Effect of Macroeconomic Indicators and CO_2 Emission on Indonesian Economic Growth

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ABSTRACT

The purpose of this study is to identify the impact of the value of trade, investment, the exchange rate of the rupiah against the dollar, industrial added value, and oil consumption and carbon dioxide emissions on Indonesia's economic growth. This study uses data from 1986 to 2018 and uses the ECM model. The results of this study are the value of trade, investment, exchange rates and industrial added value have an influence on economic growth both in the short and long term. Oil consumption and CO_2 emissions only have an influence in the long run. CO_2 emissions are the engine of economic growth, so Indonesia must change its economic development strategy that is environmentally friendly so that the next generation can utilize natural resources without damaging the environment. The use of natural resources in development needs to pay attention to environmental conditions so that environmental ecosystems are not disturbed.

Keywords: Economic Growth, Error Correction Model, CO_2 Emissions, Environmental Economics.
JEL Classifications: E27, E44, Q5

1. INTRODUCTION

Development shall be viewed as a multidimensional process which covers various fundamental changes to the social structure, custom, society and national institution, besides keeping follow up the accelerated economic growth, handling inequality of opinions, also poverty alleviation (Michael, 2000). Also, development should reflect the overall changes of society or adjustment of the social system without ignoring the diversity of basic needs, people's choosing and economic complexity (Caous and Huarng, 2020). It aims to achieve better life materially and spiritually. Economic development is an economic growth which contains the changes of economic structure, i.e. from a predominantly agricultural and mining sector to a predominantly industrialized, economy and service sector.

In macroeconomics studies, there is a short-term and long-term problem (Boediono, 1990). The short-term issue is the matter how to control the economy to avoid inflation, unemployment and

balance of payments deficit. At the same time, long-term problem is the way to keep the economic growth sustained (Ding et al., 2017) and economic efficiency (Nguyen et al., 2020).

Furthermore, every single analysis related to economic development issues need to implicate the economic variables, i.e. national income, gross domestic product, population, interest rate, rupiah exchange rate against the dollar, investment, value-added industry, export and import rate and tax revenue.

Indonesia is a country that is very rich in natural resources, so the use of natural resources is one factor driving economic growth. but if economic development based on natural resources does not pay attention to aspects of environmental sustainability it will ultimately have a negative impact on the environment itself, because basically natural resources and the environment have limited carrying capacity. In other words, economic development that does not pay attention to the capacity of natural resources and the environment will cause development problems in the future.

Environmental issues must be a major concern in the use of natural resources in economic development.

The purpose of this study is to identify the impact of the value of trade, investment, the exchange rate of the rupiah against the dollar, industrial value added, and oil consumption and carbon dioxide emissions on Indonesia's economic growth.

2. LITERATURE REVIEW

According to Smith, economic development is a mixing process of population growth and technology advance. Michael (2000) identified the development as a multidimensional process covers fundamental changes in social structure, custom, a national institution, accelerating economic growth (Saman, 2016), reduction in inequality and the abolition of poverty. The definition of economic development according to Sylwester (2000) is a long-term increase in the capability of a state to provide more economic goods for its society. This capability grows in line with the technology advance, necessary institutional and ideological adjustment and reduce environmental pollution (Egbetokun et al., 2018). This definition has three components, i.e. first, the economic growth of a country can be identified by observing its continuous increase in inventories. Second, advanced technology is the factor in economic growth which determines the level of ability growth in the provision of various goods to the people. Third, the use of technology widely and efficiently needs an adjustment in the institutional and ideological field. Therefore, the innovation generated by a human can be exploited appropriately.

The research of Adeleye et al. (2015) on the relationship of export and import against economic growth. It can be seen from Hussain and Saaed (2015) study that export and import influence economic growth in Tunisia. Besides, Adeleye et al. (2015) in Nigeria concluded that export does not influence economic growth. Based on the research of (Kartikasari, 2017) in Riau Indonesia, the aspect of import negatively affects the economic growth.

