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Effects of Energy Consumption, Economic Growth and Urbanization on Indonesian Environmental Quality

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ABSTRACT

This study attempts to investigate the impact of urbanization on environmental degradation in the presence of economic growth, trade, and use of energy for Indonesia. For this purpose, this study uses CO_2 emission as endogenous indicators and GDP per capita, the use of energy, urbanization, and trade liberalization as exogenous indicators. Annual time series data are taken from World Development Indicators (WDI) for the period of 1970 to 2018. First of all, in order to check the characteristics of the indicator ADF and PP unit root tests are applied. Results indicate that Trade and Urbanization are stationary at a level while rests of all are at first difference. Further, the study uses the ARDL-bound test to check the co-integration in the model and verifies the existence of co-integration. The long run results are estimated by ARDL methodology. Results confirmed that there does not exit the EKC hypothesis in Indonesia because economic growth boosts the carbon production level in Indonesia. Energy consumption also creates environmental degradation while trade decreases the carbon emission level. Urbanization has not significantly influenced the level of the environment. It is just because of the country's high urban development, energy use is still less due to the less income of the majority of population, and this may be one of the explanations why urbanization is not affecting the country's carbon dioxide pollution.

Keywords: Emission of CO_2, Urbanization, Use of Energy, ARDL, Development of Economy, Indonesia

JEL Classifications: Q56, N7

1. INTRODUCTION

The destruction of the environment due to anthropogenic activities is an acknowledged fact. Global climate change which is due to the burning of non-renewable energy (oil, natural gas, and oil), is a severe problem faced by the world, which eventually raises CO_2 emissions and greenhouse gases which pollute the atmosphere (Change, 2007). In the present world urban development is classified among the fastest trend in society, as many individuals are moving to cities every day for several social protection and economic needs. In ordinary situations, urbanization increases productivity, creates more wealth, provides additional economic opportunities, leads to high innovation that reshapes arts, further vices of crime, exclusion, environmental degradation, and poverty (Bloom et al., 2008). It is stated that more than 50% of people around the globe are living in urban areas according to (United Nations, 2014), and it is predicted that the amount in 2050 will reach up to 70%. The rapid increase in urbanization will lead to a focus on Africa and Asia. It is estimated that these two will reach 90% of the expansion in worldwide urbanization. According to the UN World Urbanization Prospects DESA's Population Division 2014 review, China, Nigeria and India lead to the global urbanization. The world's urban population of these three countries is anticipated to reach 37% in 2050. In India growth of urban population expected to reach 404 million in 2050, Nigeria 212 million, and China 292 million. In Nigeria, the urban population in 2013 is 50.84% as estimated by the World Bank.

In existing literature urbanization is newly known as a significant factor of carbon emissions (Abdul Aziz and Abdul Manab, 2020;

Hossain, 2011; Sharma, 2011). These studies have used CO_2 emissions as an exogenous variable and trade, urbanization, income, and energy consumption as explanatory variables. Energy consumption increased due to a rise in urbanization which eventually increases economic growth raises the trade volume in the whole world which leads to rising carbon pollution at the local and global levels. Some studies investigate the impact of economic growth, free trade, urbanization, low carbon emissions, and energy use but there is no original research to examine the association between these variables in Indonesia. Current study donates to existing research by examining the causation association among energy use, development of economy, emission of CO_2, trade openness, urban development in Indonesia during 1990-2018. According to Table 1 that is showing the data collected from year 1990 to year 2018 from the statistics issued by the world development indicators (World Bank, 2020), with the increase in the time there is increase in the use of energy and carbon emission level. The Table 1 also confirms that with the increase in the use of the energy and CO_2 emission level economic growth has also been increased. So the data confirms that there exits the positive relationship with the energy use, economic growth and CO_2 emission level. Meanwhile the use on renewable energy consumption is decreased with the passage of time.

Figure 1 is showing the association between energy consumption, consumption of renewable energy, GDP development, and the emissions of carbon dioxide (CO_2).

