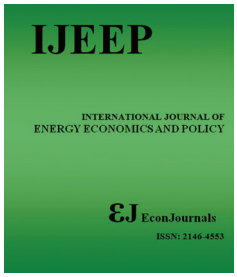

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The Asymmetry Effect of Oil Consumption, Unemployment and Broadband Technology on Economic Growth in Indonesia

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ABSTRACT

This research aims to examine the asymmetry effect of oil consumption, unemployment, and broadband technology on economic growth in Indonesia. Data on these attributes were annually collected from 2000 to 2019. The effect test result using the nonlinear autoregressive distributed lag (NARDL) model showed that oil consumption and unemployment affect economic growth asymmetrically and positively in the long and short term. Meanwhile, broadband technology affects economic growth only in the long term, and this effect is positive.

Keywords: Oil Consumption, Unemployment, Broadband Technology, NARDL Model
JEL Classifications: C120, J600, O330, O47, Q430.

1. INTRODUCTION

Crude oil is an energy source that plays an important role in the global economy, and this is evident from the supply and demand aspects. Based on the demand aspect, it is one of the commodities used by consumers, including households, to maximize their utility function (Lahiani et al., 2018). Meanwhile, from the supply aspect, it is an energy source used to produce goods, generates electricity, and drive transportation equipment (Rosnawintang et al., 2021). Increased development in various sectors and the fulfillment of household needs tend to have an impact on oil consumption (Žiković and Vlahinic-Dizdarević, 2011). CEIC (2020), reported that in Indonesia, it rose from 114,318 barrels/day to 1,626,119 barrels/day from 1967 to 2019. The highest oil consumption of 1,663,132 barrels/day was recorded in 2012. Lahiani et al. (2018) and Appiah et al. (2020) reported that an increase in oil consumption is also related to efforts to boost output and economic growth.

Žiković and Vlahinic-Dizdarević (2011), stated that oil consumed by industries and households also affects economic growth. This view is in line with the neo-classic theory where oil consumption acts as a production factor that affects economic growth (Ghali and El-Sakka, 2004).

Unemployment and broadband technology are 2 other factors that are the focus of this research. According to Okun law, the yearly reduction of the unemployment rate in every country, including Indonesia, increases economic growth (Agboli, 2021). Furthermore, broadband is a communication and information technology that requires the use of an internet network to speedily send data, voice notes, and videos. It is used by companies to increase their investment and production plans as well as to reduce operational costs and increase profits (DeStefano et al., 2017; Kabaklarli and Atasori, 2019). Therefore, it boosts national income and economic growth (Saidi et al., 2020). In the theory of endogenous growth, broadband

technology is a production factor that encourages economic growth (Sala-i-Martin, 2004).

Research on the effect of oil consumption on economic growth is still lacking (Yoo, 2006). Zou and Chau (2006) and Waleed et al. (2017), stated that an increase in oil consumption boosts economic growth. However, no research has analyzed the asymmetrical effect of oil consumption on economic growth. Bankole and Fatai (2013) determined the effect of unemployment on economic growth in Nigeria, while Bräuninger and Pannenberg (2002) investigated its impact in OECD countries. Bräuninger and Pannenberg (2002) found that rising unemployment suppresses economic growth in the long run. Bankole and Fatai (2013) reported that this factor has a positive effect. Research on the effect of broadband technology on economic growth was carried out by Gosh (2017) and Castaldo et al. (2017). They reported that this factor affects economic growth positively. To some extent, the effect of a combination of the 3 variables namely oil consumption, unemployment, and broadband technology on economic growth has not been analyzed in Indonesia.

Therefore, this research aims to examine the asymmetry impact of oil consumption and the effect of unemployment and broadband technology on economic growth. The results contribute to the literature regarding (1) the asymmetrical effect of the 3 variables, as well as (2) its analysis with the Nonlinear ARDL (NARDL) model.

2. LITERATURE REVIEW

Previous research only examined the asymmetry effect of oil consumption on economic growth (Shin et al., 2014). This section empirically reviews the symmetry effect of the 3 variables namely oil consumption, unemployment, and broadband technology on economic growth.

