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Article

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International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Wali Aya Rumbia/Muthalib, Abd Azis et. al. (2022). The effect of crude oil prices and internet on economic growth in Timor Leste. In: International Journal of Energy Economics and Policy 12 (1), S. 275 - 280. https://econjournals.com/index.php/ijeep/article/download/11992/6220. doi:10.32479/ijeep.11992.

This Version is available at:
http://hdl.handle.net/11159/8515

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(1), 275-280.

The Effect of Crude Oil Prices and Internet on Economic Growth in Timor Leste

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Received: 07 September 2021 **Accepted:** 10 December 2021 **DOI:** https://doi.org/10.32479/ijeep.11992

ABSTRACT

Continuous economic growth improves the welfare and the living standards of the people. However, for a country to experience economic growth, several factors come into play, including resource endowment, economic policies, political stability, and more. This research aimed to examine the effect of crude oil prices and internet on economic growth in Timor Leste. An autoregressive distributed lag model was used to analyze the time series data from 2005 to 2020. The cointegration test results showed that crude oil prices, internet, and economic growth are cointegrated. Based on the model coefficients, the estimation results revealed crude oil prices and internet have a significant effect on the country's long-term and short-term economic growth. The long-term effect of crude oil prices on economic growth is negative. In every 1% increase of crude oil prices, there is a 10.3% decrease in economic growth. A 1% reduction in crude oil prices leads to a 10.3% economic growth. Furthermore, the long-term effect of the internet has a long-term positive effect on economic growth. Every 1% internet increase, there is a corresponding 27.65% increase in economic growth.

Keywords: Crude Oil Prices, Internet, Economic Growth, Autoregressive Distributed Lag Model
JEL Classifications: C130, E130, E310, F620

1. INTRODUCTION

Economic growth depends on human and physical capital, technology, and labor force. The increase in the working population, the tools needed for efficient work, and other variables, such as labor, raw materials, and capital improves the economy (Tumoro, 2021). As the economy grows, the welfare of people increases proportionately. For instance, the need to improve the welfare of people makes the efforts to increase the economic growth of Timor Leste urgent. However, this depends on many factors, including crude oil prices (Awunyo-Vitor et al., 2018).

Most sectors of the economy depend on crude oil to satisfy their energy needs. The industrial processing of goods, electricity, and transportation in the real, service, and financial sectors require energy. A small change in the prices of crude oil affects all sectors in the economy. For instance, an increase in the price of crude oil raises the cost of manufactured goods, transportation, service provision, and all other economic sectors. Consequently, the welfare of people will be significantly affected because of reduced disposable income occasioned by inflation. The effects resulting from changes in crude prices have attracted researchers seeking to unravel the relationship between crude oil prices and economic growth both from a theoretical and empirical perspective (Awunyo-Vitor et al., 2018).

Crude oil prices affect economic growth through demand and supply (Jiménez-Rodríguez and Sánchez, 2005). Since crude oil

is an industrial raw material, an increase in price positively affects the cost of manufactured goods. This is because the manufacturers add the additional production costs to the overall price charged on a product, leading to inflation. In case the rate inflation is above the expected threshold, the central bank raises interest rates to suppress it. This decreases investment because of the high borrowing interest rates, hurting economic growth (Rosnawintang et al., 2021). Supply causes a transfer of wealth from oil-exporting countries, leading to increased household consumption and decreased saving rates. Although economic growth surges, saving rate declines, lowering investment. However, for crude oil-importing countries, the opposite applies.

The internet is a global network of computers that are connected and affects the global economic and business sectors (Gjika and Pando, 2020). Companies in the real and financial sectors use the internet to promote products and sell to consumers. Similarly, consumers use it to search for quality products. Investors in the financial sector use the internet to analyze the commodity price development trends in stocks, currencies, and derivatives to make informed decisions. The internet use in economic and business activities may reduce production costs and promote resource efficiency (Bahrini and Qaffas, 2019). This increases the company revenues and aggregately promote economic growth (Saidi et al., 2020).