According to Figure 1, there is an increasing and positive relation for energy use, emission of CO_2, and development of economy

Figure 1: Energy consumption, CO_2 emissions and GDP growth

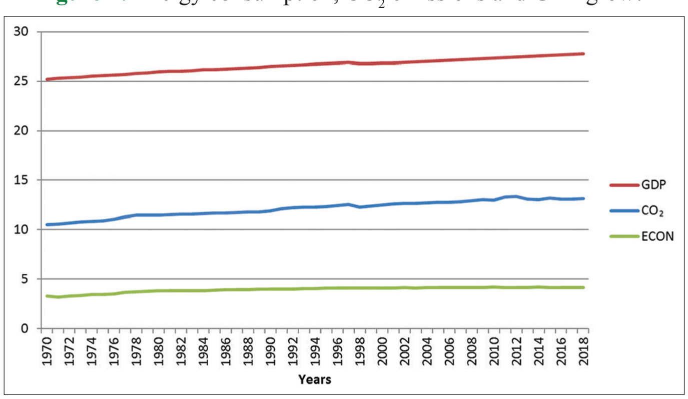


Table 1: Association between energy consumption, renewable energy consumption, GDP growth and the emissions of carbon dioxide

Year	Renewable energy	Energy use	CO_2 emissions	GDP growth
1990	11.98054361	1210.967229	3.138844339	9.00852714
1995	9.029613848	1687.351187	5.912452879	9.829085181
2000	6.743503724	2107.814275	5.420915014	8.858868177
2005	4.924525098	2558.495631	6.791853296	5.332139149
2010	3.819042295	2601.44941	7.745175905	7.424847386
2015	5.194442589	2202.367654	8.130210313	5.091515721
2016	6.569827583	2242.023671	6.131018287	4.449755765
2017	6.569827583	2273.523545	6.246101901	5.741829576
2018	6.569827583	2301.946152	6.343888782	4.74160645

in Indonesia between 1970 and 2018. That also means that in Indonesia economic development is increasing as CO_2 emission rates raise. Furthermore, it shows that with the increase in time, there is a positive association among the energy use emission of carbon in Indonesia. Hence concluded from the raw data, there exists a positive association among the economic expansion, use of energy and environmental degradation.

Amongst the proceeding sections, section 2 concludes the literature review, data and methodology are discussed in section 3, section 4 consists of results and discussion, and the last section concludes about the study as a whole.

2. LITERATURE REVIEW

In this area, studies have shown various findings, i.e., the current study of (Farhani and Ozturk, 2015) presented the monotonous association among carbon emissions and GDP which differ from the EKC method and economic growth positively effecting CO_2 emissions. It is also highlighted that the rise in urbanization could mainly increase in carbon emissions in Tunisia. Liu (2009) found the link between population development, energy efficiency, urbanization, and economic development in China for the duration 1978 to 2008 was analyzed using the ARDL-bound testing method and factor model for decomposition. The outcomes of the study in the short and long run described unidirectional causation within urban development and energy. Poumanyvong and Kaneko (2010) used the STIRPAT method then inspected the influence of urbanization on CO_2 emissions and energy usage among 99 nations during the data span of 1975-2005. The outcomes revealed that urbanization has a different effect on carbon emissions and energy usage and growth level. When urbanization rises in low-income economies, it decreases power consumption. Whereas, in high and middle-income economies, it raises energy efficiency. The entire income group positively influences on urbanization on carbon dioxide pollution, although it is more noticeable in average income economies. Martínez-Zarzoso and Maruotti (2011) identified the inverted U-shaped correlation between CO_2 pollution and urbanization as having a positive effect on low urbanization rates. On threshold examination, when economies divided into groups, the findings express that a point is recognized for the two groups, after which urbanization's emission elasticity converts negative and beyond an inevitable point rise in urbanization does not raise the level of emissions. For other income groups, urbanization is not the critical factor for rising pollution, rather than population and affluence.