Several empirical research reported that oil consumption drives economic growth, besides, Al-Mulali (2011), examined its effect in MENA countries using annual data from 1980 to 2009. The VECM panel analysis results showed that oil consumption affects economic growth in the long and short term. Behmiri and Manso (2013) used Granger causality multivariate analysis, to investigate the effect of oil consumption on economic growth in Sub-Saharan African countries. The analysis obtained from 1985 to 2011 showed similar results. Antonio and Quaresma (2015) reviewed the effect of oil consumption on economic growth in OPEC countries (Algeria, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela). The ARDL panel test results also showed that economic growth is affected in the long and short term.

Several studies found different results regarding the effect of unemployment on economic growth. Mohseni and Jouzaryan (2016) investigated its impact in Iran using annual data spanning from 1996 to 2012, and the ARDL model for analysis. The results showed that unemployment negatively affects economic growth in the long run. Castells-Quintana and Royuela (2012), used panel data to examine its effect in 39 countries in the world, and based on their analysis of annual data from 1990 to 2007, unemployment had an insignificant impact on economic growth. This is in line with the study conducted by Sadiku et al. (2015). Furthermore, Ajie et al. (2017) examined its effect in Nigeria using the ARDL model on data spanning from 1981 to 2012 and obtained that unemployment does not affect economic growth.

Several empirical studies carried out on the effect of broadband technology show that it promotes economic growth. Czernich et al. (2011) investigated its impact in OECD countries using a fixed effect panel data model. The results showed that for every 1% increase in broadband technology, economic growth increases by relatively 0.9–1.5%, therefore, it has a positive impact. Edquist et al. (2018) examined its effect in 135 countries in the world. The results of the analysis using a panel data model showed that for every 10% increase in broadband technology, economic growth increases by 0.8%, it simply implies that this variable has a positive influence. Gbahabo and Ajuwon (2019) further examined its impact on the Nigerian economy. They used the ARDL model to analyze quarterly data obtained from 2001 to 2016 and discovered that broadband technology positively affects economic growth. Meanwhile, Zhang (2021) examined the effect of broadband technology on economic growth in China using a multiple linear regression, which showed a positive effect.

3. DATA AND METHODOLOGY

3.1. Data

This research adopted a 4 time-series data, namely GDP per capita (constant 2015), oil consumption, unemployment, and broadband technology spanning from 2000 to 2019. Meanwhile, GDP per capita and broadband per 100 users are proxies for economic growth and broadband technology. The measurement units for GDP per capita, oil consumption, as well as unemployment, and broadband technology are USD, barrels per day, and %, respectively. The data source for GDP per capita, unemployment, and broadband technology users is the World Bank, while oil consumption is the Statistical Review of World Energy (https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html). For data analysis purposes, the variables that accommodate the natural logarithm of time series on economic growth, oil consumption, unemployment, and broadband technology are EGR, OCO, UNE, and BRO.

3.2. Methodology

The Nonlinear ARDL (NARDL) model proposed by Shin et al. (2014) was used to examine the asymmetry effect of oil consumption, as well as unemployment and broadband technology on economic growth. One advantage of this approach is that the regressors are not collinear with each other (Shin et al., 2014; Menegaki, 2019). The equation of the NARDL model and the time lag length, p, q, r, s or NARDL(p, q, r, s) (Pesaran, 1999) is stated as follows

$$EGR_t = C_0 + \sum_{i=1}^{p} \theta_i EGR_{(t-i)} + \sum_{j=0}^{q} (\alpha_j OCP_{(t-j)} + \beta_j OCN_{(t-j)}) + \sum_{k=0}^{r} \tau_k UNE_{(t-k)} + \sum_{l=0}^{s} \delta_l BRO_{(t-l)} + \varepsilon_t \quad (1)$$

Symbols of C_0, θ_i (i=1,2.,p), α_j, β_j (j=0,1,…,q), γ_k (k=0,1,…,q_2), and δ_l (l=0,1,…,r) are the regression parameters which are stable in time t. The ε_t residuals are identical and independently distributed

with mean 0 and constant variance (homoscedastic). *OCP*, *OCN*, *UNE*, and *BRO* regressors are exogenous to the dependent variable *EGR*. The *OCP* and *OCN* has a positive and negative shock on oil consumption respectively and, these are stated as follows

$$OCP_t = \sum_{i=1}^{t} \max[\Delta OCO_i, 0] = \sum_{i=1}^{t} \max[D(OCO_i), 0]$$

$$OCN_t = \sum_{i=1}^{t} \min[\Delta OCO_i, 0] = \sum_{i=1}^{t} \min[D(OCO_i), 0]$$

Where $D(OCO_i)=OCO_i–OCO_{i-1}=OCO–OCO(–1)$ is the change in oil consumption from time $i–1$ to i with i = 2001, 2002,…,2019.

