levels. This is consistent with macroeconomic variables such as inflation, government expenditure, world commodity prices, and foreign exchange rates that are known to experience fluctuations driven by continuous shocks and a dynamic policy regime. The verification of each of these variables as integrated of order one is crucial because it allows for the application of the Johansen cointegration test for assessing the existence of a stable long-run relationship between these variables. The results also support the application of the Vector Error Correction Model because it is most appropriate for cointegrated systems and can account for short-run dynamics as well as long-run equilibrium relationships between variables.

The results of the lag selection criteria are also presented in Table 2 and provide additional insight into the dynamic properties of the model. The results suggest that the optimal lag length is two because it results in the lowest Akaike Information Criterion of 104.1123. Although the Schwarz Criterion and Hannan-Quinn Criterion support a lower lag length of zero for this model, it is desirable to apply the Akaike Information

Criterion in multivariate systems and when analyzing macroeconomic variables because it is able to strike a balance between model parsimony and fit in capturing dynamic relationships between variables.

Table 2 Optimal Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-11416.51	NA	1.37e+39	104.3060	104.3834*	104.3373*
1	-11384.34	62.58891	1.28e+39	104.2405	104.7048	104.4280
2	-11334.30	74.15379	1.13e+39	104.1123*	104.9634	104.4561
3	-11332.18	24.31840	1.26e+39	104.2208	105.4588	104.7208
4	-11316.71	27.97310	1.38e+39	104.3079	105.9328	104.9641
5	-11294.57	39.02804	1.42e+39	104.3339	106.3457	105.1464
6	-11271.73	39.21015	1.45e+39	104.3537	106.7524	105.3242
7	-11242.59	48.69942*	1.41e+39	104.3159	107.1014	1.5.4409
8	-11233.48	14.80612	1.64e+39	104.4610	107.6334	105.7423

Source: Processed by the authors

Additional supporting evidence for the choice of using two lags can be seen in the values contained within the Final Prediction Error (FPE) column, which has a minimum relative value at the second lag specification. While the values are large in magnitude because the variables are scaled in levels, relative values across the different lag specifications show that the specifications are very similar. At the same time, the likelihood ratio (LR) statistic shows that the model adequacy improves with each additional lag, but only up to the second lag, with diminishing marginal gains from the inclusion of the additional lag.

Table 3 VECM Stability Diagnostics (AR Roots)

Root	Modulus
-0.031625 - 0.470768i	0.471829
-0.031625 + 0.470768i	0.471829
0.230043 - 0.363483i	0.430163
0.230043 + 0.363483i	0.430163
0.380145 - 0.172220i	0.417337
0.380145 + 0.172220i	0.417337
-0.273435 - 0.269759i	0.384105
-0.273435 + 0.269759i	0.384105
-0.318966	0.318966
-0.126316	0.126316

Source: Processed by the authors

The stability assessment findings, as highlighted in the results presented in Table 3, reveal that all the characteristic roots of the VECM model are contained in the unit circle. The range of modulus values, from 0.13 to 0.47, is much lower than their unit values. Therefore, it can be concluded that the stability criteria of the model have been met.

From a statistical point of view, this condition indicates that in the event of short-term shocks, the systems under consideration tend to converge progressively towards a long-term equilibrium rather than diverge. The stability of this model is very important, as it supports the validity of the dynamics of the system as described by the model. Therefore, the findings from the analysis of Impulse Response Function (IRF) and Variance Decomposition (VD) can be considered more reliable, since they are derived from stable and well-defined econometric models.

Table 4 Cointegration Test Results

Hypothesized	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.384519	376.1238	69.81889	0.0000
At most 1 *	0.320801	267.4050	47.85613	0.0000
At most 2 *	0.278571	180.7525	29.79707	0.0000
At most 3 *	0.249259	107.6118	15.49471	0.0000
At most 4 *	0.176118	43.39500	3.841465	0.0000

Source: Processed by the authors

The results of the Johansen cointegration test, as revealed in Table 4, show that the trace statistics of all the test hypotheses far exceed the corresponding 5% critical values. The constant observed value of 0.0000 for the test, therefore, confirms the rejection of the null hypothesis of no cointegration up to the “at most 4” hypothesis, thus implying the presence of up to five cointegration relationships among the variables of the study. The results, therefore, affirm the presence of a strong long-run equilibrium relationship among fuel subsidy expenditure, subsidized fuel prices, world oil prices, exchange rates, and the Consumer Price Index (CPI) in Indonesia.