Sharma (2011) analyzed 69 economies and analyzed the emission of CO_2 by applying a dynamic panel model range 1985-2005 by distributing data to income groups such as high, middle, and low-income levels. The study findings have shown that there is an increasing effect of GDP, energy use, and trade on the emission of CO_2, simultaneously, for all income groups, urbanization is negatively associated with carbon emissions. Final findings shown that trade accessibility, per-person spending, and urbanization negatively effects CO_2 pollution, while GDP, utilization of energy have a substantial effect on the emission of CO_2. Poumanyvong et al. (2012)explored the effect of urban growth on CO_2 emissions and regional domestic power use by employing the Stochastic Impacts on Population, Affluence, and Technology (STIRPAT) method for the 88 low, lower-middle and high-income economies across the duration 1975-2005. Results showed that increasing urban development in lower income level countries reduces domestic use of energy, while energy utilization was increased for higher income level countries. Initially, household energy consumption reduces and then increases in the middle-income countries more than 70%. If the sample decreases to 80 countries, then results demonstrate that industrialization in middle and lower-income level countries raises carbon pollution. In higher-income economies, the residential emissions increase in the first step, and after that urbanization rise more than 66 %. Hossain (2011) explored the association within power consumption, carbon pollution, urbanization, trade openness, and financial expansion in newly industrialized economies from 1971 to 2007. The causative outcomes described that there is no long-run correlation, and in the short-run uni-directional causality between trade liberalization and economic expansion to the emission of CO_2, from market openness to GDP growth, from trade liberalization to urbanization, from economic growth to energy usage, and from industrialization to development. In the short run, elasticity of emissions to energy usage is greater, when energy consumption rises in countries the emission level increases environmental pollution. Though, with respect to trade accessibility, industrialization and sustainable development to ecological quality is recognized in the long run for normal good.

Zhang and Lin (2012) discovered the association among the utilization of energy, CO_2 pollutions, and urban economic expansion by applying the STIRPAT model for regional and national during the data span of 1995–2010. Findings indicated that the urban population increases CO_2 emissions and energy consumption at a national level. In contrast, at the regional level, the impact is different in various regions i.e., the effect of urbanization towards the emission of carbon in the eastern province is lower to the central region. Hossain (2012) inspected the causes of energy use, CO_2 pollution, urbanization, international exchange, and economic development in Japan between 1960 and 2009. The outcome revealed that the rise in energy consumption leads to a higher environmental population but commercial openness, urbanization, and economic expansion in the long term. Sadorsky (2013) explored the urbanization, income, and industrialization on energy use by using specific correlated effects estimators and average group estimators for a panel of 76 underdeveloped countries. The outcomes showed that income and utilization of energy negatively related to as a 1% rise in income lead to reduce 0.45-0.35% energy consumption in the long-run. The urban population elasticities in long run accounted 0.07-0.12%, whereas the effect of urbanization on power dissipation exists mixed. Ponce de Leon Barido and Marshall (2014) experimentally inspected how urban populations impact emission of CO_2 by applying random and fixed effects over the period 1983-2005 among 80 nations. Results revealed that carbon emissions and urbanization are positively associated with a rise in urbanization by 1% lead to rising carbon emissions by 0.95%. Sadorsky (2014) studied the effect of industrialization and urbanization on energy use in developing countries. The findings showed that higher income boosts the consumption of energy in the short and long run. Urbanization reduces energy usage whereas industrialization increases it. Zhao and Wang (2015) described the connection of electricity consumption with the development of the economy in China by applying Granger causality and VECM methods during 1980-2012. The outcome revealed that the association between energy usage and industrialization, and the association between urbanization and financial growth is insignificant. Moreover, there is bidirectional nexus among economic expansion and vitality consumption, whereas unidirectional causation between economic progress and energy usage.

Akpan and Akpan (2012) examined the relation of Nigeria's carbon pollution, economic development, and electricity consumption for 1970-2008, using a multivariate vector error correction model. The results demonstrated an increase in long-term economic growth, carbon emissions, and electricity use. The causation relationship showed a unidirectional connection with CO_2 pollution and financial growth. Al-Mulali et al. (2015); Al-Mulali et al (2015) inspected the energetic impact of economic development, urbanization, financial advancement, exchange openness, petroleum utilization on CO_2 outflow, for 129 nations by applying composite panel for 1980-2011. The Pedroni cointegration explored the long-term relationship of variables by using the Granger causality and DOLS revealed that financial growth increases long-term and short-term environmental change as a decrease in emission of CO_2. Fossil fuel utilization is the principal cause of pollution in the environment in maximum income groups. Acaravcı et al. (2015) studied the association among per person electricity usage, GDP per capita, FDI per capita, and exchange accessibility in Turkey from 1974 to 2013 by using Granger causality and ARDL model. The outcomes of the study verified the long run nexus between variables. In the short and long run, the causality result revealed the unidirectional association among GDP and electricity consumption per capita.

