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Low Carbon Economy and Green Financing

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Abstract. Low carbon economy and Green financing need urgent actions and collaborations from all countries in the world. In 2015 United Nations call for action with the introduction of 17 Sustainable Development Goals (SDGs) and since then all countries have begun their journey to achieve the goals set by 2030. USA, EU are developed countries and market leaders in setting a high bar in progressing along the way, in contrary to developing countries. Regulations and framework in developing countries create gaps that could be easily spotted compared with developed countries. Other obstacles come from lagging in the sustainable agenda implementation in developing countries caused by combination of capabilities building, low awareness, and availability of solid framework. This research use panel unit root analysis, Johansen's co-integration analysis and Granger causality test based on error correction model for the dataset from 1971 to 2014. The result indicates that in the short run, there is one-way causality from energy consumption to CO2 emission. While in the long run the result supports the presence of cointegration relationships between variables.

Keywords: CO2 emission; Energy Consumption; GDP per capita; UN 17 SDGs

1. Introduction

Low carbon economy and Green financing need urgent actions and collaborations from all countries in the world to solve the environment, pollution, and global warming worsening problems. The 17 Sustainable Development Goals (SDGs), which are an urgent call for action adopted by all United Nations member in 2015. Developed and developing or emerging countries acknowledge that to end poverty and other deprivations are collective efforts from all. Strategies to improve health and education, reduce inequality, and prompt economic growth while tackling climate change are elaborated in 17 SGDs. Climate risk is real, we all know and unfortunately some of us had first-hand experienced on the impact of Climate risk such as physical impact from increasing natural disaster, flood, forest fire, increased damaged to crops/rice production due to prolonged drought, warmer global temperature. Report shows that the average world's surface temperature has risen about 2.12 degrees Celsius since the late 19th century, which driven mainly by the increased carbon dioxide (CO2) emission and other human activities. Based on the Climate Risk Country profile issued by USAID in 2017, Indonesia facing a future climate risk such as projected climate change in 2050 which includes increased temperature of 0.8 – 2 degrees Celsius, with greater warming over large western islands i.e Sumatra, Java, Borneo; sea level rise of 150-450 mm by 2056.

On Climate risk, this is related to the SDG number 13, "Take urgent action to combat climate change and its impact" and The Paris Agreement (legally binding international treaty on climate change) adopted by 196 parties in Paris in 2015 and later came into force in 2016. With the goal to limit global warming below 2 degrees Celsius (preferably to 1.5 degrees Celsius compared to pre-industrial level), this is a journey that require collective effort globally from countries in the world. Under Paris Agreement, countries are required to submit their plans in tackling climate action known as Nationally Determined Contributions (NDCs). In the NDCs document, countries outline actions that they will undertake to reduce the Green House Gas (GHG) emission as part of the contribution to reach the goal of Paris Agreement as well as actions undertake to build resilience to adapt to climate change. It is of great significance, motivating, and beneficial to investigate if there is any relationship between GDP per capita, Energy Consumption and CO2 emission. Put these variables altogether, this research is meant to test and answer the question of whether there is any relation between GDP per capita, energy consumption and CO2 emission both in short-term and long-term. And subsequently the potential financing opportunities that are available as part of action in tackling the Climate Risk. Some of the foreseen opportunities are the project financing where Corporation, especially those in high-intensive carbon sectors such as Mining, Oil and Gas, Power, Infrastructure, need capital and specialized financing in transformation journey

to the low carbon economy e.g Project finance, Green Bond issuance, Carbon Credit offsetting. Hence while economic in vast growth mode, there is a need of comprehensive way and real action to promote sustainable development.

1.1 Problem Statement

Problem statement in the study elaborated as follow:

- Is there causal relationship between GDP per capita, Energy Consumption and CO2 Emission.

1.2 Research Objective

The objective of this research is to test whether there is a causal relationship between GDP per capita, Energy Consumption, and the CO2 emissions. The research is also aimed to build awareness on the real Climate risk that we are facing as a nation that is in emerging or growth mode. Energy plays a vital role in economic development and also a potential key for sustainable development going forward.

2. Literature Review

2.1 Relationship between GDP per capita, Energy Consumption and CO2 emissions

The relationship between GDP per capita, energy consumption and the CO2 emission have been discussed by many researchers globally in various scopes and angles. Based on the literature review there are a wide range of mixed result from the precedent studies on economic growth, energy consumption and CO2 emission.