To examine the oil consumption's positive and negative shocks, unemployment, and broadband technology on economic growth, the following steps were adopted. First, the stationarity of all variables in the NARDL (p, q, r, s) model was evaluated, as stated in equation (1), using the Augmented Dickey-Fuller (ADF) test. The formulated hypothesis was used to evaluate not stationary time series, while its alternative is H_0: Stationary time series (Dickey and Fuller, 1979).

The second step involves examining the cointegration of oil consumption, unemployment, and broadband technology, on economic growth. This is accomplished assuming 1 variable is not at the stationary level. The ARDL(p, q, r, s) bound was tested using the cointegration regression as stated in equation (2).

$$D(EGR_t) = C_0 + \sum_{i=1}^{p-1} \theta_i D(EGR_{(t-i)}) + \sum_{j=0}^{q-1} (\alpha_j D(OCP_{(t-j)}) + \beta_j D(OCN_{(t-j)})) + \sum_{k=0}^{r-1} \tau_k D(UNE_{(t-k)}) + \sum_{l=0}^{s-1} \delta_l (BRO_{(t-l)}) + \theta_1 EGR_{t-1} + \theta_2 OCP_{t-1} + \theta_3 OCN_{t-1} + \theta_4 UNE_{t-1} + \theta_5 BRO_{t-1} + \varepsilon_t \quad (2)$$

where θ_i (i=1,2,3,4,5) are the parameters. To test for cointegration, the hypothesis formula used is H_o: all-time series are cointegrated, while the alternative is H_1: all-time series are not cointegrated, and these were determined using the F-statistic. The criterion for accepting is based on the fact that the test statistic is greater than the critical value of the upper bound I (1) (Pesaran et al., 2001).

The third step involves the estimation of the regression parameters, both long and short-term coefficients. These were obtained by estimating the error correction model ECM-ARDL(p-1, q-1, r-1, s-1) in equation (3). The ECM-NARDL is a modification of the NARDL in equation (1). The ECM-ARDL(p-1, q-1, r-1, s-1) model is stated as follows

$$D(EGR_t) = \alpha_0 D(OCO_t) + \beta_0 D(OCN_t) + \tau_0 D(UNE_t) + \delta_0 D(BRO_t) + \pi EC_{t-1} + \sum_{i=1}^{p-1} \theta_i^* D(EGR_{(t-i)}) + \sum_{j=0}^{q-1} (\alpha_j^* D(OCP_{(t-j)}) + \beta_j^* D(OCN_{(t-j)})) + \sum_{k=0}^{r-1} \tau_{iiiii}^* (\quad_{(-)}) + \sum_{l=0}^{s-1} \delta^* (\quad_{(-)}) + \varepsilon \quad (3)$$

π and EC_{t-1} are the error correction coefficient, and variable respectively, where

$$EC_{t-1}=EGR_{t-1}–\alpha OCP_{t-1}–\beta OCN_{t-1}–\tau UNE_{t-1}–\delta BRO_{t-1} \quad (4)$$

The vector ($\alpha, \beta, \tau, \delta$) is the long-term coefficient of the positive and negative shock of oil consumption, unemployment, and broadband technology. Furthermore, supposing the α and β in equation (4) are statistically significant with $\alpha \neq \beta$ then it is assumed that oil consumption asymmetrically affects economic growth in the long term. Meanwhile, supposing α_j^*, β_j^* (j = 0, 1,…,q–1) is equal to equation (3) and significant with $\alpha_j^* \neq \beta_j^*$ therefore, it was reported that oil consumption asymmetrically affects economic growth in the short term.