The effect of renewable energy on CO_2 mitigation has been explored by (Al-Mulali et al., 2015; Al-Mulali et al., 2015) for 23 European nations during 1990-2013, using co-integration methods. Pedroni cointegration test shows that there exists a long-run association among GDP growth, emission of CO_2, clean energy, and monetary growth, and industrialization. FMOLS results showed that economic growth, financial progress, and urbanization contribute to an increase in CO_2 emissions while long-term market openness decreases. Additionally, renewable energy which is obtained from waste, flammable renewables and trash, hydropower, and atomic energy impacts on CO_2 emission, whereas wind and solar power renewable energy is not significant. The Granger causality VECM claimed that in long run only economy expansion caused CO_2 emissions in all projects, while in a few models the remaining variables influenced CO_2 emits. Al-Mulali et al. (2015) examined the reasons for environmental degradation by using 14 MENA countries and cointegration methods over the period 1996-2012. Pedroni cointegration findings showed the long term association among energy consumption, ecological footprint, trade openness, urbanization, political stability, and industrial development. Moreover, FMOLS outcomes presented that urbanization, absorption of energy, industrial growth, and commercial accessibility increase environmental degradation while decreasing economic stability. The findings of the Granger causality showed correlation with the environmental footprint between parameters in long run as well as in short run.

Ben Jebli et al. (2015) used the method of panel co-integration across 24 sub-Saharan Africa economies between 1980 and 2010. Short-run causality of Granger causality revealed bidirectional causation among economic development and CO_2 pollution; bidirectional causality through real exports and CO_2 emissions; unidirectional causality between greenhouse gases and actual imports; and causality amongst sustainable energy usage and exchange accessibility. Generally, the EKC hypothesis fails to endorse examined nations in the long run. Farhani and Ozturk (2015) studied dynamic association among air pollution, climate change, and energy consumption for transition and industrialized countries of six countries panel during the data span 1990-2012. The findings of the pooled square regression analysis showed that air quality and energy consumption positively affects climate change. The results revealed that there is no substantial influence between climate change and energy consumption when accounting for state time and unique variant disruptions for the analysis. Farhani et al. (2013) observed the correlation among utilization of energy, economic development, environmental degradation, and industrialization applying the ARDL method for UAE for 1975-2011. The outcomes showed the connection of emission of CO_2 and development of the economy by using reversed U-shaped hypothesis, at first step development of the economy rises energy consumption at the per capita income rates where it decreases. Energy utilization decreases greenhouse gases and rises due to urbanization; export increases environmental sustainability over decreased CO_2 emissions. The Granger causation showed that energy consumption and carbon emissions have significant urbanization increases carbon pollution. Balibey (2015) inspected the energetic impact of CO_2 outflows, outside coordinate speculation and financial development by surveying natural Kuznets curve system for Turkey for the time of 1974-2011 by utilizing Johansen cointegration, Granger Causality tests and fluctuation deterioration examination of Vector Auto Regressive model (VAR) and impulse-response models for Malaysia (Bakhtyar et al., 2017). The finding on causality shows that economic development and FDI have a significant and increasing influence on CO_2 excretions.

3. THEORETICAL FRAMEWORK AND DATA

Throughout this study, we addressed both Stochastic influences of the regression on community, assets, and innovation (STIRPAT) and the economic models that identify the Kuznet environmental curve (EKC) within terms of income and conceptual frameworks connecting the EKC to urban growth, not just in terms of the development of the economy. The previous works (Dietz and Rosa, 1994) shed light to the concept of the dynamical composition of the STIRPAT formula, which includes numerical parameters of population density (P), participation each inhabitant (A) and the strength of manufacturing in economic relations as a degree of environmental damage innovation (T). The requirement of the model is provided in a singular year from the corresponding equation;

$$I_i = \beta P_i^{\alpha_o} A_i^{\alpha_1} T_i^{\alpha_2} e_i \quad (1)$$

Where; I_i, P_i, A_i and T_i reflects the influence of community and the development in countries i, α and β are estimated variables, and i refer to the term of the error term. IPAT is commonly used to analyze environmental factors (Cole and Neumayer, 2004; Dietz and Rosa, 1994; York et al., 2003). The hypothesis is that CO_2 production is based on demography but may adjust as the efficiency of life in metropolitan areas is reached. More precisely, economic patterns in urban environments might have different dual effects, both linked to higher wages and higher demand density than industrial development. Initially, industrialization emphasizes the push for new fuels that are changing the resource models utilized.