Several studies have been conducted to test the effect of internet on economic growth, however, the number of studies is still limited (Choi and Yi, 2009; Elgen, 2013). For example, Donou-Adonsou (2018) examined the effect of technology on economic growth in Sub-Saharan Africa and concluded that technological advancement positively affected economic growth. Salahuddin and Gow (2015) studied the influence of the internet on economic growth in South Africa. The results showed positive effects on economic growth.

Empirical studies show that crude oil prices have both positive and negative effects on economic growth. For instance, Barument et al. (2010), Abdelsalam (2020), and Awunyo-Vitor et al. (2018) showed that Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria, and the United Arab Emirates significantly gained from the changes in prices. Foudeh (2017) showed that Saudi Arabia, Ghana, and the MENA countries reaped huge benefits from changes in crude oil prices. Meanwhile, the negative influence of crude oil prices on economic growth was found by, among others, Jiménez-Rodríguez and Sánchez (2005) in the OECD countries and Sancheti and Sancheti (2020) in the United States of America. Ilhan Oztuk (2010), Odiambo (2020), and Adam et al. (2021) established that this difference in effect was caused by variances in the counties. Some are oil-importing while others are oil-exporting. The differences were also attributed to research location, time and sample. Therefore, it is vital to examine how the price of crude oil affect Timor Leste's economic growth.

Timor Leste is one of the developing countries that export crude oil. However, it has experienced a sharp decline within ten years, specifically from 2008 to 2018. For instance, the export value of crude oil in 2008 was 4988 thousand metric tons to 831 thousand metric tons in 2018 (Vereinte Nationen – Undata, 2021). The economic growth has been declining from 5.8% in 2010 to −6.8% in 2020 (Trading Economics, 2021). This is attributed to the decline in world crude oil prices in this period.

Therefore, this research aims to examine the effect of crude oil prices and the internet on economic growth in Timor Leste. That to the best of our knowledge, this research has not yet been carried out in Timor Leste. The results are expected to cover the effect of crude oil prices on economic growth, the influence of the internet on economic growth and the use of the autoregressive distributed lag (ARDL) model to examine the long-term and short-term effects of crude oil prices and internet on economic growth.

2. LITERATUR REVIEW

Darby (1982) and Hamilton (1993) studied the effect of crude oil prices on inflation and economic growth. Other academicians centered their studies both on developing and Arab countries (Akinsola and Odhiambo, 2020a). Currently, most studies on the impact of crude oil prices on economic growth are distinguished by the effects of symmetry and asymmetry. Asymmetry effect results from decomposing crude oil prices into positive and negative changes. In this section, the results from several empirical studies on the impact of crude oil prices on economic growth are reviewed, including the asymmetric effect. Additionally, previous research on the influence of the internet on economic growth is also discussed.

Using the ARDL model, Omitogun et al. (2018) examined the effect of crude oil prices on economic growth in Nigeria. The test results drawn from the years 1981 to 2016 revealed that crude oil prices have a significant long-term and short-term influence on the economic growth of a country. The long-term effects of crude oil prices on economic growth showed a positive correlation. Wen et al. (2018) used the TVP-VAR model to examine the effect of crude oil prices on economic growth in China. Based on the analysis of the results conducted every month from January 1996 to June 2017, there was a conclusion that the price of crude oil positively affects the economic growth of a country in the long run and short term. Using wavelet analysis, Mo et al. (2019) examined the effect of crude oil prices on economic growth in BRICS countries using quarterly data in 1996Q2-2018Q3. The data results analysis showed that crude oil prices positively affect economic growth in each country (China, Brazil, Russia, South Africa, and India) in the long and short term. Abbritti et al. (2020) examined the effect of crude oil prices on economic growth in the United States, and the results indicated that rising crude oil prices increase economic growth. Sadath and Acharya (2021), using annual data analysis from 1996 to 2017, tested the effect of crude oil price asymmetry in India with the assistance of the Structural Vector autoregressive model. The conclusion of the results showed that indeed crude oil price changes affect economic growth.

