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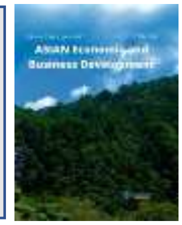

Digital Technology, Education, and Economic Growth in a Green Economy in Indonesia

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Abstract

This study investigates digital inclusion in the form of internet users, education, economic growth, and CO2 emissions to understand the digital economy and green economy in Indonesia. This research examines data from 2000 until 2020 to be able to produce "autoregressive vectors" that may be used to evaluate the causal link between variables. Based on secondary data from the World Bank, the following multivariate regression model was used to investigate the causal link between Internet Users, Economic Growth, Education, and Carbon dioxide expenditure in Indonesia. Carbon Dioxide encourages investment in Education to solve environmental problems so that the higher levels of CO2 in Indonesia's air encourage the Indonesian government to invest in education in terms of CO2 problems. Where education itself significantly increases public awareness so the relationship between education and CO2 has a significant negative correlation. And education drives future education and significantly boosts economic growth. High economic growth or a more established economy actually has a significant negative correlation with CO2 levels, which means that a green economy can be applied in Indonesia. The interesting thing is that there is a significant positive relationship between internet users and the increase in CO2 levels in the air in Indonesia. This is very interesting because the use of the internet in Indonesia has an impact on the business sector and ordering or online shopping increases the use of transportation for shipping goods which actually increases CO2 levels in Indonesia's air.

Keyword : Digital Technology, Education, Economic Growth, Green Economy, Indonesia

JEL Classification : C01, H52, O14, O44

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Background

The green and digital economies accelerate the pace of the economy. The green economy and digital economy are transforming society into a more sustainable and digitized society (Ma & Zhu, 2022). With the Covid -19 pandemic in full swing, information technology or digital technology mitigates the adverse effects of the economic crisis caused by the epidemic. This is because digital technology provides economic space to survive economically in the era of the COVID-19 pandemic (Ben-Ahmed et al.,2021).

The green economy and digital economy promote profound socioeconomic changes towards a more sustainable and digital society. Escape from the pandemic crisis is the main goal of economic development in the world. Green Economy and the economy to value green and digital priorities that build a more sustainable and more environmentally friendly economy. A sustainable economy is an economic development that not only pays attention to economic growth but also environmental sustainability (Yang et al.,2022).

The development of a green economy and digital economy is to dedicate funds for the purpose of transformation towards a greener and more digital society. Digital technology and concepts related to the digital economy accompanied by a green economy are a great opportunity to change the model of economic development as well as efforts to preserve the environment. The green and digital economy promotes a green transition, promotes digital transformation and smart, sustainable and inclusive growth (Cao et al.,2021).

The current economy is built with the aim of economic growth. However, economic growth without concern for the environment actually threatens human life and makes everything more expensive due to environmental pollution. The green economy plays a role in preserving the environment as well as building the economy (Li & Wang, 2022).

The process of economic change needs to be followed up in depth in the fields of education, institutions and manpower (Rusmingsih et al.,2021). Regarding digitization, the pandemic has provided a sizeable boost. Technological transformation was an unstoppable fact before 2020, but the restrictions on mobility caused by the health crisis have accelerated the implementation of the digital environment. Digital technology increases the speed of processing, which mainly affects small businesses and micro enterprises, which make up the majority of the business structure in Indonesia (Bawono & Widarni, 2022). This study investigates digital inclusion in the form of internet users, education, economic growth, and CO2 emissions to understand the digital economy and green economy in Indonesia.

Research Method

This research examines data from 2000 until 2020 to be able to produce "autoregressive vectors" that may be used to evaluate the causal link between variables. Based on secondary data from the World Bank, the following multivariate regression model was used to investigate the causal link between Internet User, Economic Growth, Education and Carbon dioxide expenditure in Indonesia. Here's the model :

$IR_t = \beta_0 + \beta_1 EG_t + \beta_2 ED_t + \beta_2 CO2_t + e_t$ eql 1

$EG_t = \beta_0 + \beta_1 IR_t + \beta_2 ED_t + \beta_2 CO2_t + e_t$ eql 2

$ED_t = \beta_0 + \beta_1 IR_t + \beta_2 ED_t + \beta_2 CO2_t + e_t$ eql 3
$CO2_t = \beta_0 + \beta_1 IR_t + \beta_2 EG_t + \beta_2 ED2_t + e_t$ eql 4