3.1. Data

Dataset for this analysis was collected from WDI (World Bank, 2020), from 1970 to 2018. The emission of CO_2 shows carbon dioxide pollution in kilotons (kt), Urbanization is calculated by the urban population in the total populace, GDP approximates GDP per capita growth (GDP), energy use is determined by fossil fuel usage and, trade is determined by total exports/imports as a percent of GDP.

3.2. Specification of the Model

According to (Farhani et al., 2013; Hossain, 2011), we included urbanization in the carbon emissions equation, because we estimated that CO_2 emissions would be ascertained by trade, employment, power consumption, and urban growth, our basic model has been defined here below;

$$CO_2 = A + \gamma_1 URBAN + \gamma_2 GDP + \gamma_3 ECON + \gamma_4 TRD \quad (2)$$

Take natural logarithm of the above-mentioned equation and we will get;

$$lnCO_{2t} = \delta_o + \delta_1 lnURBAN + \delta_2 lnGDP_t + \delta_3 lnECON_t + \delta_4 lnTRD_t + \epsilon_t \quad (3)$$

Above two equations as urbanization parameters used in the combustion equation, we use the Auto-Regressive Distributive lag (ARDL) model to identify the connection between the indicators studied, as seen in the equation. (4) Below;

$$lnCO2_t = \varphi_o + \sum_{i=1}^{p} \varphi_1 \Delta lnCO2_{t-1} + \sum_{i=0}^{p} \varphi_2 \Delta lnURBAN_{t-1} + \sum_{i=0}^{p} \varphi_3 \Delta lnGDP_{t-1} + \sum_{i=0}^{p} \varphi_4 \Delta lnECON_{t-1} + \sum_{i=0}^{p} \varphi_5 \Delta lnTRD_{t-1} + \pi_1 lnCO_{2t-1} + \pi_2 lnURBAN_{t-1} + \pi_3 lnGDP_{t-1} + \pi_4 lnECON_{t-1} + \pi_5 lnTRD_{t-1} + \epsilon_t \quad (4)$$

Where; $lnCO_2$ relates to CO_2 mitigation, lnURBAN is the urbanization, lnGDP is the log of economic expansion, lnECON maintains a utilization of energy, and lnTRD is trade openness trade, t denotes time spam.

First of all, we estimate equation 4 by ARDL-bound test to verifying the long-run association among the model which is explained by (Pesaran et al., 2001). That used F-stats to check the co-integration between the indicators; for example, the exogenous indicators have a long-run association with the endogenous indicators. For this purpose use the F-statistics test, the null hypothesis of F-statistics are there exists no-cointegration in the equation which is represented by H_o: $\pi_1=\pi_2=\pi_3=\pi_4=\pi_5=0$. While on the other hand the alternative hypothsis are there exist co-integration in the model and that is represented by H_o: $\pi 1\neq\pi_2\neq\pi_3\neq\pi_4\neq\pi_5\neq 0$. According to (Pesaran et al., 2001) if the value of F-statistics is more significant than the lower and upper bound of significance level (i.e., 1, 5 and 10%) then rejected the null hypothesis which means there exists the co-integration in the model and on the other hand if F-statistics value is less than lower and upper bound of significance level then the null hypothesis is accepted and results from there does not exist the co-integration in the model which is also explained by (Pesaran and Pesaran, 1997). Using equation (5) for checking long-term ARDL coefficients;

$$lnCO_{2t} = \varphi_o + \sum_{i=1}^{p} \varphi_1 \Delta lnCO_{2t-1} + \sum_{i=0}^{p} \varphi_2 \Delta lnURBAN_{t-1} + \sum_{i=0}^{p} \varphi_3 \Delta lnGDP_{t-1} + \sum_{i=0}^{p} \varphi_4 \Delta lnECON_{t-1} + \sum_{i=0}^{p} \varphi_5 \Delta lnTRD_{t-1} + \epsilon_t \quad (5)$$