Several studies have been conducted to test the asymmetric effect of crude oil prices on economic growth. For instance, Akinsola and Odiambo (2020b) examined the effect of crude oil prices on economic growth in 7 low-income Sub-Saharan African countries, including Gambia, Ethiopia, Mozambique, Mali, Tanzania, Senegal, and Uganda. Data spanning from 1990 to 2018 was subjected to scrutiny using the ARDL nonlinear panel model, and it was shown that crude oil prices affect economic growth in

the long term and short term. An increase in its prices negatively affects economic growth, whereas a decrease in its prices positively affects economic growth. Baek et al. (2021) undertook research on 31 provinces in China regarding the asymmetric effect of crude oil prices on the economic growth in 31 using the ARDL nonlinear panel model. The test results on quarterly data in the period 2000: Q1–2019: Q2 showed that crude oil prices affected the economic growth in all the provinces. Furthermore, Kiswani (2021) investigated the effect of crude oil prices on economic growth in ASEAN-5 countries, including Indonesia, Taiwan, the Philippines, Singapore, and Malaysia. Data drawn from the periods 1970–2015 was analyzed using the ARDL nonlinear panel model. It was found that a reduction in crude oil prices positively affected the economic growth in all countries.

Haftu (2019), Zhang and Danish (2019), Habibi and Zabardast (2020), Cheng et al. (2021), David and Grobler (2020), Saidi et al. (2020), and Rosnawintang et al. (2021) carried out research on the influence of the internet on economic growth. Haftu (2019) used the panel data model to analyze the influence of the internet on economic growth in Sub-Saharan African countries. The annual data for the period between 2006–2015 was used, and the results revealed the internet does not affect economic growth. Using the same test model, Zhang and Danish (2019) tested the influence of the internet on economic growth in Asian countries. They used data drawn from the period between 1990 and 2016, and the results concluded that the internet does not affect economic growth. Habibi and Zabardast (2020) also used the panel data model to research the influence of the internet on economic growth in the Middle East and OECD countries. The data test results for 2000-2017 showed that the internet positively affects economic growth in OECD countries but does not affect economic growth in the Middle East countries. Cheng et al. (2021) used data drawn from 2000 to 2015 to explore whether the internet affects economic growth in 72 countries across the globe with the help of the panel data analysis model. The results revealed that the internet contributes positively to economic growth. David and Grobler (2020) analyzed the influence of the internet on economic growth in African countries using the panel data model. From their analysis, it was concluded that the internet positively affects economic growth. Saidi et al. (2020) analyzed the influence of the internet on Indonesia's economic growth using the ARDL-IGARCH-M model. The results of the analysis of the annual data for the period between 1974 and 2017 showed that the internet affects economic growth only in the short term. Moreover, Rosnawintang et al. (2021), using the ARDL panel model and data from 1995 to 2018, examined ASEAN countries (Indonesia, Taiwan, Singapore, the Philippines, and Malaysia), and the results showed that the internet affects economic growth in the long and short term. From their analysis, it was found that the effect of crude oil prices on economic growth is positive in the long term.

3. DATA AND METHODOLOGY

3.1. Data

This research used annual time series data from 2005 to 2020 consisting of crude oil prices, internet, and gross domestic products (GDP). The price of West Texas Intermediate (WTI) crude oil with units of measure USD per barrel was used as a proxy for the price of crude oil, a population of while internet users per 100 population of users were used as a proxy for the internet, and a constant 2010 per capita GDP (in USD) was used as a proxy for the economic growth. The OIL variable accommodated crude oil price data logarithm, ITU accommodated the the internet user data logarithm, and GRO accommodated GDP per capita data. The source of data for GDP per capita and internet user was the World Bank, while the data source for WTI crude oil prices was the US Energy Information Administration.

3.2. Methodology

The autoregressive distributed (ARDL) model was used to examine the effect of crude oil and internet prices on Timor Leste's economic growth. This model is advantageous in different ways, such as involving variables that are stationary at the first level or difference. However, one of the variables cannot be stationary on the second difference. The number of observations in the sample can be small. ARDL can eliminate endogeneity between explanatory variables for the parameter estimation results not be biased (Marque et al., 2016; Alfaoui, 2018).