In parallel, the results of the Granger causality test, as revealed in Table 5, show the presence of significant short-run causality among some of the variables of the model. Notably, the test revealed that subsidized fuel prices (SFP) Granger Cause CPI at the 1% significance level, as the value of the test statistic equals 0.0013. The implication of the finding is that the government can forecast the movement of inflation in the country in the short run by observing the fluctuations in the prices of fuel that it subsidizes. The test also revealed that CPI Granger Causes world oil prices (GOP) as the value of the test statistics equals 0.0162, thus implying the potential of the CPI to forecast the movement of world oil prices in the short run, possibly through the feedback of the demand side into the world market. However, the test failed to reveal the presence of causation from fuel subsidy expenditure (FSUB), GOP, and EXC to CPI in the short run, as well as from CPI to FSUB and EXC in the same time frame.

Table 5 Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.
FSUB does not Granger Cause CPI	226	0.01801	0.9222
CPI does not Granger Cause FSUB	226	2.24504	0.1083
SFP does not Granger Cause CPI	226	6.84208	0.0013
CPI does not Granger Cause SFP	226	0.01479	0.9853
WOP does not Granger Cause CPI	226	2.15993	0.1178
CPI does not Granger Cause WOP	226	4.19753	0.0162
EXC does not Granger Cause CPI	226	1.90665	0.1510
CPI does not Granger Cause EXC	226	0.26544	0.7671
SFP does not Granger Cause FSUB	226	10.1799	6.E-05
FSUB does not Granger Cause SFP	226	0.33321	0.7170
WOP does not Granger Cause FSUB	226	12.0420	1.E-05
FSUB does not Granger Cause WOP	226	0.58434	0.5583
EXC does not Granger Cause FSUB	226	6.18258	0.0024
FSUB does not Granger Cause EXC	226	2.70703	0.0689
WOP does not Granger Cause SFP	226	1.92187	0.1488
SFP does not Granger Cause WOP	226	3.80847	0.0237
EXC does not Granger Cause SFP	226	1.90302	0.1516
SFP does not Granger Cause EXC	226	5.14915	0.0065
EXC does not Granger Cause WOP	226	1.86913	0.1567
WOP does not Granger Cause EXC	226	2.1295	0.1360

Source: Processed by the authors

Apart from its direct impact on inflation, the results indicate that SFP Granger has a strong Granger causality relationship with FSUB ($p < 0.0001$), suggesting that changes in subsidized fuel prices have a close relationship with the amount of fiscal subsidy expenditure. The Granger causality relationship from GOP to FSUB is also highly significant ($p < 0.0001$), with EXC Granger-causing FSUB ($p = 0.0024$), thus reiterating that fluctuations in oil prices as well as changes in the exchange rate contribute to changes in Indonesia's subsidy spending.

Moreover, Table 5 shows that subsidized fuel prices (SFP) have Granger causality relationships with inflation (CPI) as well as exchange rates (EXC), as indicated by the results of the Granger causality test. The results show that subsidized fuel prices (SFP) have statistically significant p-values. This suggests that fluctuations in domestic prices as well as changes in exchange rates can be used to forecast changes in government-regulated fuel prices. The results of the Granger causality test indicate that there is a nuanced relationship between international factors and domestic prices in the short run. The results of the vector error correction model (VECM) estimate in Table 6 show that there are both long-run and short-run relationships between fuel subsidy expenditures (FSUB), subsidized fuel prices (SFP), global oil prices (GOP), exchange rates (EXC), and inflation (CPI). In particular, the error correction term in the equation for inflation (CPI) in Table 6 is negative and statistically significant at -0.71. This suggests that inflation acts as the primary adjustment mechanism in the system if there is a divergence from the long-run equilibrium. In essence, changes in global oil prices as well as exchange rates cause disequilibrium in the system. In the short run, prices adjust to bring the system to equilibrium. In the long run, inflation tends to converge to its equilibrium. The results thus show that Indonesia's inflation dynamics respond to changes in international factors as well as domestic prices.