Description :

IR: Internet user
EG : Economic growth
ED : Education
CO2 : Carbon dioxide
E : error term
t : time series
β : the magnitude of the effect of causality
eql: equation

This study uses vector calculations where each regression relationship will be brought together so that each variable will alternately become the dependent variable and the independent variable. The zero theory of Dickey-Fuller, taken from the PP test, and p=1 is the formula in $\Delta yt = (\rho - 1)yt\text{-}1 + ut$, in which Δ – for the first time different operators. This research used the following equation for the "unit root test":

$$\Delta Y_1 = \alpha_0 + \beta_0 T + \beta_1 Y_{t-1} + \sum_{i-1}^{q} \alpha_1 \Delta Y_{t-1} + e_t$$

Description:

Y as the variable is being examined for unit root
T as the variable which indicates the "linear trend," the "lag difference" means is $\Delta Yt{-}1$,
$\alpha 0$ are shown as "constant term," with the
"t" as a "time trend" indicator.
The null and alternative hypotheses for the "unit root test" are as follows:
H_0: α=0
H_1: α≠0

Result and Discussion

The ADF test evaluates the probability of autocorrelation in the error component if the series being evaluated is non-stationary. The following are the results of the unit root test:

Table 1: ADF's Unit Root Test on IR, EG, ED and CO2 data in Indonesia

Variable	Unit Root	Include in the examination Equation	Statistics for the ADF Test	5% Critical Value	Description
Internet Users (IR)	Level	Intercept	6.626153	1.0000	
	First Diff	Intercept	-0.254496	0.9143	
	Second	Intercept	-7.999192	0.0000	Stationer

	Diff				
Economic Growth (EG)	Level	Intercept	-0.527808	0.8660	
	First Diff	Intercept	-2.315331	0.1770	
	Second Diff	Intercept	-3.930462	0.0081	Stationer
Education (ED)	Level	Intercept	-1.943341	0.3073	
	First Diff	Intercept	-3.053167	0.0478	Stationer
Carbon Dioxide (CO2)	Level	Intercept	-2.252162	0.1957	
	First Diff	Intercept	-5.132887	0.0007	Stationer

The CO2 and ED data at the first difference, the data are stationary, and the EG and IR data at the second difference level is stationary. The ADF test is worth -7.999192 with a critical value of 0.0000. Smaller than the p-value, in this case, the ED and CO2 data shows stationary at the first difference compared to the original data. From here we can take the next step in determining vector analysis.

The lag duration sensitivity is required for both the VAR and the causality tests. It's vital to pick an appropriate optimal lag time before starting a VAR or causality test inquiry. The following are the findings of the lag test:

Table 2 : Optimum lag test at Lag 0 to 3 IR, EG, ED and CO2 data

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-187.3797	NA	70565.33	22.51526	22.71131	22.53475
1	-112.1908	106.1491*	71.66114	15.55185	16.53211	15.64929
2	-91.93837	19.06108	65.32603*	15.05157	16.81602	15.22696
3	-68.32074	11.11418	115.1042	14.15538	16.70403	14.40872
4	1604.250	0.000000	NA	-180.7353*	-177.4024*	-180.4040*

Table 2 shows the findings of the Optimum Lag test. At Lag 0 to 4, the results show that the variable lengths of lag IR, EG, ED and CO2 data are at FPE, AIC, SC, and HQ at Lag 1. Because the findings of the five components are identical, then lag 1 will be chosen.

Table 4 : VAR Model Analysis

	CO2	ED	EG	IR
CO2	0.408029	0.089837	-0.534970	0.222559
	(0.40115)	(0.29108)	(0.80509)	(0.34697)
	[1.01714]	[0.30863]	[-0.66449]	[0.64144]

