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How Do Global Energy and Food Prices and Exchange Rates Affect Inflation? An Application of a Nonlinear Autoregressive Distributed Lag Model for Indonesia

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ABSTRACT. This study aims to investigate the asymmetric effects of changes in international prices of energy and food and the monetary variables, including exchange rates and policy interest rates, on consumer price index (CPI) inflation in Indonesia. This study employs the Nonlinear Autoregressive Distributed Lag (NARDL) model for the period July 2005 to December 2023. The findings indicate that increases in global food prices led to a significant rise in the Consumer Price Index (CPI), indicating inflation. The study also provides empirical evidence of the asymmetric effect of changes in international food prices on the CPI. The exchange rate emerged as the variable with the most influence on inflation, with the depreciation and appreciation of the local currency. Lessons from these findings, in implementing monetary policy, authorities need to focus on inflation originating from supply shocks, which are influenced by changes in global energy and food prices and exchange rates.

1. Introduction

Along with increasingly dynamic global economic development, the issue of the relationship between inflation and external factors is increasingly receiving attention from academics and policymakers. Countries adopting inflation targeting cannot be separated from external factors influencing inflation [1]. Consequently, in evaluating monetary policy that has been carried out, the role of external factors that affect inflation must be kept from the attention of policymakers. Policymakers' actions still play a vital role in domestic inflation dynamics in today's economic globalization [2].

Inflation in a country's economy has broad implications, including banking performance, capital markets, taxation, household consumption, poverty, investment, and economic growth.

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Several studies reveal how inflation affects banking performance [3, 4], meanwhile, how inflation impacts the stock market, for example in studies by Chiang and Chen [5] and Sia et al. [6]. Inflation also affects tax revenues, including household consumption, as shown in the study conducted by Yossinomita et al. [7] and Batrancea [8]. The impact of inflation on poverty, for example, was studied in a study conducted by Meo et al. [9], and on investment, for instance, in the study by Asab and Al-Tarawneh [10]. Inflation also influences economic growth, as in the study by Ezako [11].

As a country with a small open economy, Indonesia has implemented an inflation-targeting framework in its monetary policy to stabilize inflation. The implementation of inflation targeting began in July 2005. The beginning of the inflation targeting period was officially marked by high inflation and exceeding the target inflation due to rising fuel oil prices in 2005 due to rising world oil prices. Inflation in 2005 was 17.11 percent, while the targeted inflation was 8±1 percent. There is a large gap between actual inflation and target inflation. Due to the high increase in inflation in 2005, the inflation targeted for 2006 was adjusted upwards from 6 to 8 percent. However, since 2008, the surge in global food prices, which exceeded the increase in crude oil prices, has also triggered domestic inflation. In 2013-2014, inflation increased with the surge in world food prices. Subsequently, there was a downward trend in inflation until the COVID-19 pandemic in 2021. In 2022, inflation will increase due to increased global commodity prices.

The increase and decrease in global crude oil and food prices during 2005 – 2023 correlate with the growth and decline in inflation. To stabilize inflation, the central bank implemented a policy interest rate that, before August 2016, used the BI rate and afterward used BI7DRR. During the period 2005 – 2023, changes in policy interest rates responded to inflationary movements that occurred. The downward trend in inflation is responded to by policy interest rates, which tend to fall before 2022. In 2022, interest rates will increase in line with rising domestic inflation due to rising global commodity prices and adjusting to the FED interest rate due to inflation in the United States, which tends to be high.

External factors that cause inflation originate from sources outside a country's economy, with import prices being a key driver. Notably, the empirical findings of previous studies [12-15] underscore the pivotal role of exchange rates and global commodity price fluctuations in driving domestic inflation. These studies, renowned for their rigorous methodologies and robust results, form the cornerstone of our review.

Many studies have been carried out regarding the importance of external factors from various factors. The exchange rate is one of the main variables that significantly influences the economy. Regarding a country's economy, besides the exchange rate influencing economic growth according to the previous studies [16-18], the exchange rate also affects inflation according to the other studies [19-22], and especially in studies of inflation-targeting economies

[23-24]. However, from previous studies, the analysis of the influence of global commodity prices and exchange rates combined with monetary variables is generally still limited to symmetric and asymmetric effects. Still, it partially focuses on one particular variable analyzed in the model. Likewise, the inflation variable analyzed is the consumer price index and its changes, which measure inflation. Studies on this matter have yet to be linked to inflation targeting, which focuses on stabilizing inflation by referring to targeted inflation.