In the short run, the estimates provided in Table 6 point to several key transmission channels. For instance, changes in subsidized fuel prices (SFP) have a direct and statistically significant impact on both consumer prices (CPI) and fuel subsidy expenditure (FSUB). Conversely, inflation has strong short-run persistence properties and plays a significant role in driving the paths of global oil prices (GOP) as well as the exchange rate (EXC). In this regard, there is evidence of a two-way transmission process in which the evolution of domestic prices can have an impact on external sector variables, most plausibly via inflationary expectations. The sensitivity of the exchange rate to lagged inflation as well as oil prices further points to a close relationship between domestic price stability and external sector developments. A closer inspection of the results points to the fact that Indonesia's vulnerability to global oil prices results not only from its external sector links but also from the interaction between its fuel prices, subsidy policies, as well as exchange rate pressures. In this context, as international oil prices go up, the government will need to raise resources to sustain its subsidized fuel prices. The additional pressure on the government's finances has the potential to create macro-fiscal instability as well as to spur exchange rate depreciation.

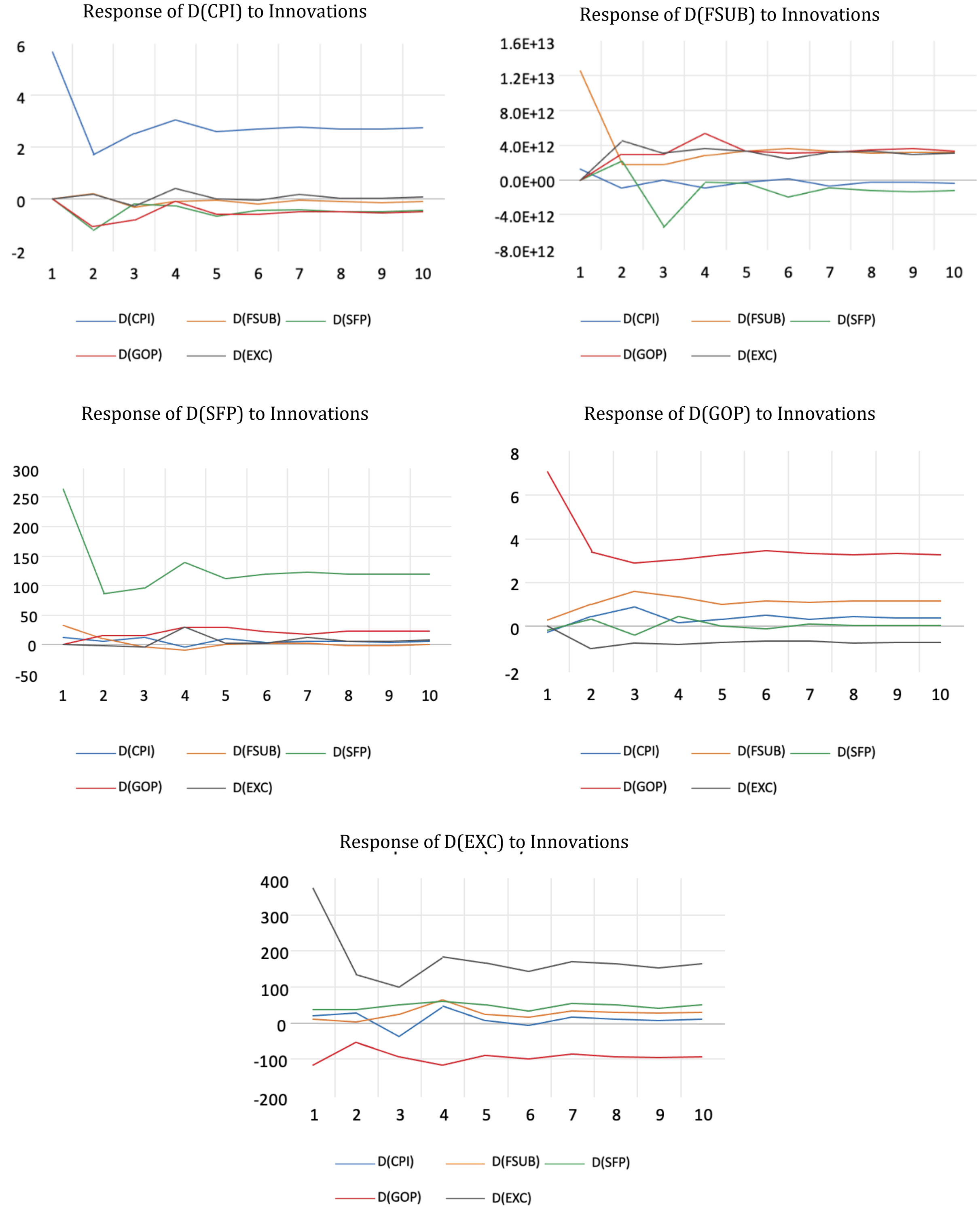
Table 6 VECM Estimation Results

Cointegrating Eqα	CoinEq1				
D(CPI(-1))	1.000000				
	2.08E-12				
D(FSUB(-1))	(2.7E-13)				
	[7.84911]				
	0.052740				
D(SFP(-1))	(0.01603)				
	[3.29058]				
	-3.987679				
D(WOP(-1))	(0.49707)				
	[-8.02245]				
	-0.059413				
D(EXC(-1))	(0.01223)				
	[-4.85968]				
C	1.814206				
Error Correction:	D(CPI,2)	D(FSUB,2)	D(SFP,2)	D(WOP,2)	D(EXC,2)
	0.002949	-3.44E+11	-1.748496	0.081528	3.091527
CoinEq1	(0.01647)	(3.6E+10)	(0.77085)	(0.02045)	(1.13701)
