The Impact of Natural resources, CO2 Emission, Energy use, Domestic Investment, Innovation, Trade and Digitalization on Economic growth: Evidence from 52 African Countries

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Abstract:

The aim of this paper is to examine the impact of natural resources, CO2 emission, energy use, domestic investment, innovation, trade, and digitalization on economic growth in the case of 52 African Countries. To attempt our goal, we used annual data of 52 African countries for the period 1996 to 2021 which was estimated by using random effect model, fixed effect model and Hausman test. Empirical results indicate that domestic investment, exports, natural resources and final consumption expenditure have a positive impact on economic growth. Also, we found that labor force, imports and energy use have a negative effect on economic growth. However, we found that CO2 emission, innovation and internet use don't have any effect on economic growth. The study recommends vital policies that should focus on promoting domestic investment, exports, natural resources, and final consumption to stimulate economic growth in African countries. Similarly, it recommends creating new strategies to manage the role of the active population, imports, energy consumption, CO2 emissions, innovation, and digitalization to make their effects influential in improving the economic growth.

Keywords: Natural Resources, CO2 Emission, Energy Use, Domestic Investment, Innovation, Trade, Digitalization, Economic Growth, African Countries.

JEL Classification : C10 ; C23 ; E22 ; F11 ; J60 ; O31 ; O40 ; O47 ; O55 ; Q20 ; Q40 ; Q50.

1. Introduction

Africa is the least developed and least advanced continent on the planet. The economic situation is progressing but raises the question, in a context of strong population growth, of its ability to cope with the increase in mass unemployment, the weight of the external debt, the increase in poverty and the aggravation social conditions. Within the framework of the Sustainable Development Goals, Africa was affected by this dilemma like the whole world. However, the issue of sustainability is a tale of paradox for African countries. Indeed, African countries suffer from several controversial issues such as poor economic performance, allocation of resources to support the core of growth, ecological aspect, pollution, weak investments, weak institutions, low level of digitalization, poor use of energy, problems related to research and development and the poor situation of the trade balance. As part of the analyses of the determinants of economic growth, the objective of this work is to verify the impact of the most important macroeconomic aggregates in economic activity on economic growth in Africa. Specifically, we will look at the impact of natural resources, CO2 emissions, energy use, domestic investment, innovation, trade and digitalization on economic growth in the framework of 52 African countries.

Many scholars and economists have linked the importance of economic growth with good health, a place to live, access to education, nutrition, social connections, respect, peace, rights, a healthy environment, and happiness. These are just a few of the many aspects that matter to us in our lives and are easily achieved through stable, strong and long-term economic growth. For this reason, many studies have sought to research the determinants of economic growth to know how to advance the economies of countries.

Several theories have indicated the importance of domestic investment in enhancing economic growth. Empirical work has shown contradictory results. For example, Bakari (2016a), Bakari (2017a), Bakari (2021a), Bakari and Tiba (2022);Mkadmi et al (2021a) Bakari et al (2020a), Bakari and Tiba (2019a), Bakari and Mabrouki (2018), Shabbir et al (2021) Nguyen and Trinh (2018) Tran and Hoang (2018) Kobilov (2020) Anwar and Elfaki (2021) have shown that domestic investments have favorable effects on the progression of economic growth. Other studies created by Bakari (2020), Bakari and El Weriemmi (2022a), Bakari and Bouchoucha (2021), Mkadmi et al (2021b), Bakari et al (2020b), Bakari et al (2019a), Bakari and Fakraoui (2019), Bakari (2019a), Ewubare and Worlu (2020), Aslan and Altinoz (2021), Ogunjinmi (2022) have shown that domestic investments have adverse effects on economic growth.