The ARDL model formula, which has a time lag length of p, q, and r written ARDL (p, q, r) is as follows

$$GDP_t = C + \sum_{i=1}^{p} \alpha_i GDP_{(t-i)} + \sum_{j=0}^{q} \beta_j OIL_{(t-j)} + \sum_{k=0}^{r} \gamma_k ITU_{(t-k)} + u_t \quad (1)$$

In equation (1), u_t is an independent residual, identically distributed, and homoscedastic. The parameters of C, α_i (i=1,2,…, p), β_j (j=0,1,…,q) and γ_k (k=0,1,…,r) are stable in the long run (Pesaran and Shin, 1999). A model with equation (1) is also called the long-term model (Ozturk and Acaravci, 2010). Equation (1) is equivalent to equation (2) (Heij et al., 2004) and is denoted as follows:

$$D(GRO_t) = \beta_0 D(OIL_t) + \gamma_0 D(ITU_t) + EC_{t-1} + \sum_{i=1}^{p-1} \alpha_i D(GRO_{(t-i)}) + \sum_{j=0}^{q-1} \beta_j D(OIL_{(t-j)}) + \sum_{k=0}^{r-1} \gamma_k D(ITU_{(t-k)}) + u_t \quad (2)$$

where the variable EC_{t-1} is an error correction variable leading to long-term stability. The variable of EC_{t-1} meet the equation

$$EC_{(t-1)} = GRO_{t-1} - \frac{C}{1-\sum_{i=1}^{p}\alpha_i} - \frac{\sum_{j=0}^{q}\beta_i}{1-\sum_{i=1}^{p}\alpha_i} OIL_{t-1,} - \frac{\sum_{k=0}^{r}\gamma_k}{1-\sum_{i=1}^{p}\alpha_i} ITU_{t-1,}$$

The equation 2 model (2) is called the error correction model, abbreviated as ECM-ARDL (p–1, q–1, r–1) or the short-term model. This model is useful for testing the short-term effect of crude oil prices and internet on economic growth. Equation (2) is

also useful for eliminating the multicollinearity of the explanatory variables (Koop, 2006; Saidi et al., 2017).

Testing the effect of crude oil prices and internet on economic growth was conducted following several test steps. The first one was to test the stationarity of all variables to ensure no variable is stationary in the second difference or process I(2). In this test, The augmented-Dickey Fuller test (ADF) by Dickey and Fuller (1979) was used. To strengthen the conclusion, the variable stationarity test known as the Phillips Perron stationary test (PP), developed by Phillips and Perron (1988), was used. The two tests have the same hypothesis formulation; H_0: time series is not stationary against the alternative hypothesis H_1: time series is stationary The decision to test it aimed to reject the hypothesis H_0 (accept hypothesis H_1) in case the probability of the test statistic is less than the significance level of 1%, 5%, or 10%.

The second step involved the cointegration relationship between crude oil prices, internet, and economic growth and was examined using the ARDL bound cointegration test. The ARDL (p–1, q–1, r–1) bound model is given below.

$$D(GRO_t) = \beta_0 D(OIL_t) + \gamma_0 D(ITU_t) + \sum_{i=1}^{p-1} \alpha_i D(GRO_{(t-i)}) + \sum_{j=0}^{q-1} \beta_j D(OIL_{(t-j)}) + \sum_{k=0}^{r-1} \gamma_k D(ITU_{(t-k)}) + \vartheta_1 GDP_{t-1} + \vartheta_2 OIL_{t-1} + \vartheta_3 ITU_{t-1} + u_t \quad (3)$$

To test cointegration using equation (2), the steps taken include testing the significance of the parameters ϑ_i (i=1,2,3) using the hypothesis formula H_0: $\vartheta_1=\vartheta_1=\vartheta_1=0$ (There is no cointegration between variables) against the alternative hypothesis H_1: There is ϑ_i (i=1,2,3) so that $\vartheta_i \neq 0$ (there is cointegration between the variables). F-test or Wald's test was used for hypothesis testing. The test was carried out by comparing the statistic and critical value test of the lower bound I(0) and the upper bound I(1). The assumption is that if the value of the test statistic is greater than the critical value of the upper bound, it is concluded that there is cointegration between crude oil prices, internet, and economic growth with a significance level of 1%, 5%, or 10%. The last step involved checking the residual assumptions to confirm whether there was autocorrelation, normality, and homoscedasticity using the Breud Pagan LM, Jarque Bera, and ARCH LM test. The residual assumptions also check the ARDL model parameters (p, q, r) stability using the CUSUM and the CUSUM Square test (Brown et al., (1975)).