	[0.17912]	[-9.46832]	[-2.26827]	[3.98648]	[2.71900]
	-0.705864	1.13E+11	2.210544	0.012747	0.107707
D(CPI(-1),2)	(0.06719)	(1.5E+11)	(3.14540)	(0.08345)	(4.63949)
	[-10.5060]	[0.76172]	[0.70279]	[0.15275]	[0.02322]
	-0.330123	8.95E+10	3.287768	0.123785	-10.37097
D(CPI(-2),2)	(0.06343)	(1.4E+11)	(2.96961)	(0.07879)	(4.38020)
	[-5.20436]	[0.63910]	[1.10714]	[1.57116]	[-2.36769]
	2.38E-14	-0.190890	3.40E-12	-1.01E-13	-6.64E-12
D(FSUB(-1),2)	(3.0E-14)	(0.06659)	(1.4E-12)	(3.7E-14)	(2.1E-12)
	[0.78795]	[-2.86665]	[2.40916]	[-2.70419]	[-3.18964]
	-8.09E-16	-0.064132	1.94E-12	-1.64E-14	-5.06E-12
D(FSUB(-2),2)	(2.5E-14)	(0.05410)	(1.1E-12)	(3.08E-14)	(1.7E-12)
	[-0.03302]	[-1.18541]	[1.68951]	[-0.53779]	[-2.98993]
	-0.004971	2.45E+10	-0.577825	-0.002306	-0.069287
D(SFP(-1),2)	(0.00159)	(3.5E+09)	(0.07444)	(0.00198)	(0.10980)
	[-3.12603]	[6.96674]	[-7.76204]	[-1.16748]	[-0.63101]
	-0.002621	-3.58E+09	-0.316030	-0.04381	0.02873
D(SFP(-2),2)	(0.00166)	(3.7E+09)	(0.07781)	(0.00206)	(0.11477)
	[-1.57700]	[-0.97642]	[-4.06149]	[-2.12231]	[0.25035]
	-0.135778	-7.75E+11	-4.946906	-0.239914	10.91137
D(WOP(-1),2)	(0.07038)	(1.6E+11)	(3.29510)	(0.08742)	(4.86029)
	[-1.92909]	[-4.98659]	[-1.50129]	[-2.74435]	[2.24501]
	-0.165922	-5.83E+11	-4.356669	-0.089823	3.938051
D(WOP(-2),2)	(0.05827)	(1.3E+11)	(2.72799)	(0.07238)	(4.02381)
	[-2.84743]	[-4.52818]	[-1.59702]	[-1.24107]	[0.97869]
	0.000610	-8.45E+09	-0.108412	0.002156	-0.459135
D(EXC(-1),2)	(0.00118)	(2.6E+09)	(0.05526)	(0.00147)	(0.08151)
	[0.516471]	[-3.24112]	[-1.96184]	[1.47059)	[-5.63291]
	-0.001274	-4.02E+09	-0.111540	0.01365	-0.317509
D(EXC(-2),2)	(0.00099)	(2.2E+09)	(0.04627)	(0.00123)	(0.06825)
	[-1.28885]	[-1.84183]	[-2.41062]	[1.11234]	[-4.65221]
	0.005951	1.87E+10	0.485927	-0.028576	4.142449
C	(0.37972)	(8.4E+11)	(17.7769)	(0.47163)	(26.2210)
	[0.01567]	[0.02232]	[0.02733]	[-0.06059]	[0.15798]