(Jun et al., 2021) conducted research on the impact of globalization, non-renewable energy consumption, and economic growth on CO2 emission for selected South Asian economies during 1985–2018 under the EKC framework. The results identified that globalization is positively associated with CO2 emission. (Akbostanci et al., 2009) studied the relationship between income and environment in Turkey using time series and panel data for the periods1968–2003 and 1992–2001 respectively. Increasing relationship between CO2 emissions and income indicated in their research. (Kasperowicz, 2015) examined the relationship between CO2 emissions and economic growth for 18 EU Member Countries from 1995 to 2012 using data panel approach and basic ECM estimation to verified short and long-run relationship between GDP and CO2 emissions. The result for the short-run is positive due to the fast increase in production, energy use hence increases CO2 emissions. While in the long-run the relationship is negative, this in the back of development of new low-carbon technologies which enables lower CO2 emissions at the same production level.

2.3 Carbon Credit

Under Kyoto protocol on Clean Development Mechanism (CDM), allow Annex I countries to implement emission-reduction projects in developing countries. This project will be able to produce Certified Emissions Reductions (CER) credits, each equivalent to one tonne of CO2. In a nutshell, the projects must provide an emission reduction to be considered under CDM. The other market-based mechanism under Kyoto Protocol is the Emission Trading System (ETS), in which allows countries that have emission units to spare to sell this excess capacity to countries that are over their targets[1]. Thus, a new commodity was created in the form of emission reductions or removals (carbon offset). Carbon is now tracked and traded like any other commodity, this supply and demand for emission units establishes the market price, also known as the "carbon market".

According to article published by McKinsey (*How the Voluntary Carbon Market Can Help Address Climate Change | McKinsey*, n.d.)[2], Carbon credits or Carbon offsets have an important role to play in tackling the climate risk. This mechanism enables individual, corporations to support decarbonization beyond their own carbon footprint, hence could help in accelerating transition to a lower carbon economy. With this, it could also support financing of projects for CO2 removal, to balance out the CO2 emissions that will remain in decarbonization journey. While the voluntary carbon credit market has been experiencing significant momentum, it is still relatively small. McKinsey estimates that annual global demand for carbon credits could reach up to 1.5 to 2.0 gigatons of carbon dioxide (GtCO2) by 2030 (i.e 15 times from 2020 which is only 0.1 GtCO2) and up to 7 to 13 GtCO2 by 2050. Translated to a $5 billion to $30 billion market size in 2030 at the low end and more than $50 billion at the high end. (*A Blueprint for Scaling Voluntary Carbon Markets | McKinsey*, n.d.)[3]. In Indonesia context, the carbon credits opportunity lies in introduction or improvement of sustainable forest management in reducing emissions from deforestation and forest degradation, at the same time developing forest conservation and enhancement of forest carbon stocks. (Tomich et al., 2002) in their research on Carbon offsets for conservation and development in Indonesia, concluded that carbon offsets through agroforestation deemed

[1] https://unfccc.int/kyoto_protocol
[2] How the Voluntary Carbon Market Can Help Address Climate Change | McKinsey, n.d
[3] A Blueprint for Scaling Voluntary Carbon Markets | McKinsey, n.d.

more feasible as alternative of carbon offset with relatively lower cost.

With reference to precedent studies, in the context for Indonesia economy as a developing country, economic and human activities have increasing negative effects on the environment. It is also noted that energy consumption is positively correlated to CO2 emission. Thus, developing countries must determine the feasible options how to reduce carbon emissions as the economy grow (sustainable development).

3. Data dan Research Methods

3.1 Data

Data used in this research are Indonesia GDP per capita (current USD), energy consumption (kg of oil equivalent per capita) and CO2 emissions (kt) data for the period of 1975 to 2018 (44 years). Source of data is taken from World Bank database.

GDP per capita is gross domestic product divided by mid year population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Energy Consumption refers to energy use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. Energy use is measured per kg of oil equivalent per capita. CO2 emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

3.2 Research Methods

The method use in this research is descriptive analysis, error correction model, panel unit root analysis, panel co-integration analysis (Johansen's co-integration test), panel causality analysis (Granger Causality test). The relationship between cointegration and error correction models, first suggested by Granger (Engle & Granger, 1987).