ED	-0.324223	1.154069	0.613470	-0.436159
	(0.39513)	(0.28672)	(0.79301)	(0.34176)
	[-0.82054]	[4.02512]	[0.77360]	[-1.27620]
EG	-0.136398	0.093401	0.557006	0.108460
	(0.19005)	(0.13790)	(0.38142)	(0.16438)
	[-0.71770]	[0.67730]	[1.46036]	[0.65982]
IR	0.057030	0.007060	-0.137678	0.710344
	(0.43063)	(0.31248)	(0.86425)	(0.37247)
	[0.13243]	[0.02259]	[-0.15930]	[1.90712]
C	17.22960	1.528184	34.76813	-6.870222
	(10.4316)	(7.56936)	(20.9355)	(9.02260)
	[1.65168]	[0.20189]	[1.66073]	[-0.76145]
R-squared	0.512713	0.985922	0.562925	0.994638
Adj. R-squared	0.122883	0.974660	0.213265	0.990349
Sum sq. resids	32.23102	16.97047	129.8203	24.11234
S.E. equation	1.795300	1.302707	3.603058	1.552815
F-statistic	1.315222	87.54286	1.609923	231.8915
Log likelihood	-31.98049	-25.88667	-45.21610	-29.22354
Akaike AIC	4.313736	3.672281	5.706958	4.023530
Schwarz SC	4.761102	4.119647	6.154323	4.470896
Mean dependent	17.20396	26.30880	11.81207	17.21472
S.D. dependent	1.916939	8.183605	4.062161	15.80659

The relationship between IR and IR itself is significantly positive, with something like a coefficient of 0.710344 and a t-statistic of 1.90712. The relationship between IR and ED is significantly positive with a coefficient of 0.007060 and a t-statistic of 0.02259, meaning that the higher the IR, the higher the ED. Likewise, the relationship between IR and EG is significantly negative, with a coefficient of -0.137678 and a t-statistic of -0.15930, meaning that the lower the IR, the higher the EG. The relationship between EG and CO2 is significantly negative, as evidenced by the coefficient -0.136398 and the t-statistic [-0.15930. This shows that an increase in Internet user will increase CO2 emission, a decrease in Internet User in this study will also increase Economic Growth, as well as the variable Education if it decreases it will cause an increase in CO2 emission. Carbon Dioxide encourages Education investment to solve environmental problems so that the higher CO2 levels in Indonesia's air encourage the Indonesian government to invest in education in terms of CO2 problems. Where education itself significantly increases public awareness so that the relationship between education and CO2 has a significant negative correlation with a coefficient of -0.324223. And education drives future education with a coefficient of 1.154069. As well as encouraging economic growth significantly with a coefficient of 0.613470. High economic growth or a more established economy actually has a significant negative correlation with CO2 levels, which means that a green economy can be implemented in Indonesia. The interesting thing is that there is a significant positive relationship between internet users and the increase in CO2 levels in the air in Indonesia. This is very interesting because the use of the internet in Indonesia has an impact on the business sector and ordering or online shopping increases the use of transportation for shipping goods which actually increases CO2 levels in Indonesia's air.

Table 5 : Granger Causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
EDU does not Granger Cause CO2	17	3.03045	0.0852
CO2 does not Granger Cause EDU		3.68928	0.0549
EG does not Granger Cause CO2	17	2.12915	0.1686
CO2 does not Granger Cause EG		1.05207	0.4386
IE does not Granger Cause CO2	17	0.59071	0.6791
CO2 does not Granger Cause IE		0.54030	0.7111
EG does not Granger Cause EDU	17	2.36992	0.1391
EDU does not Granger Cause EG		0.82220	0.5461
IE does not Granger Cause EDU	17	1.08045	0.4270
EDU does not Granger Cause IE		0.89130	0.5113
IE does not Granger Cause EG	17	0.47171	0.7559
EG does not Granger Cause IE		0.50226	0.7358

Table 4 shows the findings of the Granger causality test study. The findings reveal that there is no single causal link between variables, as shown by the fact that none of them has a probability of less than 5%.

Conclusion

Carbon Dioxide encourages investment in Education to solve environmental problems so that the higher levels of CO2 in Indonesia's air encourage the Indonesian government to invest in education in terms of CO2 problems. Where education itself significantly increases public awareness so the relationship between education and CO2 has a significant negative correlation. And education drives future education and significantly boosts economic growth. High economic growth or a more established economy actually has a significant negative correlation with CO2 levels, which means that a green economy can be applied in Indonesia. The interesting thing is that there is a significant positive relationship between internet users and the increase in CO2 levels in the air in Indonesia. This is very interesting because the use of the internet in Indonesia has an impact on the business sector and ordering or online shopping increases the use of transportation for shipping goods which actually increases CO2 levels in Indonesia's air.

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