Source: Processed by the authors

When the Rupiah (IDR) depreciates, fuel import costs expressed in domestic currency go up. In this context, there will be a higher demand for subsidy expenditures as well as higher risks of inflation. In this regard, external shocks as well as domestic policy interactions can create a feedback loop that can sustain macro-fiscal instability as well as inflationary pressures. Similar results have been observed in other developing economies in which import inflation driven by exchange rate pressures as well as fuel prices can create additional pressures on government finances as well as inflationary risks (Ait, 2025; Aly, 2025; Ye et al., 2023).

Figure 2 Impulse Response Functions (IRFs) of Macroeconomic Variables to Structural Shocks
Response to Cholesky One S.D. (d.f. adjusted) Innovations



Source: Processed by the authors

A more comprehensive policy framework is therefore necessary. For example, the gradual alignment of subsidized fuel prices with global market conditions is expected to minimize the impact of adjustment shocks in the future. Simultaneously, better coordination with monetary policy and measures to stabilize the exchange rate is necessary to offset the impact of global commodity price shocks on inflation in the economy. Without this coordination, fuel price interventions may not stabilize inflation and may merely delay the pressures to a later period. The findings of this study support the adoption of an integrated macroeconomic framework in which fuel pricing policy, risk management in the fiscal policy sphere, and exchange rate stabilization interact synergistically to sustain inflation control and long-term sustainability in the context of fiscal policy.

The impulse response function (IRF) shown in Figure 2 represents the dynamic transmission of structural shocks between Indonesia's macroeconomic variables over ten different periods. The IRF of inflation (ΔCPI) clearly shows that inflation shocks stemming from the CPI have a sustained positive impact, which is indicative of high inflation persistence. The IRF of subsidized fuel price shocks (ΔSFP) also shows a significant direct impact on CPI, though this diminishes after the third period and is indicative of a relatively short-term transmission of government policy changes on consumer prices. Finally, the IRF of global oil price shocks (ΔGOP) suggests a limited direct transmission of such shocks on inflation and CPI, which could be indicative of a relatively small direct impact of international commodity price volatility on domestic inflation and possibly being absorbed via auxiliary mechanisms such as the exchange rate and fiscal buffers.