4. Discussion

4.1 Panel Unit Root Analysis

Panel unit root analysis is undertaken as the initial step to estimate the model using vector error correction model, this to test whether the data is stationary in order to do subsequent cointegration test. In this research, unit root analysis is tested using three different unit root tests including Levin, Lin & Chu Test (Levin et al., 2002), IPS-W-statistic (Im et al., 2003), ADF-Fisher Chi-square (Augmented Dickey Fuller, 1979), and PP-Fisher Chi-square tests (Phillips and Perron, 1988).

4.2 Descriptive Analysis

Descriptive analysis conducted on the data set to provide a description or summarize the data. Descriptive analysis is often used when reviewing any past or present data. This is because raw data is difficult to interpret, while the metrics offered by descriptive analysis are much more focused. The below is the descriptive analysis result from dependent and independent variables conducted using Eviews.

Table 1
Descriptive Analysis Result

	DEPENDENT_Y	INDEPENDENT_1_X1	INDEPENDENT_2_X2
Mean	217965.3	1058.179	578.4736
Median	178195.0	651.4407	593.1801
Maximum	490050.0	3694.359	883.9215
Minimum	38987.54	79.17819	297.3061
Std. Dev.	138530.4	1018.927	201.5920
Skewness	0.495527	1.598485	0.025950
Kurtosis	1.981585	4.402868	1.454651
Jarque-Bera	3.702153	22.34586	4.383130
Probability	0.157068	0.000014	0.111742
Sum	9590474.	46559.89	25452.84
Sum Sq. Dev.	8.25E+11	44643140	1747491.
Observations	44	44	44

Dependent variable (Y) is the CO2 emission, independent variable 1 (X1) is GDP per capita growth and independent variable 2 (X2) is Energy Consumption.

- CO2 emission data has mean 217.965, median 178.195, data range from 38.987 (min) to 490.050 (max)
- GDP per capita growth has mean 1.058, median 651, data range from 79 (min) to 3.694 (max)
- Energy Consumption has mean 578, median 593, data range from 297 (min) to 883 (max)

4.4 Panel Unit Root Test Result

As the basic step to estimate Vector Error Correction Model (VECM), panel unit root test is undertaken. This to ensure that the data is stationary. Panel unit root analysis is tested using three different unit root tests including Levin, Lin & Chu Test (Levin et al., 2002), IPS-W-statistic (Im et al., 2003), ADF-Fisher Chi-square (Augmented Dickey Fuller, 1979), and PP-Fisher Chi-square tests (Phillips and Perron, 1988).

Table 4.4.1 shows the results of the panel unit root tests for all the variables (GDP, Energy Consumption, and CO2) at Level. All the variables are not significant (prob > 0.05) under individual unit root result, meaning that they are stationary at level under Levin, Lin & Chu (LLC) for common unit root test; While in Table 4.2.2 where panel unit root test is performed at the first difference, results suggest that all the variables are statistically significant (prob < 0.05) which means the variables are stationary in the First Difference under all the tests (LLC, IPS and Fisher). Individual unit root test on the variables also tested and shows the same result at Level and at First difference. Thus, it can be concluded that every variable is integrated of order one, this mean that the data is stationary and meet the condition for subsequent step, which is to test the co-integration using Johansen co-integration. Johansen co-integration test will be performed to test the long run relationship between variables.

Table 2
Result of Unit Root Test (First difference)

Group unit root test: Summary
Series: DEPENDENT, INDEPENDENT_1, INDEPENDENT_2
Date: 01/16/22 Time: 01:27
Sample: 1971 2014
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.68787	0.0000	3	126
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.54209	0.0000	3	126
ADF - Fisher Chi-square	67.4682	0.0000	3	126
PP - Fisher Chi-square	67.4081	0.0000	3	126

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Eview 12 calculation

4.5 Johansen co-integration test

Johansen co-integration test is undertaken to test the long run direction of the cointegrating relationship. Under Johansen co-integration test, null hypothesis defined as there is no co-integration between variables.