The final step is to check the assumptions of the NARDL(p, q, r, s) model namely the residuals and parameter stability. In addition, normality, autocorrelation, and residual homoscedasticity assumptions were evaluated using Jarque Bera (JB), Breusch-Godfrey Serial Correlation LM (BGSCLM), and ARCH tests. Furthermore, the parameter stability was determined with the CUSUM and CUSUM Square tests. The parameters of the NARDL model are stable supposing the statistical trend curve is between the 2 5% significance limits (Brown et al., 1975). The exogenous nature of the regressor variables was evaluated using the J-statistical, or Durbin-Wu-Hausman (DWH) tests. This has a χ^2 distribution with degrees of freedom equal to the number of regressors. The formulation of the J-statistical test hypothesis is that H_o: *OCP*, *OCN*, *UNE*, and *BRO* are exogenous to EGR. Conversely, the alternative H_1: *OCP*, *OCN*, *UNE*, and *BRO* is endogenous to EGR. The criterion is based on accepting H_0 supposing the test statistic value is less than the significance level of 1%, 5%, or 10% (Heij et al., 2004; IHS-Markit, 2017).

4. RESULTS AND DISCUSSION

4.1. Results

The stationarity test was carried out to ensure that in the second differences, the ARDL variables are not stationary. The statistical values related to the ADF test results are shown in Table 1. The positive and negative shocks of oil consumption, unemployment, broadband technology, and economic growth are stationary in the first differences or integrated order 1, I(1).

The result of the F-statistical value is 8.938, while that of the critical upper bound I(1) at a significance level of 1% is 5.84. By comparing these 2 statistical values, it is evident that the F-statistic is greater than the critical upper bound, therefore, the proposed hypothesis is accepted. In other words, the positive and negative shocks of oil consumption, unemployment, broadband technology, on economic growth are cointegrated or have a long-term relationship.

The estimated results of the long and short-term coefficients are shown in Table 2. In panel A, the long-term coefficient of broadband technology has a positive effect at a 1% significance level. Meanwhile, the long-term positive and negative shock coefficients for oil consumption are also significant and insignificant at 1%,

respectively. Furthermore, the long-term unemployment and broadband technology are positive and significant at 5%, and 1%, respectively. Therefore, oil consumption asymmetrically and positively affects economic growth in the long run. Similarly, unemployment and broadband technology also have an impact in the long term. In panel B, the positive shock coefficients of oil consumption and unemployment are significant at 1%. However, in the short term, oil consumption and unemployment affect economic growth asymmetrically and positively, while broadband technology has an insignificant effect.

The final step is to check the model assumptions. The statistical probability values of ARCH, BGSCLM, and JB listed at the bottom of Table 2 are greater than the 5% significance level. The residuals of the ARDL (2, 3, 3, 2) model are homoscedastic, have no autocorrelation, are normally distributed, and are stable. It was therefore concluded that the statistical trend curves of the CUSUM and CUSUM Square tests are between the 2 5% significance limits as shown in Figure 1. Furthermore, the DWH test result is 1.22E-34 which is less than the critical value of 13,277 realized at a significance level of 1%, therefore, hypothesis In other words, the regressors of the NARDL model are exogenous.

4.2. Discussion

The statistical inference test results showed that oil consumption has an asymmetric and positive effect on the Indonesian economic growth both in the long and short term. This is related to industrial progress in the country where it serves as raw materials for manufactured goods, while transportation and electricity are optimally utilized, to boost the economy. These results are in line with the findings of Al-Mulali (2011), Behmiri and Manso (2013), as well as Antonio and Quaresma (2015).

Furthermore, this research also showed that unemployment positively affects economic growth. This is because, in Indonesia, an increase in its rate was recorded from 2000 to 2007 while a decline was reported in 2019. Meanwhile, an increase was reported in the GDP per capita from 2000 to 2019. The decline in the unemployment rate put significant pressure on economic growth. This implies that the government has not successfully suppressed its rate through its monetary policy, however, this finding contradicts' Okun's law. In terms of empirical research, it is inconsistent with the findings of Quintana and Royuela (2012), Sadiku et al. (2015), and Ajie et al. (2017) that stated unemployment has an insignificant effect on economic growth. Also, Mohseni and Jouzaryan (2016) reported that it negatively affects economic growth. These different findings are due to the characteristics of the country used as the research location (Ozturk, 2010; Edward et al., 2016) and also the period the research data was used (Adam et al., 2021). Furthermore, the results of this study are in line with that of Bankole and Fatai (2013).