This research proposes a dynamic research model with the development of the Autoregressive Distributed Lag (ARDL) model to analyze the asymmetric influence of global commodity prices on CPI, including energy and food prices involving exchange rates and monetary variables involving policy interest rates. Domestic inflation is proxied by the changes in CPI. The increase and decrease in CPI, which means inflation and deflation in the inflation targeting period, have indications of relative stability in the situation of changes in global energy and food prices and exchange rate dynamics with the response of monetary policy through policy interest rates. Inflation targeting aims for relatively stable inflation even though it is affected by changes in international energy and food prices and exchange rate dynamics. This analysis can provide empirical and policy contributions to implementing inflation-targeting policies, a central issue in current monetary policy practice.

2. Literature Review

2.1. Global Energy and Food Prices on Inflation

In implementing inflation targeting, the monetary authority seeks to control inflation towards the targeted inflation. Global economic conditions, characterized by dynamic movements in world commodity prices, are challenging to control domestic inflation. Filardo et al. [25] stress the importance of changes in commodity prices in shaping monetary policy. Therefore, the dynamics of world commodity prices play a significant role in price stabilization and the achievement of targeted inflation.

The increase in world commodity prices is the cause of the spike in inflation, which is increasingly evident today. Rizvi and Sahminan [26] stated that global energy prices impact domestic inflation in Brazil, Russia, India, Indonesia, China, and South Africa (BRICS). Rising oil prices and overall energy prices drive inflation in the countries. Sek [27] provides evidence that energy prices represented by oil prices have an asymmetric effect on inflation through increases in consumer, producer, and industrial prices. The rise in inflation through the transportation CPI was very significant due to the increase in oil prices.

Sarmah & Bal [28] and Moussa et al. [29] have also empirically proven the asymmetric influence of oil prices on inflation. The existence of an effective monetary policy that allows the asymmetric impact of rising oil prices increases price rigidity in the economy [30]. Price changes

also impact inflation and include crude oil, natural gas, and coal. As Zhang et al. [31] and Binder [32] empirically prove, rising natural gas prices encourage inflation. Meanwhile, Guo et al. [33] provide empirical evidence that coal prices have an asymmetric positive effect on CPI inflation.

Besides world energy prices, food prices are another main factor influencing inflation through pass-through to import prices and CPI inflation. Discussions of previous empirical findings confirm that rising global food prices drive inflation in a country. Empirical results of cross-country studies [34] show that rising world food inflation increases domestic inflation in developed and developing countries. The effect of the rise in world food inflation is more significant in developing countries than in developed countries. A study conducted by Rizvi and Sahminan [26] shows that the increase in world food prices impacts increasing inflation in Indonesia and India. Likewise, Samal et al. [35] empirically prove that world food price changes positively affect inflation.

According to Adolfson [36], changes in domestic prices are influenced by the prices of imported intermediate goods, which determine marginal costs in production, and the prices of imported finished goods, which are passed through to domestic prices. International energy and food prices specified in the world market and denominated in US dollars will influence domestic prices. According to Carriere-Swallow et al. [37], crude oil and food are internationally traded commodities whose price changes will affect domestic prices.