The research of Nawatmi (2013), and Rustan (2013) was on the relationship of capital investment and economic growth. It can be concluded from the research that foreign capital investment can encourage the economic growth through its role which completes the lack of resource between targeted investment and domestic savings that can be mobilized. Research conducted by Cành and Lua (2020) concluded that public investment in Vietnam in the past period did not affect economic growth in an inverted U-shape pattern. Meanwhile, investment from the private sector, state-owned companies and FDI has a positive effect on short-term economic growth. The study conduct by Mahmoodi (2017) explain the importance of economic growth, renewable energy (RE) and carbon dioxide emission (CO_2) to developing countries.

The relationship between exchange rates and economic growth has been carried out by (Kandil and Dincer, 2008). The research aims to examine the effect of exchange rate fluctuations on real output, price levels, and the real value of the components of aggregate demand in Turkey and Egypt. The results of the study concluded that the anticipated exchange rate appreciation had a significant adverse effect on real output growth both in Turkey and in Egypt.

The research of Alam (2013), Ajmair and Hussain (2017) and Ceylan and Özkan (2013) was on the impact of value-added industry on economic growth. The result of the research is the value added of industries influence economic growth.

The relationship between energy consumption and economic growth has been carried out (Al-mulali and Sab, 2013). This study aims to investigate the impact of total primary energy consumption and CO_2 emissions on economic development in 16 developing countries. The results show that there is a long-term relationship between total primary energy consumption and CO_2 emissions with economic development in the countries investigated. It was also found that primary energy consumption has a positive causal relationship with economic development and other economic aspects play an important role in achieving high economic performance with higher pollution consequences.

Research on the relationship between CO_2 emissions and economic growth was conducted by (Ali et al., 2016). His research analyzes the relationship between economic growth, nuclear energy consumption and carbon dioxide (CO_2) emissions for panels from 25 countries during the 1993 to 2010 period. The results of his research concluded that for developed countries, short-term causality that runs from CO_2 emissions to economic growth, while a strong form of causality shows the dependence of CO_2 emissions on economic growth and nuclear energy consumption seen to have an impact on CO_2 emissions. As for developing countries, there is a short-term causality which shows that economic growth causes CO_2 emissions.

3. RESEARCH MATERIALS AND METHODS

This research is qualitative research. Qualitative research is a systematic scientific study of every detail, phenomenon and its relationship. The purpose of qualitative research is to improve and utilize the model of mathematical, theories and hypothesis which related to the economic phenomenon. The data were collected from secondary data which sourced from Central Bureau of Statistics, World Bank various publications from 1986 to 2015. Secondary data is the data obtained from other researchers in the form of both oral and written. No need to directly observe the field through investigation or others.

In our research we use the equation function:

$$GDP = f (Trade, GFCF, ER, IVA, OP, OC, CE) \qquad (1)$$

Where GDP is Domestic Gross Product, Trade is the value of trade, GFCF is Gross Fixed Capital Formation, ER is the exchange rate, IVA is industry value added, OP is oil production, OC is oil consumption, and CE is carbon dioxide emissions.

The first step of this method is to pretest the individual time series used to confirm that they are not stationary. This can be done with standard DF unit root testing and ADF tests. Take the case of two different xt and yt series. If both are I (0), the standard regression

analysis will be valid. If the data is integrated in a different order, e.g. one becomes I (1) and the other becomes I (0), you must change the model (Eq. 2). If both are integrated in the same order (usually I (1)), we can estimate the ECM model in the form of an equation:

$$\Delta GDP_t = \gamma_o + \gamma_1 \Delta Trade_t + \gamma_2 \Delta GFCF_t + \gamma_3 \Delta ER_t + \gamma_4 \Delta IVA_t + \gamma_5 \Delta Opt_t + \gamma_6 \Delta Oc_t + \gamma_7 \Delta CE_t + \gamma_8 (GDP_{t-1} - \beta_o - \beta_1 Trade_{t-1} - \beta_2 GFCF_{t-1} - \beta_3 ER_{t-1} - \beta_4 IVA_{t-1} - \beta_5 Op_{t-1} - \beta_6 Oc_{t-1} - \beta_7 CE_{t-1} - \varepsilon_t) + v_t \quad (2)$$

If these two integrated variables and ECM exist, they are cointegrated by the Engle-Granger representation theorem.