where is it; $\ln CO_2$ refers to the CO_2 emissions, lnURBAN is the urbanization, lnGDP is the economic expansion, lnECON is the use of energy and lnTRD is the trade liberalization, the subscript t indicates the timer-spam. To choose the model's lag length, the Bayesian Schwarz (SBC) criterion is chosen, and an error correction term is used to evaluate the variable's short-run dynamics;

$$lnCO_{2t} = \varphi_o + \sum_{i=1}^{p} \varphi_1 \Delta lnCO_{2t-1} + \sum_{i=0}^{p} \varphi_2 \Delta lnURBAN_{t-1} + \sum_{i=0}^{p} \varphi_3 \Delta lnGDP_{t-1} + \sum_{i=0}^{p} \varphi_4 \Delta lnECON_{t-1} + \sum_{i=0}^{p} \varphi_5 \Delta lnTRD_{t-1} + pecm_{t-1} \quad (6)$$

After Pesaran (1997), the long-term stability coefficient and the short-term parameters are evaluated with the help of the cumulative sum of recursive residues (CUSUM) and the combined sum of recursive residue squares (CUSUMSQ). Furthermore, there we also use the Ramsey reset test to confirm the stability of the model.

4. RESULTS AND DISCUSSION

Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root used to check the sequential order of integration among the indicators. Furthermore, verifies, the probability of operating ARDL is practicable or not.

The results showed that use of energy and trade liberalization are stationary at level, which means they are an order of integration is I (0). At the same time, CO_2 mitigation, urbanization, and development of the economy are not stationary at the levels, but at the first difference, it is stationary, which reflects that the variables I (1). Consequently, within corporation variables order, we can perform the ARDL as (Pesaran et al., 2001) proposed that ARDL brings the variables together I (0) and I (1) (Table 2).

4.1. ARDL Cointegration Results

According to (Pesaran and Shin, 1998; Pesaran et al., 2001) ARDL is the most commonly recognized approaches because of it has many benefits over certain approaches of co-integration (Engle and Granger, 1987; Johansen, 1988). Some of ARDL's benefits are (a) the integration order is not constantly the same, (b) ARDL may function with a small sample, and (c) at the same time it gives the short and long-run coefficients. Since the equation will give the same result in simplified form (Ozturk and Acaravci, 2010; 2013). Given its limitations, ARDL remains the best regression approaches commonly used in economics for estimation.

Table 3 shows the outcome of the ARDL co-integration, which shows that perhaps the F estimate (5.634221) is superior than the critical upper and lower bounds, as seen in the table according to the (Narayan, 2005) rejection of the null hypothesis. It reflects that there is cointegrated exists after the rejection of the null hypothesis for all significant levels, but 1% will be the strongest significant level concerning the economy. The relation of variables in the long-run can be conducted with the help of equation (5), present in Tables 4 and 5.

The long-term result seen in Table 4 earlier indicates that urban growth has a marginal positive influence on CO_2 exposure which suggests that urbanization has not a significant effect on Indonesia's CO_2 production, the finding supported the conclusions (Martínez-Zarzoso and Maruotti, 2011) following study of the thresholds of developing countries, which demonstrates that the elasticity of the

Table 2: Unit root tests

Tests	Augmented Dickey-Fuller		Phillips-Perron	
Variables	t-statistic	Prob.	t-statistic	Prob.
CO_2	−2.2742	0.4394	−2.1367	0.5128
D(CO_2)	−6.8598***	0.0000	−7.9509***	0.0000
ECON	−1.4490	0.8332	−1.4001	0.8484
D(ECON)	−8.6685***	0.0000	−8.4621***	0.0000
GDP	−2.4183	0.3658	−2.1583	0.5011
D(GDP)	−5.0091****	0.0009	−4.9772***	0.0010
TRAD	−3.4037**	0.0156	−3.3303**	0.0189
D(TRAD)	-----	-----	-----	-----
URBAN	−4.5070***	0.0007	−2.7422*	0.0745
D(URBAN)	-----	-----	-----	-----