In the case of the nexus between natural resources and economic growth, Sachs and Warner (1997), Atkinson and Hamilton (2003), Ding and Field (2005), Mehrara (2009), Boyce and Emery (2011), Zuo and Schieffer (2014), Tiba (2019), Tiba and Frikha (2019) found that natural resources have positive effect on economic growth. However, Brunnschweiler (2008), Brunnschweiler and Bulte (2008), Cavalcanti et al (2011), Sarmidi et al (2014), Ouoba (2016) and Arin and Braunfels (2018) confirmed that natural resources affect negatively economic growth. For the case of the link between CO2 emission and economic growth, we found that Ahmad and Du (2017) ; Bakhsh et al(2017); Chaabouni et al (2016); Ma et al (2016) ; Nasir and Rehman (2011); Ozturk andAcaravci (2013), Saidi and Mbarek (2016) proved that there is a positive relationship between CO2 emission and economic growth. However, we denote those other studies such as Ajmi et al (2015), Azomahou et al (2006), Baek and Pride (2014), Dogan and Aslan (2017), Roca et al (2001), Salahuddin et al (2016), Bakari et al (2021a) confirmed that CO2 emission has a unfavorable incidence on economic growth.

For the third stage of our review of the literature concerning the link between energy consumption and economic growth, several studies such as Inglesi-Lotz (2016), Rafindadi and Ozturk (2017), Fotourehchi (2017), Anwar et al. (2017), Bhattacharya et al. (2017), Kutan et al. (2018), Ntanos et al. (2018), Bakari and Tiba (2021) have shown that energy consumption has a positive effect on economic growth. On the other hand, other studies have shown that energy consumption has a negative effect on economic growth such as Eden and Jin (1992), Cheng (1995), Menyah and Wolde-Rufael (2010), Ozturk and Acaravci (2010), Payne and Taylor (2010), Shahbaz et al (2017), Lee and Jung (2018), Islam et al. (2022), Namahoro et al (2021).

Innovation has become a prominent issue in various fields, economics, finance, management, marketing, engineering, biology, geology, chemistry, physics, medicine, mechanics, electrical etc. It is also an influential issue for industries and governments, and it illustrates a modern world, where David Ricardo's comparative advantage is no longer the important element of development. Some economists such as Segerstrom (1991), Wong et al (2005), Verspagen (2005), Yang (2006), Beneki et al (2012), Galindo and Mendez (2014), Sohag et al (2015), Mabrouki (2018), Maradana et al (2019), Bakari (2021b) found that innovation has a positive effect on economic growth. In the other hand, Bilbao-Osorio and Rodríguez-Pose (2004), Wang (2013), Feki and Mnif (2016), Chen et al (2017) found that innovation has a negative impact on economic growth.

For several economic theorists, exports are considered as an important factor of economic growth and development. In fact, the expansion of exports makes it possible to make investments more competitive and innovative, which results in an increase in the rate employment, a reduction in the unemployment rate and a reduction in poverty. Similarly, exports are a source of foreign currency inflows which translates into a refinement of the trade balance. In some studies and empirical works, several authors such as Riyath and Jahfer (2016), Sunde (2017), Faisal et al. (2017), Ozkan and Dube (2018), Bakari (2021c), Bakari and El Weriemmi (2022b), Bakari et al (2021b), Bakari (2017b) have confirmed the existence of a positive relationship between exports and economic growth. On the other hand, and especially in the context of developing countries, several studies carried out by Iftikhar et al (2016), Kurihara (2015), Adams et al (2016), Ronit and Divya (2014), Gokmenoglu et al (2015), Bakari (2019b), Bakari and Saaidia (2017) have shown that exports are not a source of economic growth.

Regarding the link between imports and economic growth where the hypothesis of imports of growth assumes that the motor imports of the economy if the majority of the structures are machines and equipment that can stimulate Investments, which results in an increase in productivity and therefore an increase in exports which results in an improvement in the trade balance. As examples, Velnampy and Achchuthan (2013), Azeez et al (2014), Ahmed et al (2014), Andrews (2015), Hamdan (2016), Rai and Jhala (2015), Fannoun and Hassouneh (2019), Bakari and Mabrouki (2016), Abdelhafidh and Bakari (2019), Bakari et al (2018), Bakari (2018), Bakari (2017c), Bakari (2017d) have shown that imports are a source of economic growth. Likewise, other studies as Meraj (2013), Cambazoglu and Karaalp (2014), Turan and Karamanaj (2014), Zaheer et al (2014), Adeleye et al (2015), Kartikasari (2017), Bakari (2016b) Bakari et al (2019b), Bakari and Tiba (2019b) have shown that imports are not a source of economic growth.