The second step is to estimate the model using the ordinary least squares: $GDPt-1 = \beta_o + \beta_1 Tradet-1 + \beta_2 GFCFt-1 + \beta_3 ERt-1 + \beta_4 IVAt-1 + \beta_5 Opt-1 + \beta_6 Oct-1 + \beta_7 CEt-1 + \varepsilon t$ If the regression is not false as determined by the test criteria described above, the ordinary least squares will not only be valid, but in fact are super consistent (Stock, 1987). Then the predicted residue $\varepsilon t = GDPt-1 - \beta_o - \beta_1 Tradet-1 - \beta_2 GFCFt-1 - \beta_3 ERt-1 + \beta_4 IVAt-1 + \beta_5 Opt-1 + \beta_6 Oct-1 + \beta_7 E CO_2 t-1$ of this regression are stored and used in the regression variable that is different plus the error terms that are left behind (Eq. 3).

$$\Delta GDP_t = \gamma_o + \gamma_1 \Delta Trade_t + \gamma_2 \Delta GFCF_t + \gamma_3 \Delta ER_t + \gamma_4 \Delta IVA_t + \gamma_5 \Delta Op_t + \gamma_6 \Delta Oc_t + \gamma_7 \Delta CE_t + \gamma_8 ecm_{t-1} + v_t \quad (3)$$

Then a cointegration test is performed to see whether there is a short-term relationship with the long-term.

4. RESULTS AND DISCUSSION

Before conducting the regression with ECM test, the stationary test must be conducted first to know whether the variable used is stationary or not. If the data are not stationary, the regression value is fake (spurious), it appears the phenomenon of auto-correction,and it cannot generalize the regression to the different times. In this case, the unit root test with the method of Augmented Dickey Fuller is conducted, as in Table 1, it can be seen that in the level test there is no stationary variable because the probability value of all of the variable is more than 0.05 except for the stationary oil production of the level. On the 1st difference, all of the variablesare known to be stationary where the probability value of all the variable are under 0.05.

On the Table 2 prob. (f-statistic) value is 0.000 which is smaller than 0.05, (α) shows the speed of adjustment which its long-term equation is valid.The equation result to the model of 1 and 2 is that there is consistency of Trade, GFCF variable influence (the total of investment in the house country economy), ER, IVA (Industry, value added), OP (Oil Production), OC (oil Comsumption) and CE (CO_2 Emmision) have an influence toward economic growth.

Then, the long-term equation is used as a co integration testing base. Co integration test is used to give an early indication that the used model in the long term *cointegration relation.* Cointegration test in this research is done by conducting the Augmented Dicker Fulley (ADF) Unit Root Test toward the residual data with the

Table 1: The Augmented Dickey-fuller test statistic

Variable	ADF test			
	Level		First difference	
	t-statistic	Probability	t-statistic	Probability
Log (GDP)	−0.920565	0.7670	−3.609020	0.0121**
Log (TRADE)	−2.542587	0.1163	−7.247015	0.0000***
Log (GFCF)	−1.038618	0.7256	−4.264874	0.0026***
Log (ER)	−1.301137	0.6153	−5.650274	0.0001***
Log (IVA)	−2.289529	0.1818	−4.243356	0.0026***
Log (OP)	−3.234524	0.0271**	−5.146118	0.0002***
Log (OC)	−0.489765	0.8806	−5.340071	0.0001***
Log (CE)	3.007835	1.0000	−4.558071	0.0010***