Table 3
Panel cointegration test result using Johansen's co-integration methodology
Date: 01/16/22 Time: 22:46
Sample (adjusted): 1976 2014
Included observations: 39 after adjustments
Trend assumption: Linear deterministic trend
Series: DEPENDENT INDEPENDENT_1 INDEPENDENT_2
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.488004	37.95130	29.79707	0.0046
At most 1	0.179288	11.84318	15.49471	0.1646
At most 2 *	0.100655	4.137448	3.841465	0.0419

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.488004	26.10812	21.13162	0.0092
At most 1	0.179288	7.705736	14.26460	0.4094
At most 2 *	0.100655	4.137448	3.841465	0.0419

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Eview 12 calculation

Based on Trace test result (the first block presented in Table 4.3.1) and Max-eigenvalue test (the second block presented in Table 4.3.1), each result denotes rejection of hypothesis null. In other words, the result supports the presence of co-integration relationships at the 5% significance level. This concludes that in the long run the variables are moving into the same direction.

4.6 Managerial Implication

Based on the study, there are some managerial implications that can be outline as follow:

1. It is noted that in the short run there is one-way or unidirectional causal relationship from Energy Consumption to CO2 Emission. Energy plays a vital role in economic growth, and we can't stop the energy consumption while the economy continues to grow. This condition creates the drive and urge the importance to switch from conventional energy to renewable or more green and clean energy. This is a space where room for improvement need to be accelerated such as via transfer knowledge from other countries with more advanced technology or knowledge of renewable energy source.
2. Given the direction going forward is low-carbon economy, there is a lot of opportunities for Corporation (especially those who are operate in high carbon intensive industry) to transform to more clean or green or sustainable energy. Where at this stage this is still rare, and not many Corporations has the capital or investment to transform their business toward this direction. This should be seen as an opportunity for Financial Institution to support the financing part in the transformation.

5. Closing

5.1 Conclusion

Based on the analysis conducted to test the relationship between Indonesia economic growth (GDP per capita), energy consumption and CO2 emission. The result indicates that in the short run, there is one-way or unidirectional relationship of energy consumption to CO2 emission and in the long run, Johansen's cointegration test supports the presence of cointegration relationships within the variables. Therefore, the needs to accelerate the energy transformation as well as technology and financial innovation are imperative for Indonesia to be able to meet the demand of sustainable development towards low carbon economy in the long run.

With the fact that Indonesia is the 4th populous country in the world and the economy is in developing mode (GDP per capita and energy consumption will continue to grow), the question is how the country can provide a sustainable grow meaning as the economy growing to ensure it will not be deteriorating the environment (in the form of CO2 emissions). Hence the urgency on the availability of clean or green or renewable energy source need to be accelerated (as of 2018, renewable energy consumption in Indonesia is at the lower end, only 21 percent of total energy consumption[4]). Energy conservation and framework or policies with focus on clean or green energy technologies should be a priority as part of the sustainable development planning in Indonesia, particularly with aim to reduce CO2 emissions while accelerating economic growth.

The Carbon Credit or Carbon offset can also be considered as one of the feasible options to help decarbonize, Indonesia can leverage or learn from the existing or established Carbon Markets in other countries. Indonesia has a geographical condition where almost 50 percent of the land area is forest and reforestation has been ongoing in the past few years. This geographical condition by default give Indonesia a huge potential for nature-based solution as a producer of carbon credit stock. This is another white space which is still new for Indonesia but have a huge potential to be explored. Finally incentives, green financing is also crucial to low carbon economy.

5.2 Suggestion

Some suggestion based on the study can be provided from two angles, one is for subsequent or further study on the similar topic where it could provide more extensive and in-depth analysis or research. And suggestion for respective parties i.e policy maker, Financials Institutions, Regulator, etc.

5.2.1 For Further Research

Some suggestion that can be considered for further research as follow :

- This research is conducted specifically for one country (Indonesia), subsequent research can consider extending this to more than one country in-scope for research. For example, the scope can be further extended up to region level (more than one country within the same region) or research for countries

[4] Source : Worldbank Data

categorized as Developed and Developing countries. This in order to provide a comparison of the result between these two groups.

- In relation to the data limitation, it can be suggested once the recent data is available the study can be conducted with more recent data in order to provide more relevant situation as there is a three years time difference between the last data available (2018) and the year when the study is conducted (2022).
- Variables such as incentives for firms that create less environment pollution should also be explored.

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