***, ** and * show 1%, 5% and 10% level of significance respectively

Table 3: ARDL bound test

Test statistic	Value	K
F-statistic	5.634221	4
	Critical limits	
Level of significance	I_0 bound	I_1 bound
5%	2.86	4.01
1%	3.74	5.06

Table 4: ARDL long-run estimates

Variable	Coefficient	Std. error	t-statistic	Prob.
URBAN	0.1180	0.0827	0.1545	0.1180
GDPPC	0.2917***	0.0378	7.7082	0.0000
ECON	0.3861**	0.1458	2.6482	0.0123
TRAD	−0.2594**	0.1034	−2.5091	0.0172
C	3.6172***	0.3469	10.4271	0.0000

***, ** and * show 1%, 5% and 10% level of significance respectively

Table 5: ARDL short-run estimates

Variable	Coefficient	Std. error	t-statistic	Prob.
D(CO_2(−1))	0.6424***	0.1242	5.1722	0.0000
D(CO_2(−2))	−0.0238	0.1163	−0.2048	0.8390
D(CO_2(−3))	0.2779**	0.1077	2.5791	0.0146
D(URBAN)	1.1726***	0.2194	5.3455	0.0000
D(GDPPC)	0.3015***	0.0573	5.2590	0.0000
D(ECON)	0.3991**	0.1733	2.3034	0.0277
D(TRAD)	0.0384	0.0940	0.4086	0.6855
D(TRAD(−1))	−0.2431**	0.0874	−2.7821	0.0089
D(TRAD(−2))	−0.2607**	0.0839	−3.1091	0.0039
CointEq(−1)	−1.0338***	0.1542	−6.7056	0.0000

***, ** and * show 1%, 5% and 10% level of significance respectively

industrialization of CO_2 emissions is negative at a particular stage and that when urban development rises beyond that point, it do not enhance higher CO_2 pollution and result has also verified it (Hossain, 2012) Who said the urbanism had no significant effect on Japan's carbon mitigation. However, the finding runs contrary to the latest result (Farhani and Ozturk, 2015; Zhang and Lin, 2012), who believed that accelerated urbanization would lead to higher CO_2 concentrations for Tunisia and China. Possible causes, why urbanization development has little effect on CO_2 output in Indonesia, may be linked to income inequality in the nation and poverty rates.

Growth of the economy has had a significant positive effect on greenhouse gases, as a 1% rise in economic development could correspond to a 0.2917% increase in CO_2 emission levels; the outcome supported the results of other researchers (Akpan and Akpan, 2012; Al-Mulali et al., 2015). Consumption of energy also had a boosts the emission of CO_2 as, based on a study, a 1% increase in use of energy will cause a 0.3861% increase in emission of CO_2; it supported the study (Hossain, 2012). However, the trade liberalization hurts the emission of CO_2, since a rise of 1% in exchange openings could reduce CO_2 pollutants by 0.2594% in Indonesia, this result, thus, supported (Al-Mulali et al., 2015; Al-Mulali et al., 2015; Nawaz et al., 2019).

Short-term results show that urbanization has a positive and significant effect on the carbon emission level and there it supports the hypothesis of (Farhani and Ozturk, 2015; Zhang and Lin, 2012) they believed that accelerated urbanization would lead to greater CO_2 as long-term economic productivity and energy usage positively accelerate CO_2 emissions over the longer term. However, trade accessibility still preserves the position. Diminish CO_2 pollution, for example, in the long run. According to the vague, ECM term has negative and significant that also verifies that there exit long-run associations in-between the indicators. Moreover, it also confirms that if the model moves to the dis-equilibrium stage, then it will move to its origin with a speed of 1.03%. That shows that the model will come to its origin within a year.

To explain the efficiency and accuracy of the model, the result of model diagnostics are presented in Table 6. Overall model diagnostics confirm that the model is good fit and results are unbiased and also the estimated equation and parameters are consistent and stable. R-square and Adj. R-square confirms that exogenous indicators explained almost 99% to endogenous indicators. DW and LM test indicates that there does not exist a problem of autocorrelation in the model. At the same time, the Heteroskedasticity test also indicates that there does not exist the problem of Heteroskedasticity in the model. Jarque Bera test indicates that the residuals are normally distributive and Ramsey rest and CUSUM and CUSUMsq test indicate that the model and estimates are consistent and stable. The result of CUSUM stability test and CUSUMQ stability test is reported in the Figures 2 and 3.