Nowadays, and especially after the Covid 19 health crisis, the impact of digitalization on the economy activity of countries remains a topical subject and central research question to have modern savings. Pradhan et al (2013), Salahuddin et al (2015), Tripathi and Inani (2016), Rahimi and Rad (2017), Saidi and Chebli (2017), Bakari (2021d), Bakari (2022), Bakari et al (2022), Bakari (2019c) found that digitalization has a positive effect on economic growth. However, Stiroh (2002), Noh and Yoo (2008) Maurseth (2018), Bakari and Tiba (2020), Bakari et al (2020c) proved that digitalization has a negative impact on economic growth.

2. Data and methodology

The static gravity model has long been one of the most successful empirical models in economics, ordering remarkably well the enormous variation seen in economic interaction across space in trade movements, the determinants of economic growth, the influences of domestic and foreign direct investment and factor movements. The good fit and relatively tight clustering of coefficient estimates in the vast empirical literature suggests that an underlying economic law must be at work. In most empirical studies, estimates of severity have been both singularly successful. They have produced some of the clearest and strongest empirical conclusions in economics {see: Anderson (2010)}.

Referring to the works of Barro (1996), Barro (2003), Chakraborty and Mazzanti (2021), Ciccone and Jarociński (2010), Cuaresma et al (2014), Boldeanu and Constantinescu (2015), Petrakos and Arvanitidis (2008), Dewan and Hussein (2001), Kahouli and Maktouf (2015), Kahouli (2019), Omri (2014), Lin et al (2021), Usman et al (2022), Batrancea et al (2022), Ali et al (2021), Tiba and Frikha (2020), Tiba (2019), Tiba et al (2016) the basic model is written as follows:

$$\mathbf{Y_{it}} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 DI_{it}} + \boldsymbol{\beta_2 X_{it}} + \boldsymbol{\beta_3 NR_{it}} + \boldsymbol{\beta_4 FCE_{it}} + \boldsymbol{\beta_5 L_{it}} + \boldsymbol{\beta_6 M_{it}} + \boldsymbol{\beta_7 EU_{it}} + \boldsymbol{\beta_8 CO2_{it}} + \boldsymbol{\beta_9 I_{it}} + \boldsymbol{\beta_{10} IN_{it}} + \boldsymbol{\gamma_i} + \boldsymbol{\varepsilon_t}$$

To linearize the equation, all variables are logarithmically transformed. Table 1 denotes the selected variables and their sources.

Table n°1: Presentation of the database

Variables	Descriptions	Measures	Sources
DI	Domestic Investment	Gross fixed capital formation (constant 2015 US$)	World Bank Indicators / Perspective Monde
X	Export	Exports of goods and services (constant 2015 US$)	World Bank Indicators / Perspective Monde
NR	Natural Resources	Total natural resources rents (constant 2015 US$)	Calculated by the authors using World Bank indicators / Perspective Monde
FCE	Final Consumption Expenditure	Final consumption expenditure (constant 2015 US$)	World Bank Indicators / Perspective Monde
L	Labor	Labor force, total	World Bank Indicators / Perspective Monde
M	Imports	Imports of goods and services (constant 2015 US$)	World Bank Indicators / Perspective Monde
EU	Energy consumption	Energy use (kg of oil equivalent per capita)	World Bank Indicators / Perspective Monde
CO2	CO2 emissions	CO2 emissions (kt)	World Bank Indicators / Perspective Monde
I	Innovation	Patent applications, residents	World Bank Indicators / Perspective Monde
IN	Internet use	Individuals using the Internet	Calculated by the authors using World Bank indicators / Perspective Monde
Y	Economic growth	Gross Domestic Product (constant 2015 US$)	World Bank Indicators / Perspective Monde

Source: Constructed by the authors

The main goal of this study is to investigate the impact of natural resources, CO2 emission, energy use, domestic investment, innovation, trade (exports and imports) and digitalization on economic growth in the case of 52 African Countries[1] over the period 1996- 2021. All data are obtained from the World Bank database. In the context of estimates based on the gravity model, it is necessary to consider the existence of marked individualities between the elements of the sample and the relationships that they maintain between them. For this reason, it is necessary to consider the diversity of the individuals that it is accepted that it is rational to introduce into the equation, additional elements reflecting the diversity of the population which constitutes the panel. Theoretically, the question is whether to specify the equation according to panel data methodology with fixed individual effects or random individual effects. We will attempt to describe the two types of individual effects most used in the literature, namely fixed effects and random effects. The most widely used theoretical solution to determine which of the two types of estimates would be more appropriate is the Hausman test.