Another finding is that broadband technology positively affects economic growth in the long term. It accelerates the delivery of data, voice notes, and images in the global internet network. This technology is used by all companies, households, and governments to speed up the delivery process and cost-efficiency. The Indonesian government has launched and implemented its development to provide optimal services in connection with the increasing demand for certain information and communication services. Therefore, the positive influence of broadband technology on economic growth is based on the implications of the developmental efforts earlier mentioned. These are in line with the theory proposed by Sala-i-Martin (2004) and also the empirical studies carried out by Woessmann et al. (2011), Edquist et al. (2018), Gbahabo and Ajuwon (2019), and Zhang (2021).

Table 1: ADF test results

Variables	Level		First Difference		Process
	Intercept	Intercept and trend	Intercept	Intercept and trend	
OCP	–0.6344	–2.1803	–3.2614**	–3.1708	I (1)
OCN	0.1906	–1.7050	–3.1840**	–3.1702	I (1)
UNE	0.0172	–4.8028*	–3.6982**	–3.9996**	I (1)
BRO	–4.1787**	–2.4046	–3.4143**	–3.8093**	I (1)
EGR	0.7056	–2.5925	–3.2751**	–2.9483**	I (1)

*, ** significant at 1%, 5%

Figure 1: CUSUM Test and CUSUM square test

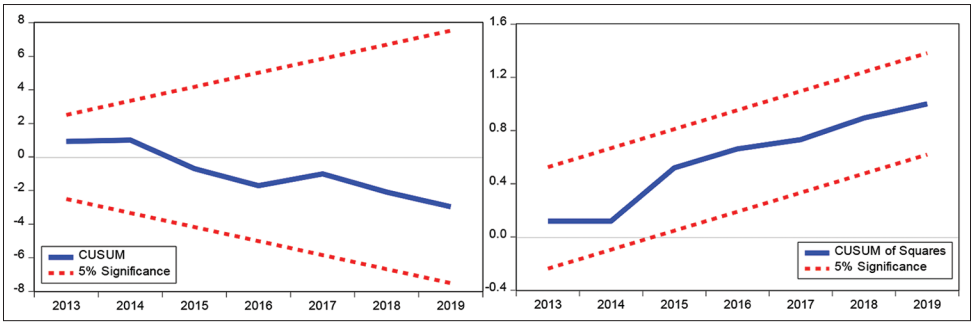

Table 2: Long and short-term coefficients estimation

Constant and independent variable	Coefficient	t-Statistics	P-value
Long-term coefficients, dependent variable: EGR			
OCP	1.7261	5.7887	0.0007
OCN	–0.3741	–1.0694	0.3204
UNE	0.3623	2.5262	0.0395
BRO	0.0488	3.9591	0.0055
C	35.9674	200.8646	0.0000
Short-term coefficients, dependent variable : D (EGR)			
D (EGR(–1))	–0.7964	–4.5025	0.0028
D (EGR(–2))	–0.3229	–3.3690	0.0119
D (OCP)	0.1440	8.7079	0.0001
D (UNE)	0.0179	3.6723	0.0079
EC(–1)	–0.1727	–9.5883	0.0000

P values of test statistics: ARCH, BGSCLM, and JB are 0.610, 0.066, and 0.765, respectively

5. CONCLUSION

Crude oil plays an important role in the world economy because it is needed in the transportation, industrial, and electricity sectors, and is also utilized by various households. Furthermore, unemployment is a macroeconomic variable that has to be suppressed, according to Okun's law, a decrease in its rate tends to increase economic growth. Broadband technology also needs to be continually developed because it has a positive impact on the economy.

This research examines the asymmetric effect of oil consumption, unemployment, and broadband technology on economic growth. An annual time series data spanning from 2000 to 2019 was utilized, as well as the Nonlinear ARDL (NARDL) model.

The stationary test results proved that all variables are stationary in the first differences. Meanwhile, the cointegration test showed that the positive and negative shocks of oil consumption, unemployment, broadband technology, and economic growth are cointegrated. The effect test using the NARDL model showed that in the long term, oil consumption asymmetrically affect economic growth, also, unemployment, and broadband technology affect economic growth. These 3 variables (OCP, UNE and BRO) have a positive influence on economic growth. Meanwhile, in the short term, oil consumption asymmetrically affect economic growth, and unemployment also affect economic growth.

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