4. EMPIRICAL FINDINGS AND DISCUSSION

4.1. Empirical Findings

The stability of all variables was tested using the ADF and the PP test. The analysis found that the crude oil price variable is stationary in the first difference and the internet and economic growth variables are stationary at the level and the first difference. The results of these calculations are shown in Table 1.

Since not all variables are stationary at the level, the next step involved a cointegration test. The ARDL bound cointegration test was also used. Before carrying out the cointegration test, there was need to determine the length of the ARDL model time lag based on the AIC (Akaike Information Criterium) information criteria. The optimal ARDL model time lag length was given as p=3, q=2, and r=3. The ARDL(2,1,2) bound model was used. The calculation result of the F-statistical value from the ARDL bound test was 490.9847. Compared with the critical value of the upper bound I(1) with a significance level of 1%, 6.028 is obtained. Therefore, crude oil prices, internet, and economic growth are cointegrated at a significance level of 1%. This means that the three variables have a long-term relationship.

The ARDL (3,2,3) long-term and the ECM-ARDL(2,1,2) short-term coefficients are then estimated. Table 2 shows the estimation results of all coefficients, including the intercept (constant term). The long-term coefficients of the ARDL(3,2,3) model in Panel A are significant, where crude oil prices and internet are 5% and 1% significant. In Panel B, the short-term coefficients of all variables in all-time lags of the ECM-ARDL (2,1,2) model are 1% significant. Therefore, crude oil prices and internet affect Timor Leste's long-term and short-term economic growth. For every 1% increase in crude oil prices, there is a corresponding economic growth decrease of 10.3% in the long-term effect. In every 1% increase in the number of internet users, economic growth increases by 27.65%.

Table 1: Stationarity test for variables

Variables	ADF Test		PP test	
	Constant	Constant and Linear Trend	Constant	Constant and Linear Trend
OIL	−1.498385	−2.209883	−1.605311	−1.915738
D (OIL)	−3.442999**	−2.859713	−3.530545**	−4.631388**
ITU	−2.390586	−1.330106	−4.772583*	−3.413529***
D (ITU)	−5.775158*	−5.018506*	−5.374493*	−5.152712*
GRO	−4.843467*	−2.193595	−1.812432	−0.861639
D (GRO)	−1.333368	−4.050179**	−4.157927*	−11.10705*

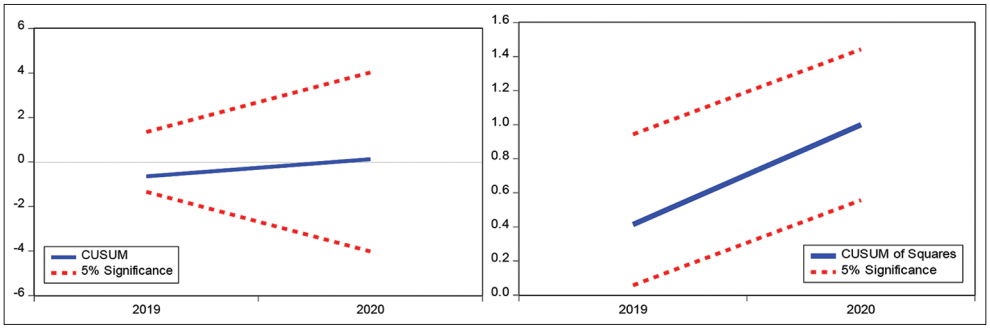
*, **, *** significant at 1%, 5%, 10% level. Source: Own processing