3. Empirical results

This section denotes our empirical results. In fact, it includes descriptive statistics, correlation analyses, fixed-effect, and random-effect static gravity model estimates. We initialize with the analyses of descriptive statistics.

3.1.Descriptive Statistics

As is known in recent empirical works, there is a pre-test of the data which is often appreciated as considerable to prove the hypotheses or information about the correlation between the targeted variables. According to Table 2, the probability of rejection for all variables was less than 5%, indicating that they were considered during the study (All the Jarque Bera probabilities of the variables are all equal to 0%).

[1] The selected countries are Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Djibouti, Egypt, Arab Rep., Equatorial, Guinea, Ethiopia, Eritrea, Eswatini, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Libya, Liberia, Madagascar, Malawi, Mali, Mauritius, Mauritania, Morocco, Mozambique, Namibia, Myanmar, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zimbabwe and Zambia.

Table n°2: Descriptive Statistics

	Y	CO2	DI	EU	FCE	I
Mean	3.66E+10	20647.20	7.80E+09	724.9244	3.42E+10	148.4036
Median	1.04E+10	2950.000	2.15E+09	478.6991	8.99E+09	22.50000
Maximum	5.03E+11	447930.0	1.16E+11	3353.526	4.23E+11	1027.000
Minimum	5.32E+08	10.00000	1960426.	9.548060	5.69E+08	1.000000
Std. Dev.	7.39E+10	60472.06	1.47E+10	691.7165	6.92E+10	251.6860
Skewness	3.641142	4.878026	3.252454	2.239109	3.450115	2.056551
Kurtosis	17.39789	29.03885	14.90687	7.267634	15.12638	6.241858
Jarque-Bera	13743.31	40109.86	8659.773	956.6783	8192.041	379.4104
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4.64E+13	25705760	8.81E+12	434954.6	3.45E+13	49270.00
Sum Sq. Dev.	6.91E+24	4.55E+12	2.44E+23	2.87E+08	4.83E+24	20967474
Observations	1300	1300	1300	1300	1300	1300
	IN	**L**	**M**	**NR**	**X**	
Mean	10.31511	7694960.	1.15E+10	11.74139	9.82E+09	
Median	3.000000	4155002.	4.00E+09	7.662744	3.64E+09	
Maximum	84.12036	62259271	1.64E+11	67.88997	9.89E+10	
Minimum	0.000108	112644.0	50193970	0.001172	42076218	
Std. Dev.	15.54308	10109921	2.02E+10	12.03549	1.66E+10	
Skewness	2.017694	2.493348	3.252451	1.825826	2.993351	
Kurtosis	6.659040	10.37012	15.10429	6.515685	12.67188	
Jarque-Bera	1526.920	4206.743	8088.113	1374.661	5542.028	
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	
Sum	12739.16	9.81E+09	1.18E+13	15075.95	1.01E+13	
Sum Sq. Dev.	298118.9	1.30E+17	4.17E+23	185846.3	2.84E+23	
Observations	1300	1300	1300	1300	1300	

Source: Authors' calculations using Eviews 12 software

Skewness and kurtosis, other statistical measures, indicate whether the variable of interest follows a normal distribution. The overall skewness and kurtosis coefficients confirm that the variables follow normal distribution. The maximums and minimums of all the variables are different, which proves that there is a variation of the variables over time.

3.2.Correlation Analysis

The linear, or Bravais-Pearson, correlation coefficient measures both the strength and direction of an association. Varying from -1 to +1, it is worth 0 when there is no association. The closer this coefficient is to -1 or +1, the stronger the association between the two variables, until it is perfect. Indeed, it is used to evaluate the dependence between two random variables, or statistical link. The most famous correlation test, or Pearson's linear correlation coefficient, consists in calculating the quotient of the covariance of the two random variables by the product of their standard deviations.