2.2. Exchange Rate, Interest Rate, and Inflation

In literature studies, the exchange rate is not only positioned as an endogenous variable, as in the study by Supriyanto et al. [38], but also plays a role as an exogenous variable. The influence between the exchange rate and monetary policy on inflation in the literature review has confirmed a theoretical relationship that can be tested in previous empirical studies [15, 27, 39]. provide evidence that the exchange rate is the main factor most significantly affects domestic inflation. How changes in exchange rates affect domestic consumer prices is measured through the exchange rate pass-through. The asymmetric effect of the exchange rate can mean asymmetric exchange rate pass-through, as in recent studies [40-42]. Also, changes in exchange rates affect import prices in sectors that require imported production inputs in the production process. The explanation of the model is based on microeconomic foundations, according to Adolfson [36], which states that changes in import prices, which impact domestic prices, are influenced by exchange rate pass-through. In the short run, Sharma and Dahiya [43] prove that there is a relationship between inflation and the exchange rate. Monfared and Akin [44] also found empirical evidence that the exchange rate significantly increases inflation. Similarly, Omolade et al. [45] and Ugwu et al. [46] provide research results showing that the exchange rate substantially impacts inflation. Lamia & Djelassi [23] state that implementing inflation targeting in monetary policy stabilizes inflation, exchange rate volatility, and exchange rate pass-through. Exchange

rate movements also influence the monetary policy stance in the inflation-targeting period, as stated by Özdemir [47]. Empirically, inflation targeting reduces exchange rate volatility [48].

In inflation modeling, a study by Chen et al. [49] involves monetary variables of interest rates. Based on their empirical findings, interest rates hurt inflation. An increase in interest rates reduces inflation and vice versa. The significant relationship between policy interest rates and inflation makes interest rates efficient in controlling inflation through monetary policy [50]. According to Kim and Chen [51], an interest rate-based monetary policy framework is more effective than a quantity-based monetary policy framework. The increasing importance of interest rates as a monetary policy instrument is in line with the shift in monetary policy rules from those that focus on monetary aggregates, usually the money supply, to those that focus on interest rates. According to Taylor [52], since velocity is more volatile, interest rate has become more reliable as an instrument in monetary policy, especially in low inflation rates.

Monetary policy aims to stabilize inflation by targeting it to always lead to target inflation. The impact of implementing inflation targeting empirically shows low and stable price levels [1]. However, if monetary policy is solely aimed at controlling the effect of increasing energy prices, which drives inflation, then monetary policy could be counterproductive, although monetary policy tightening significantly controls inflation [53].

3. Methodology

3.1. Variable and Data

The model we have developed places the CPI as the central focus of our research, as it serves as the dependent variable. On the other hand, the independent variables encompass energy prices, food prices, exchange rates, and a monetary policy variable. This monetary policy variable is represented by the policy interest rate, a key instrument in controlling inflation. Hence, our research model incorporates the policy interest rate as a control variable, underscoring its importance in our study.

The CPI analyzed in this model is the general CPI, a composite of all expenditure groups for commodities by households in Indonesia with a base year of 2012. The CPI is expressed in natural logarithms in the model, whose changes indicate inflation. Energy prices, abbreviated to EP, are in the index, weighing 84.6 percent for crude oil, 10.8 percent for natural gas, and 4.6 percent for coal. The energy price index is a monthly index based on nominal US dollars, 2010=100. Data were analyzed in natural logarithms (ln). In the index, food prices, abbreviated to FP, are weighted at 28.25 percent for cereals, 40.75 percent for oils and meals, and 31 percent for other foods. Other foods include sugar, bananas, beef, chicken, and oranges. The monthly food price index is based on nominal US dollars, 2010=100. Data were analyzed in natural logarithms (ln). The exchange rate, abbreviated to ER, is measured in IDR/USD. Data were analyzed in

natural logarithms (ln). Finally, the policy interest rate, abbreviated to PR, is represented by the BI rate and has been effective since August 2016, changing to the BI-7 Day Reverse Repo Rate (BI7DRR). The unit is percent.

The period we have chosen for our research is significant, as it spans the implementation of inflation targeting in Indonesia. This period, officially starting from July 2005 and extending to December 2023, allows us to model the changes in global commodity prices that influence inflation, along with monetary variables such as the exchange and policy interest rates. To ensure the accuracy and reliability of our data, we accessed information, including the CPI, exchange rate, money supply, and policy interest rate, from online sources provided by Bank Indonesia. Energy and food prices, crucial components of our analysis, were accessed from the World Bank website.