Table 2: ARDL (3,2,3) model and ECM-ARDL (2,1,2) model

Variables and constants	Coefficient	t-statistic	Probability
(A) ARDL (3,2,3) model with dependent variable GDP			
OIL	−1.033011	−5.579800	0.0307
ITU	0.276545	11.30360	0.0077
C	9.850940	15.23950	0.0043
(B) ECM-ARDL (2,1,2) model with dependent variable D (GDP)			
D (GRO(−1))	−0.890502	−40.16853	0.0006
D (GROP(−2))	−0.940434	−36.49508	0.0007
D (OIL)	0.114800	37.90092	0.0007
D (OIL(−1))	−0.217448	−46.83994	0.0005
D (ITU)	−0.521126	−72.37759	0.0002
D (ITU(−1))	−0.382994	−39.64072	0.0006
D (ITU(−2))	0.046240	13.36310	0.0056
EC(−1)	0.471919	70.07030	0.0002

Sign *, ** means significant at significant levels 1%, 5%. The statistical probability value of the JB test is 0.860326, while the values of the BPLM test and ARCH LM test according to the F-statistic are 0.5174 and 0.2597

Figure 1: Stability test of ARDL(3,2,3) model parameters



The final analysis involved checking the ARDL (3,2,3) model assumptions, both the residual and parameters' stability. The statistical values of the residual assumption test are listed at the bottom of Table 2. Considering the BPLM, ARLM, and JB tests probability values, it can be concluded that residuals are homoscedastic and normally distributed with no autocorrelation. All parameters are stable in the period 2005 to 2020, as indicated by the stability model. This is indicated by the graph showing the pattern of changes in the ARDL (3,2,3) model parameters, which is between the two limit lines 5% significance as indicated in Figure 1.

2.2. Discussion

Crude oil prices in Timor Leste affect economic growth in the long term and short term. This is in line with Omitogun et al. (2018), Wen et al. (2018), Mo et al. (2019), Akinsola and Odiambo (2020), Baek et al. (2021), Kiswani (2021), and Sadath and Acharya (2021). However, it contravenes these studies on the nature of the effect. This study shows that an increase in the price of crude oil has a negative effect, contradicting previous ones that established a positive effect on economic growth. This difference is attributed to the diverse country characteristics and the data period (Ozturk, 2010, Odiambo, 2020; Adam et al., 2021). Furthermore, the internet positively affects economic growth, which is in line with Salahuddin and Gow (2015), Donou-Andonsou (2018), Habibi and Zabardast (2020), Saidi et al. (2020), David and Grobler (2020), Rosnawintang et al. (2021), and Cheng et al. (2021) but contradics Haftu (2019) and Danish (2019).

The analysis from this research provides the following proposals for the policy set up and implementation by the Timor Leste government. First, the government should increase the production capacity of crude oil. Second, the government should put resources towards exploring new oil reservoirs and work towards increasing the production capacity to increase crude oil exports. There is a need to encourage internet use by making it readily available across the country and affordable. This can be achieved by developing the technological infrastructure, both hardware and software, and equipment.

5. CONCLUSION

Crude oil plays a significant role in the Timor Leste economic growth. It is a useful resource in industrial production processes, transportation, and power generation. Since it is a basic necessity for industrial growth and economic development, countries with little or no oil import need crude oil to meet domestics needs. Generally, the increase in demand for imports on many occasions causes an increase in crude oil prices. The internet also plays an important role in economic and business activities. For instance, it is used to share data and conduct online transactions within a country and worldwide.

In a bid to examine the effect of crude oil and internet prices on economic growth in Timor Leste, the ARDL model was used to analyze data spanning from 2005 to 2020. The cointegration test results showed that the crude oil price, internet, and economic growth have a long-term relationship. The coefficient estimation results from the ARDL and the ECM-ARDL model show that crude oil prices and the internet affect economic growth in the long term and short term. In the long term, every 1% crude oil price rise leads to a decrease in economic growth by 10.3%. The result is similar in the case of a price reduction in crude oil prices. For every 1% increase in internet users, economic growth will increase by 27.65%.

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