In addition, based on the fiscal aspect, as presented in the IRF graph in Figure 2, the fuel subsidy expenditure (ΔFSUB) is significantly affected by the shocks in subsidized fuel prices (SFP) and global oil prices (GOP). This is because Indonesia is structurally vulnerable to external price movements and policy responses. Moreover, it is interesting to note that an increase in ΔSFP directly and significantly affects ΔFSUB, which reflects the burden on the Indonesian government in maintaining subsidized fuel prices.

The exchange rate (ΔEXC) is significantly and substantially affected by the shocks in the CPI and global oil prices (GOP) in the medium term, which reflects that inflationary pressures and global oil prices increase the risks of currency depreciation in Indonesia. In addition, the reaction of the exchange rate to its own shocks is persistent, suggesting that once currency volatility is experienced, it will persist and may increase macroeconomic uncertainty in Indonesia. As suggested by the dynamic processes observed in the IRF, the results not only indicate the presence of statistically significant relationships but also suggest the processes through which subsidy policy interacts with external conditions. Thus, the complex relationship between subsidies, global prices, and inflation can be understood as the result of these interacting processes, which operate through multiple transmission channels. Fuel subsidies are used as a policy tool to offset the effects of increases in global oil prices on inflation. However, as suggested in Figure 2, these effects are conditional on the behavior of other macroeconomic variables, including external conditions.

Increases in global oil prices expose the government to risks of increases in domestic fuel prices, which can be offset through increases in subsidy expenditure. However, increases in subsidy expenditure, especially if sustained, can have adverse effects on macroeconomic stability, including the exchange rate. Thus, when the exchange rate depreciates, the effects of increases in global oil prices on inflation are magnified. With the exchange rate depreciating, the cost of maintaining fuel subsidies increases, as the government must maintain the price differential between international and domestic markets.

This bidirectional process, therefore, suggests that the role of fuel subsidies extends beyond the temporary moderation of the rate of inflation to the manner in which external shocks, such as increases in the price of oil or currency depreciation, are transmitted to the domestic economy. This, in turn, may ultimately lead to feedback effects on the sustainability of the subsidy system itself, such as the lagged response to the moderation of the rate of inflation, which may result in a more pronounced rate of price increases, or the strong exchange rate response to external shocks, which may negate the effectiveness of the subsidies by increasing the rupiah price of imported oil products. In this context, the reciprocal nature of the process becomes obvious, with subsidies impacting the rate of inflation, and the rate of inflation, along with exchange rate fluctuations, impacting the magnitude of the subsidies that are needed to maintain price stability within the domestic economy.

Fuel subsidies, global oil prices, and exchange rate fluctuations are key determinants of inflation performance and are linked through a series of complex and interdependent transmission channels (Vadlamannati et al., 2024; Zhang et al., 2022). These relationships underscore that subsidies cannot be understood in terms of their immediate and direct impacts on inflation; rather, they must be understood in terms of a much wider macro-fiscal framework in which external shocks, subsidies, exchange rate fluctuations, and inflation are constantly and cumulatively interacting and impacting each other. These interactions are not limited to domestic macroeconomic variables and shocks but also involve external variables and shocks.

The results of variance decomposition, as shown in Table 7, clearly demonstrate the contribution of each of these variables to changes in inflation performance over ten different periods. In the very short term, in period 1, inflation is entirely driven by its own shocks and therefore contributes 100% of its forecast error variance, which is a classic innovation effect without contemporaneous impacts of any of the other variables on inflation performance. However, as we move into period 2, we see the impacts of external and policy variables on inflation performance. By period 3, shocks in global oil prices explain 4.1% of changes in inflation performance in Indonesia; changes in subsidized fuel prices explain 3.4%; and changes in the exchange rate explain 0.3%. These relationships remain relatively consistent throughout the ten periods and underscore that while inflation performance is largely driven by its own shocks and performance, external shocks on global oil prices and changes in subsidized fuel prices also remain relevant and important determinants of inflation performance in Indonesia.