3.2. Model

The model in this research consists of the Nonlinear Autoregressive Distributed Lag (NARDL) models in the long-run and short-run form. The model was applied to the NARDL model developed by Shin et al. [54]. The model is designed to analyze the influence of global energy and food prices, exchange rates, and policy interest rates on the CPI in logarithms. The monetary policy variable is proxied by the policy interest rate. The qualitative approach to monetary policy in the inflation-targeting period is emphasized by involving the policy interest rate in the model rather than the money supply as a monetary variable.

The dependent variable in this model is the CPI in the natural logarithm, whose changes mean inflation/deflation. An increase in CPI in logarithms means inflation; conversely, a decrease in CPI in logarithms means deflation. A higher inflation rate than the target is the basis for considering monetary policy contraction to reduce the high inflation rate. On the other hand, if inflation falls below the target, the monetary authority will be allowed to carry out monetary expansion to encourage economic growth and employment.

$$\Delta LCPI_t = \delta_0 + \delta_1 LCPI_{t-1} + \delta_2^+ LEP_{t-1}^+ + \delta_2^- LEP_{t-1}^- + \delta_3^+ LFP_{t-1}^+ + \delta_3^- LFP_{t-1}^- + \delta_4^+ LER_{t-1}^+ + \delta_4^- LER_{t-1}^- + \delta_5 PR_{t-1} + \sum_{i=1}^{k-1} \gamma_{1i} \Delta LCPI_{t-i} + \sum_{i=0}^{l-1} \left(\gamma_{2i}^+ \Delta LEP_{t-i}^+ + \gamma_{2i}^- \Delta LEP_{t-i}^-\right) + \sum_{i=0}^{m-1} \left(\gamma_{3i}^+ \Delta LFP_{t-i}^+ + \gamma_{3i}^- \Delta LFP_{t-i}^-\right) + \sum_{i=0}^{n-1} \left(\gamma_{4i}^+ \Delta LER_{t-i}^+ + \gamma_{4i}^- LER_{t-i}^-\right) + \sum_{i=0}^{p-1} \gamma_{5i} \Delta PR_{t-i} + \varepsilon_t \quad (1)$$

Notes:

$$LEP_t^+ = \sum_{j=1}^{t} \Delta \mathrm{LEP}_j^+ = \sum_{j=1}^{t} max\left(\Delta \mathrm{LEP}_j, 0\right) \quad (2a)$$

$$LEP_t^- = \sum_{j=1}^{t} \Delta \mathrm{LEP}_j^- = \sum_{j=1}^{t} min\left(\Delta \mathrm{LEP}_j, 0\right) \quad (2b)$$

Similar positive and negative partial sum decompositions, as formulated in equations (2a) and (2b), can be applied to other regressors in the model, including LFP and LER.

Meanwhile, the expected long-run parameters and asymmetric effects from equation (1) are as follows.

$$-\frac{\delta_2^+}{\delta_1} > 0, -\frac{\delta_2^-}{\delta_1} > 0, -\frac{\delta_2^+}{\delta_1} \neq -\frac{\delta_2^-}{\delta_1}$$
$$-\frac{\delta_3^+}{\delta_1} > 0, -\frac{\delta_3^-}{\delta_1} > 0, -\frac{\delta_3^+}{\delta_1} \neq -\frac{\delta_3^-}{\delta_1}$$
$$-\frac{\delta_4^+}{\delta_1} > 0, -\frac{\delta_4^-}{\delta_1} > 0, -\frac{\delta_4^+}{\delta_1} \neq -\frac{\delta_4^-}{\delta_1}$$
$$-\frac{\delta_5}{\delta_1} < 0$$

Furthermore, short-run parameter estimates and error correction term (ECT) can be provided from the NARDL model expressed in equations (3) and (4) for the model in equation (1).