***: Significant in 1%, **: Significant in 5%, *: Significant in 10%

Table 2: Estimation long-run coefficient

Dependent variable: Log (GDP)	Model 1		Model	
	Coef.	Prob.	Coef.	Prob.
LOG (TRADE)	−0.17358	0.0010***	−0.11185	0.0474**
LOG (GFCF)	0.478595	0.0000***	0.367238	0.0001***
LOG (ER)	0.107093	0.0001***	0.072416	0.0159**
LOG (IVA)	0.335879	0.0067***	0.55881	0.0013***
LOG (OP)	-	-	−0.08706	0.0533*
LOG (OC)	−0.23846	0.0643*	−0.22052	0.0710*
LOG (CE)	0.260373	0.0117**	0.197544	0.0499**
C	11.95985	0.0000***	8.558662	0.0003***
Adj. R square	0.998167		0.998167	
F statistik	2359.866	0.0000***	2359.866	0.000***
ADF test statistic	t-statistic	Prob.	t-statistic	Prob.
	−3.41085	0.0171**	−3.77208	0.0075***

***: Significant in 1%, **: Significant in 5%, *: significant in 10%

result that the probability value of all the ECT variable equations is below 0,05. It gives information that ECT variable is stationary on the level and shows that all of the variables co integrate to each other so the testing can be continued to the stage of the estimation of the short-term equation.

The valid and good ECM model must have significant ECT. ECT measures the regress and response of any periods deviating from the equilibrium. ECM model of this research is prob. (f-statististic) value in Table 3 of 0.0000 which is smaller than 0.05 (α) and ECT(−1) value orall of the equations which show the speed of adjustment which is negative and significant. It shows that this ECM model is valid and significantly affect in the short term as well as in the long term. R^2 adjusted value model 1 is 0.93, or in other words, 93 % variable diversity of economic growth is influenced by a free variable in the model, and about 07% of the variable diversity of economic growth is influenced by free variable outside the model. Based on the short-term equation, by using ECM method, it produces ECT coefficient. This coefficient measures the regress and response of each period deviating from the balance. According to Gujarati (2003) correction coefficient of ECT imbalance in the form of absolute value, explains how fast the time needed to get the balance value. ECT coefficient value of 0.3538 in the model 1 means that the difference between economic growth with its balance value of 37.25% will be adjusted within one year.

Based on Tables 2 and 3 can be analyzed the effect of each variable in the short term and long term. Both in the short term (Table 2)

Table 3: Estimation short-run coefficient

Dependent variable: D (Log (GDP))	Model 1		Model 2	
	Coef.	Prob.	Coef.	Prob.
LOG (TRADE)	−0.1267	0.0004***	−0.1232	0.0006***
LOG (GFCF)	0.3484	0.0000***	0.3427	0.0000***
LOG (ER)	0.0549	0.0179**	0.0505	0.0292**
LOG (IVA)	0.3069	0.0006***	0.2840	0.0143**
LOG (OP)	−0.0710	0.3417	0.0183	0.6365
LOG (OC)	-	-	−0.0532	0.4861
LOG (CE)	0.0967	0.1815	0.0964	0.1895
ECT(−1)	−0.3538	0.0211**	−0.3390	0.0491
C	0.0121	0.0208**	0.0125	0.0218
Adj. R square	0.933576		0.934496	
F statistic	48.1879	0.0000	41.0154	0.0000
Ramsey reset test (F statistic)	3.690959	0.0672	3.167737	0.0889
LM test (Obs*R-squared)	2.064003	0.3563	4.170412	0.1243
Heteroskedasticity test (Obs*R-squared)	11.28262	0.1268	14.70795	0.0651
Normality test	JB	Prob	JB	Prob
	1.1350	0.5666	1.3063	0.5204

***: Significant in 1%, **: Significant in 5%, *: Significant in 10%

and the long term (Table 3) Trade variables (trade value), GFCF (total of investment in the house country economy), exchange rate (ER) and IVA (industry value added) have an influence on growth economist. Oil consumption and CO_2 emissions do not have an influence on economic growth in the short term, but oil consumption and carbon dioxide emissions have an influence on economic growth in the long run.