Table 7 Variance Decomposition Results

Variance Decomposition od D(CPI):						
Period	S.E.	D(CPI)	D(FSUB)	D(SFP)	D(WOP)	D(EXC)
1	5.682799	100.0000	0.000000	0.000000	0.000000	0.000000
2	6.165016	92.73813	0.086598	3.981473	3.124965	0.068834
3	6.722157	91.82194	0.335578	3.441089	4.136230	0.265166
4	7.498141	92.77378	0.292020	3.003140	3.443438	0.487353
5	7.891938	92.32435	0.268331	3.361022	3.616211	0.430090
6	8.369751	92.33536	0.284828	3.284380	3.709486	0.385945
7	8.840426	92.56386	0.259066	3.152495	3.655262	0.369315
8	9.271602	92.61156	0.254114	3.148949	3.649044	0.336336
9	9.685715	92.62456	0.252015	3.150302	3.664674	0.308445
10	10.08621	92.71541	0.242540	3.102740	3.649460	0.289847

Source: Processed by the authors

In terms of the ten-period window, the intrinsic process dominates the inflationary process, with the inflation shocks (CPI) dominating the forecast error variance by more than 91%. This suggests that the process exhibits a high degree of persistence in the inflationary series. At the same time, the role of the global oil prices (GOP) and the subsidized fuel price adjustments (SFP) has been significant, though less so, with the exchange rate (EXC) playing a less significant role. The overall message from the above findings is that the external energy shocks and the subsidized fuel price adjustments, though important, are not the dominant factors in the Indonesian inflation process, with the fluctuations in the fuel subsidy expenditures (FSUB) playing a relatively minor role in the overall inflation process, thus suggesting that the subsidies play an important role in the overall macroeconomic environment but not directly in the inflation process. The overall message from the above findings is that the Indonesian inflation process is largely self-sustaining but is vulnerable to developments in the global oil market and adjustments in subsidized fuel prices.

Based on the results of variance decomposition presented in Table 7, it is also possible to assess the effectiveness of fuel subsidies from a wider macroeconomic perspective. Theoretically, subsidies should help mitigate the impact of external shocks on inflation and support macroeconomic price stability. However, as shown in the results, this potential is relatively small. The share of expenditures on fuel subsidies in CPI variance is small, and therefore such expenditures cannot significantly stabilize the impact of global oil price shocks and changes in administered fuel prices on domestic inflation. On the contrary, inflation is mainly driven by its own persistence and external cost pressures. From this point of view, fuel subsidies are only a limited and indirect tool of macroeconomic support and cannot be considered as a tool for ensuring sustainable price stability on its own. This is because it is necessary to complement it with better fiscal discipline, a more adequate and transparent approach to fuel pricing, and a more effective approach to managing the exchange rate to mitigate external pressures and sustain long-term inflation control.

CONCLUSION

This study shows that the fuel subsidy system of Indonesia is linked to the inflation process and this linkage occurs both through the equilibrium adjustment mechanisms and the price adjustment mechanisms. The findings from the VECM also show that the domestic inflation rate acts as the major adjustment variable to correct the deviations caused by the global oil price shocks and the changes in subsidized fuel prices. At the same time, the changes in the subsidized fuel prices have a quick impact on the inflation rate and, at the same time, impact the fiscal burden of the fuel subsidies. Therefore, the energy pricing policy acts as the major transmission channel for the impact of macroeconomic shocks on price stability.

However, the variance decomposition results also show that the impact of the fuel subsidies on the inflation rate is not as significant as the impact of the inflation persistence, the impact of the global oil prices and the exchange rate changes. Therefore, the fuel subsidies cannot be used as a tool for stabilizing the prices and the effectiveness of the fuel subsidies also depends on the fiscal and external sector conditions.

This study also acknowledges the following limitations of the current study. The linear VECM model used for the current study does not consider the non-linear relationships between the variables. The current study also does not include the monetary policy variables as the system of the equation used for the current study does not include these variables. Therefore, the future studies can be based on the non-linear models and include the monetary policy variables and the inflationary expectations to have a better understanding of the impact of energy price shocks on the inflation rate.

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