$$\Delta LCPI_t = \delta_0 + \sum_{i=1}^{k-1} \gamma_{1i} \Delta LCPI_{t-i} + \sum_{i=0}^{l-1} \left(\gamma_{2i}^+ \Delta LEP_{t-i}^+ + \gamma_{2i}^- \Delta LEP_{t-i}^-\right) + \sum_{i=0}^{m-1} \left(\gamma_{3i}^+ \Delta LFP_{t-i}^+ + \lambda_{3i}^- \Delta LFP_{t-i}^-\right) + \sum_{i=0}^{n-1} \left(\gamma_{4i}^+ \Delta LER_{t-i}^+ + \gamma_{4i}^- LER_{t-i}^-\right) + \sum_{i=0}^{p-1} \gamma_{5i} \Delta PR_{t-i} + ECT_{t-1} + \mathrm{w}_t \quad (3)$$

with:

$$ECT_{t-1} = LCPI_{t-1} - (\rho_1^+ LEP_{t-1}^+ + \rho_1^- LEP_{t-1}^- + \rho_2^+ LFP_{t-1}^+ + \rho_2^- LFP_{t-1}^- + \rho_3^+ LER_{t-1}^+ + \rho_3^- LER_{t-1}^- + \rho_4 PR_{t-1}) \quad (4)$$

The expected value for ECT is between -1 and 0.

4. Results and Discussion

4.1. Results

Before determining the selected NARDL model, the unit root test obtained the results presented in Table 1. Unit root testing applies ADF and DF GLS testing by including constant and linear trend in testing equation. The test results show that all the variables analyzed, except the policy interest rate (PR), are not stationary at the level. Therefore, all variables are stationary at the first difference, I(1), except the policy interest rate, I(0). With mixed stationary variables I(0) and I(1), and as long as there are no stationary variables in the second difference or I(2), these characteristics are included in the criteria for applying the NARDL model as a development of the ARDL model.

Table 1: Unit root test results

Variable		ADF Test	DF GLS Test
In level	LCPI	-3.5309**	-0.2612
	LEP^+	-0.9177	-1.1299
	LEP^-	-2.9789	-2.9432**
	LFP^+	-1.9507	-1.0119
	LFP^-	-2.1896	-2.2611
	LER^+	-2.6103	-2.6322
	LER^-	-2.1480	-0.9130
	PR	-3.5132**	-3.7773***
In first difference	ΔLCPI	-10.6008***	-10.4881***
	ΔLEP^+	-10.8165***	-10.7574***
	ΔLEP^-	-8.4221***	-8.2650***

	ΔLFP^+	-9.5312***	-9.5562***
	ΔLFP^-	-9.147334***	-8.7770***
	ΔLER^+	-10.8731***	-10.8387***
	ΔLER^-	-10.8731***	-12.655***
	ΔPR	-6.3716***	-5.0597***

*** significant at α = 1 percent; ** significant at α = 5 percent

The estimated NARDL model is determined then the optimum lag is selected from the general ARDL model (k,l+,l-,m+,m-,n+,n-,p) as stated in equations (3) with the criteria used based on the minimum Akaike Information Criteria (AIC) value. With a model specification determined based on theoretical and literature studies, the model with the chosen optimum lag is ARDL(3,0,1,1,0,2,2,1).

Table 2: Bounds test results

F-statistic	Sig.	Lower Bound	Upper Bound	Conclusion
	10%	1.92	2.89	The test results
12.1064	5%	2.17	3.21	reject Ho
	1%	2.73	3.90	

H_0: No long-run relationships

Based on the bounds test, the test results concluded that the model has a long-run relationship (see Table 2). With a level of α = 1 percent, the F-statistic value obtained exceeds the upper bound. This result means that the test results reject the null hypothesis that no long-run relationship exists in the model.