Table 6: Model diagnostics

Tests	Prob.
R-squared	0.99467
Adjusted R-squared	0.992893
Durbin-Watson	2.092037
LM	0.4113
Heteroskedasticity	0.2003
Normality	0.0938
Ramsey Reset	0.7356

Figure 2: CUSUM stability test

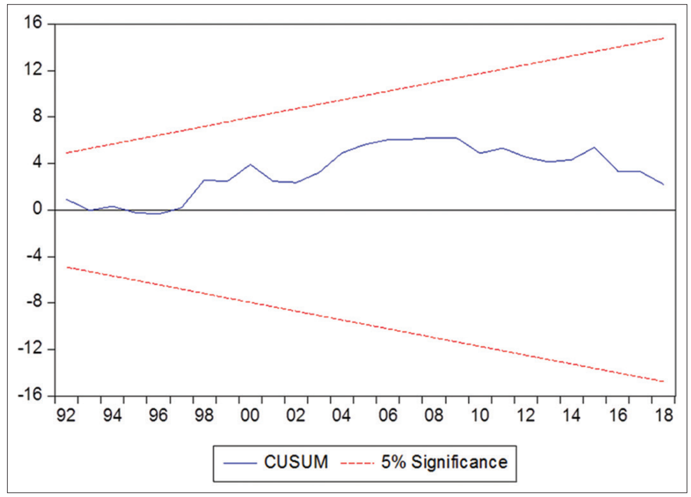
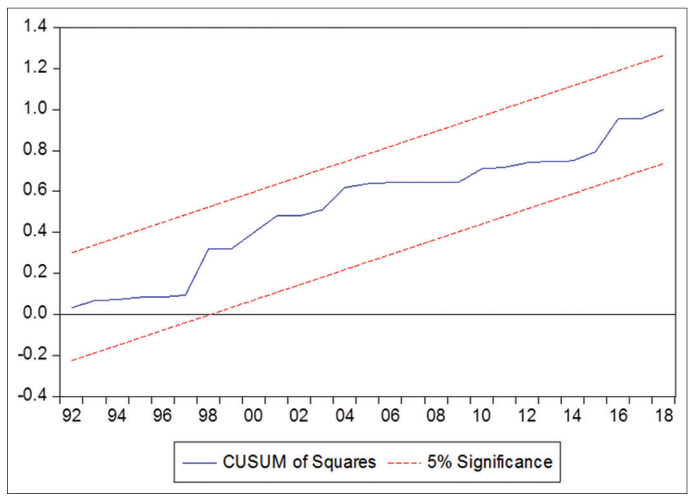


Figure 3: CUSUMSQ stability test



5. CONCLUSION AND POLICY RECOMMENDATION

The entire study evaluated whether the rise in the number of residents living in Indonesia's metropolitan areas can cause higher

CO_2 pollution from 1970 to 2018. The co-integration outcome suggested the existence of a long-run association among the indicators, and we discarded the null hypothesis at a 1% level of significance. The primary long-term consequence shows that urbanization does not significantly impact Indonesia's carbon dioxide emissions for the observation timeframe. Although use of energy and economic expansion have a encouraging impact on the production of CO_2, opening to trade has had a inverse effect. According to the short-term fluctuations of variables, urbanization has a significant and positive impact on environmental degradation in Indonesia. Because of urbanization, the demand for energy use increase which results from an increase in the level of carbon emission level, on the other hand, the pattern of other remaining indicators is same as in the long run. Political consequences are that policymakers will implement more qualified initiatives that will make the government increasingly accessible and interconnected with the rest of the country to minimize contamination in the environment in the region.

So, according to analysis conclusion, policymakers must not pay attention to urban development when contemplating strategies to solve pollution issues, as an improvement in city residents has little to do with a increase in CO_2 pollution, possibly due to the decrease in income of most individuals in the country. The adoption of desirable initiatives to limit the amount of carbon pollution is necessary, given the massive hazards induced by constant emissions from energy consumption, renewable energy sources could be among the best alternatives given its lower prices and damages environmental.

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