The role of trade in economic development can be seen from the coefficient value, which is −0.1267 in the short term. This means that trade is a barrier to Indonesia's economic development because it has a negative coefficient. If the value of trade increases by 1%, it will reduce economic growth by 0.13% and will worsen in the long run (shown by the greater negative value of −0.1736). This happens because the role of imports is increasing from year to year. The increase in imports is not only for consumption of final goods, but also for capital goods and intermediate goods, which results in increasing dependence on imported goods.

The role of investment in the house country economy on economic growth can be seen from the coefficient value of 0.3484. This value indicates that if investment is increased by 1%, the economy will grow by 0.35%. Economists believe that investment formation is an important factor that plays a vital role in a country's economic growth and development. When entrepreneurs or individuals or the government make an investment, there will be a certain amount of capital invested, there are a number of purchases of capital goods (which are not consumed), but are used for production, so that it can spur productivity to produce goods and services. The role of investment will increase in the long run, this is indicated by the increasing value of the GFCF coefficient.

The role of the exchange rate on economic growth is shown to be a coefficient value of 0.0549 in the short term, meaning that if the rupiah depreciates by 1% then the economy will grow by 0.055%. The depreciation of the rupiah shows that the value of the rupiah is weakening, and this will have an impact on the price of goods becoming cheap and will increase demand for goods in the country

from abroad. In the long term, the exchange rate will weaken, and prices of goods from foreign glasses will be cheaper. This condition is increasingly unfortunate, because increased economic growth due to the weakening of the rupiah will have an impact on the high cost of imported goods. This problem will become a big problem if the weakening of the exchange rate has an impact on the decline in demand for imports of capital goods and intermediate goods imports, which will impact on the decline in domestic production.

The role of CO_2 emissions in the short term has no effect on economic growth in Indonesia, but in the long run CO_2 emissions are driving economic growth. The coefficient in the long run is 0.26, meaning that if CO_2 emissions increase by 1% will lead to economic growth of 0.26%. 1% increase in economic growth due to increased 3.84% of CO_2 emissions, this is very dangerous for the environment in the future. Indonesia has had to implement sustainable economic growth, which is economic growth that can still leave the results of development for the next generation by implementing environmentally friendly development.

Guided by the 1997 Kyoto Protocol and the 2007 Bali Road Map encourage Indonesia to create a National Action Plan (RAN) to address climate change. In the RAN it is stated that the industrial sector in 2020 can reduce greenhouse gas emissions by 1 million tons of CO_2 equivalent if self-funding or 5 million tons of CO_2 equivalent with the assistance of foreign donors. The more often or more goods are consumed, the more energy needs will increase (especially for items that require electricity assistance) at the time of its use, and also when making the items themselves. The higher its needs, the availability of Indonesian energy will also decrease. Not to mention electricity production, such as in Indonesia which is still dominated by power plants powered by fossil fuels such as diesel and coal, which of course will produce carbon dioxide emissions. That is why, lifestyle contributes to the emission of greenhouse gases produced per individual. Indonesia's success in converting kerosene to household needs with gas needs to be continued for the eastern region. To support the reduction of CO_2 emissions in Indonesia, it is necessary to take steps such as increasing the efficiency of

household appliances, utilizing biogas and biodiesel, building smart public street lighting, and installing Energy Saving Solar Lights.

5. CONCLUSIONS

The concept of sustainable development is a necessity to reconcile economic development, quality of life and the environment within a diverse political framework that is interrelated at the international and global level. Development does not only pursue the target, but also needs to maintain the quality of the environment.

Trade plays a role in economic development, through increasing exports and decreasing imports. Whereas in Indonesia trade becomes an obstacle in increasing economic growth, this is due to a decrease in the competitiveness of the exported goods produced, as well as dependence on imported raw materials. Gross Fixed Capital Formation and industrial added value have an influence in driving economic growth. With a very large area, Indonesia is in need of additional investment to drive the pace of economic growth. With investment will encourage employment, increased employment coupled with an increase in human resources will encourage economic growth.

CO_2 emissions have an important role in driving economic growth in the long run. Although CO_2 emissions have a role to encourage economic growth, the role of CO_2 emissions must be minimized through green economic development, which is a model of economic development based on sustainable development and ecological economic knowledge.

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