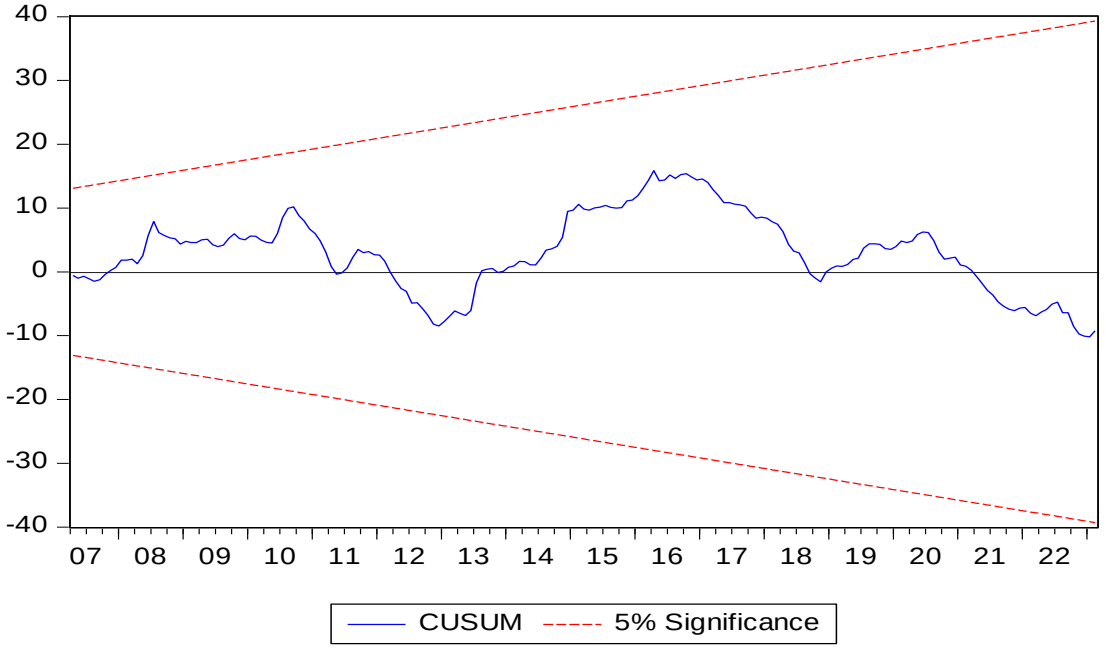

Figure 1: CUSUM test for model stability

Based on the CUSUM test to detect model stability, the results presented in Figure 1 show that the selected model is stable within the specified analysis period.

Table 3: Long-run effects

Regressors	Coefficients	Wald t-statistic of asymmetric effect test
LEP^+	-0.0454	-3.2036***
LEP^-	0.0215	
LFP^+	0.1914***	3.5431***
LFP^-	-0.1670*	
LER^+	0.4303***	-0.2504
LER^-	0.4745***	
PR	-0.0074	

*** significant at α = 1 percent; * significant at α = 10 percent

The estimation results of the NARDL model with the CPI response variable and a set of explanatory variables involving the policy interest rate as a monetary policy variable are presented in Table 3. During the period of implementing the inflation-targeting policy, energy prices did not significantly influence the CPI, although an asymmetric effect was identified in the long run. Increases in energy prices (EP+) and decreases in energy prices (EP-) do not significantly affect changes in CPI which cause inflation/deflation.

For food prices, the model estimation results show that with α = 1 percent, the increase in food prices (FP+) significantly positively affects the CPI. In the long run, rising global food prices will encourage domestic inflation. Meanwhile, the reduction in food prices (FP-) did not have a positive effect, although it was significant, on CPI. A decrease in international food prices is associated with increased CPI in the long run. These results confirm the significant asymmetric effect of global food prices on domestic CPI. So, the positive impact is only significant on CPI in the long run when there is an increase in international food prices.

For the exchange rate, the increase in IDR/USD (ER+), which means depreciation of the rupiah, significantly affects the increase in CPI, which means it causes inflation. On the other hand, the decline in Rp/USD (ER-), which shows the appreciation of the rupiah, also significantly reduces the CPI, which means it triggers deflation. Strong evidence regarding these influences is based on model estimation results with conclusions using α = 1 percent. In the long run, depreciation (appreciation) of the rupiah can increase (decrease) the CPI. Changes in the exchange rate in this study influence the CPI with a coefficient close to the same value. The Wald test proves that the asymmetric effect is not significant. Therefore, rupiah depreciation can have the same effect as rupiah appreciation in influencing changes in CPI in the long run.

Regarding monetary policy, the results show that the policy interest rate (PR) is assumed to have a symmetric effect, where an increase (decrease) in the PR reduces (increases) the CPI

with the same coefficient, not significantly in the short run. Even though it has a negative coefficient, which means that an increase in interest rates reduces CPI, and a decrease in interest rates increases CPI, this effect is not statistically significant.

Table 4: Short-run effects

Regressors	Coefficient	Total effect	Wald t-statistic
$\Delta LCPI_{t-1}$	-0.0276	-0.2348	-2.6508***
$\Delta LCPI_{t-2}$	-0.2072***		
ΔLEP^{-}_{t}	-0.0200**	-0.0200	-2.3056**
ΔLFP^{+}_{t}	0.0636***	0.0636	2.7228***
ΔLER^{+}_{t}	-0.0395	-0.1070	-3.0571***
ΔLER^{+}_{t-1}	-0.0675***		
ΔLER^{-}_{t}	0.0872***	0.1798	4.0136***
ΔLER^{-}_{t-1}	0.0926***		
ΔPR_t	0.0128***	0.0128	5.4704***
ECT_{t-1}	-0.0950***		

*** significant at α = 1 percent; ** significant at α = 5 percent

In the short run, the NARDL model estimation results capture the effects of lags of CPI changes of one and two months to current CPI changes (see Table 4). The total negative effect means that there are characteristics of fluctuating CPI movements in the short run. Without lag, a decrease in changes in international energy prices increases CPI changes in the short run. Meanwhile, increasing changes in global food prices significantly increased changes in CPI.

There is an asymmetric effect of changes in exchange rates on changes in CPI in the short run. Depreciation and appreciation each have a total effect on reducing and CPI changes. The effect that is in line with expectations is the rupiah's appreciation, which significantly reduces changes in the CPI. The appreciation effect is distributed over two months, and the total effect is positive. Meanwhile, changes in policy interest rates positively affect changes in CPI. Changes in CPI that increase (decrease) are influenced by changes in interest rates that increase (decrease). The behavior of CPI changes does not match theoretical expectations, which generally occur in the short run.

The ECT coefficient in the NARDL model is significant, and its value is negative, less than zero, and higher than -1. This means that the behavior of CPI will move towards long-run equilibrium when short-run deviations are corrected. An ECT value that is too small in absolute terms means that the time to reach equilibrium in the CPI dynamics takes a very long time.

4.2. Discussion

In the long run, energy prices do not significantly influence CPI. Energy prices, including those of crude oil, gas, and coal, are insignificant; both increases and decreases in CPI are possible

due to the role of energy subsidies, such as fuel, gas, and electricity subsidies for households. Energy subsidies can restrain the rate of increase in CPI when there is an increase in energy prices and vice versa. However, energy subsidies can prevent the CPI from increasing significantly so that inflation that might arise can be contained. The results of a study conducted by Murjani [55] provide empirical evidence that the role of energy subsidies in Indonesia is significant in preventing the increase in CPI. Even if energy subsidies are increased, CPI can be reduced in the short and long run. Government policies synergistic with monetary policy within an inflation targeting framework to achieve a stable inflation target also contribute to efforts to prevent inflation from increasing if there is a spike in global energy prices. The results of this study are also in line with the conclusions of the study conducted by Akhmad et al. [56]. In their simulation, an increase in energy prices, especially crude oil, could increase domestic fuel prices and, in turn, inflation if the government provided no subsidies. The results of this study can provide new insights regarding changes in global energy prices and domestic inflation, especially during the inflation targeting period. Price stabilization is the government's target amidst fluctuations in world commodity prices, especially energy prices.

In the long run, increasing global food prices will increase the CPI significantly, which means it will cause inflation. The asymmetric influence of food prices on inflation is proven because the coefficient of influence is more significant on the increase in food prices than the decrease in food prices, which does not meet expectations with a negative coefficient. The increase in CPI, which indicates inflation due to rising food prices, is a dynamic of price development that is generally included in the category of volatile food inflation, which originates from rising global food prices. The results of this study confirm the results of research conducted by Furceri et al. [34] and Samal et al. [35], which is viewed from the asymmetric effects. Because food inflation is one of the main contributors to domestic inflation, changes in global food prices will also impact domestic inflation, considering that Indonesia still imports several primary food commodities such as rice, wheat, soybeans, milk, and beef.

Furthermore, the increase in global food prices, which was responded to by the rise in domestic consumer prices, while a decrease in consumer prices did not react significantly to the decline in food prices, indicates the existence of an antithesis of price rigidity behavior in the economy. This condition means that commodity prices tend to be responsive to adjusting when they rise rather than changing when they fall.

In this research, the exchange rate has a positive effect on CPI. Asymmetric effects, as expected, were not proven in this study. The increase in the exchange rate (IDR/USD), which means the rupiah is depreciating, impacts the rise in CPI. On the other hand, the decline in the exchange rate (IDR/USD), which means the rupiah appreciates, impacts the decline in CPI. The effect of rupiah depreciation and appreciation on the increase and decrease in CPI has almost the

same coefficient. The empirical findings in this study indicate that the exchange rate pass-through into consumer prices is symmetric, which is different from the asymmetric exchange rate pass-through in the empirical findings by Monfared and Akin [44], and Valogo et al. [57]. The effect of rupiah depreciation on the increase in CPI in inflation targeting tends to be lower with a smaller coefficient than the results in non-special periods of inflation targeting, as in a study by Arintoko et al. [39]. Inflation targeting provides a conducive environment that supports a reduction in exchange rate pass-through into consumer prices in line with monetary policy efforts to achieve price stabilization in the face of exchange rate fluctuations. The influence of exchange rates on this research model is most significant compared to other variables. Therefore, the exchange rate is the variable that influences inflation most. This result is in line with the empirical findings of Sek [27], who states that the exchange rate is the main factor determining inflation.

Policy interest rates do not significantly negatively affect CPI in the short and long run. An increase (decrease) in the policy interest rate does not significantly reduce (increase) the CPI. In implementing inflation targeting, the monetary policy stance is through the reaction of interest rates to actual inflation relative to target inflation so that it is possible that interest rates do not have a direct effect on CPI in the short run. Also, the strong impact of the increase in global food prices and the depreciation of the rupiah on the rise in CPI will likely weaken the influence of interest rates on CPI in the long run. In contrast, interest rates appear to respond more to inflation in the short run. So, in this study, it cannot be proven that interest rates hurt inflation. This empirical finding is in line with findings by Bui and Gábor [58] that interest rates do not fully capture the monetary policy stance, so the effect of interest rates is limited in influencing inflation. Also, in this case, monetary policy becomes counterproductive in controlling inflation when global price factors drive the inflation trend, as stated by Atiq-ur-Rehman [53].

5. Conclusion

The research results conclude that global food prices have an asymmetric effect on CPI compared to energy prices. Food price fluctuations significantly impact domestic CPI more than energy prices. Energy prices do not significantly impact CPI, so they also do not affect inflation. Energy subsidies such as fuel and gas subsidies for households allow energy price increases to not cause a significant rise in CPI, which triggers inflation. Meanwhile, a significant increase in food prices increases CPI, which causes inflation, while an insignificant reduction in food prices reduces CPI, which causes deflation. This indication is the antithesis of price rigidity.

The exchange rate is the variable with the most significant influence on inflation. Changes in import prices caused by changes in exchange rates are transmitted to consumer prices, where changes reflect inflation. The asymmetric effect of the exchange rate is indicated by the

impact of appreciation, which reduces domestic inflation, rather than the depreciation of the rupiah, which has no significant effect on increasing inflation.

Monetary policy variables, such as policy interest rates, were not proven to have a negative effect on CPI according to theoretical expectations. CPI movements during the research period do not represent the impact of contractionary or monetary expansion policies. Still, they are more strongly influenced by changes in global food prices and exchange rates. Also, policy interest rates respond to inflation rather than affecting inflation in the short run.

In implementing monetary policy in response to inflation, it is hoped that the central bank will not focus too much on the targeted monetary variables. In implementing monetary policy, the monetary authority also needs to focus on the source of inflation from the supply side, which is influenced by changes in global energy and food prices and exchange rates. The synergy of efforts to control inflation by the central bank, the central government, and regional governments in stabilizing inflation is more focused on the availability and sufficiency of food commodities and reducing dependence on imports of food and energy commodities when there is an increase in global energy and food prices. Efforts to reduce reliance on imports also mean efforts to reduce the burden on the government budget in providing energy and food subsidies. Efforts to stabilize the exchange rate also remain focused on controlling import prices.

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