Table n°3: Correlation Analysis

	Y	**CO_2**	**DI**	**EU**	**FCE**	**I**	**IN**	**L**	**M**	**NR**	**X**
Y	**1**										
CO_2	0.84	**1**									
DI	0.82	0.75	**1**								
EU	0.62	0.89	0.60	**1**							
FCE	0.98	0.80	0.78	0.56	**1**						
I	0.75	0.88	0.56	0.72	0.76	**1**					
IN	0.17	0.15	0.38	0.16	0.19	0.15	**1**				
L	0.70	0.37	0.51	0.11	0.73	0.37	-0.02	**1**			
M	0.91	0.87	0.91	0.69	0.89	0.75	0.40	0.54	**1**		
NR	0.22	0.05	0.34	-0.04	0.13	-0.11	-0.10	0.22	0.18	**1**	
X	0.84	0.93	0.80	0.84	0.77	0.75	0.20	0.38	0.89	0.25	**1**

Source: Authors' calculations using Eviews 12 software

Table 3 presents the results of the Pearson correlation test. We have noticed that there is a strong positive correlation between CO2 emissions and economic growth, between domestic investments and economic growth, between energy consumption and economic growth, between final consumption and economic growth, between innovation and economic growth, between labor force and economic growth, between imports and economic growth and between exports and economic growth. Similarly, we noticed that there is a weak positive correlation between natural resources and economic growth and between digitalization and economic growth.

3.3.Results of Estimation of Static Gravity Model

Table 4 denotes the results of the estimation of the static gravity model. The Hausman test has a probability of less than 5% with a probability equal to 1.58%, which means that the fixed-effect gravity model will be retained. The latter's empirical results indicate that Domestic Investment 'Log (DI)', Export 'Log (X)', Natural Resources 'Log (NR)', and Final Consumption Expenditure 'Log (FCE)' have a positive impact on Economic Growth 'Log (Y)'. Moreover, we found that Labor 'Log (L)', Imports 'Log (M)', and Energy Consumption 'Log (EU)' have a negative effect on Economic Growth 'Log (Y)'. However, we found that CO2 emissions 'Log (CO2)', Innovation 'Log (I)', and Internet use 'Log (IN)' have no effect on Economic Growth 'Log (Y)'.

More precisely, a 1% increase in domestic investment leads to a 0.173859% increase in economic growth; a 1% increase in exports leads to a 0.251451% increase in economic growth; a 1% increase in natural resources leads to a 0.0.03719% increase in economic growth; a 1% increase in final consumption leads to an increase of 0.828415% in economic growth; a 1% increase in imports leads to a decrease of 0.290758% in economic growth; a 1% increase in the active population leads to a decrease of 0.046203% in economic growth; a 1% increase in energy consumption leads to a 0.056199% decrease in economic growth. For other variables such as CO2 emissions, innovation and digitalization have no effect on economic growth since their coefficients have insignificant probabilities which are greater than 5%.

Table n°4: Estimation of Static Gravity Model

Dependent Variable: LOG(Y)						
Methods	**Panel Least Squares**		**Fixed Effect Model**		**Random Effect Model**	
Variable	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***
C	4.696573	0.0000	**2.143656**	**0.0197**	4.696573	0.0000
LOG(DI)	0.132557	0.0000	**0.173859**	**0.0000**	0.132557	0.0000
LOG(L)	-0.021041	0.2639	**-0.046203**	**0.0224**	-0.021041	0.2517
LOG(X)	0.270951	0.0000	**0.251451**	**0.0000**	0.270951	0.0000
LOG(M)	-0.399598	0.0000	**-0.290758**	**0.0000**	-0.399598	0.0000
LOG (CO_2)	0.136632	0.0000	**0.038697**	**0.2600**	0.136632	0.0000
LOG(EU)	-0.092997	0.0001	**-0.056199**	**0.0190**	-0.092997	0.0000
LOG(NR)	0.032562	0.0000	**0.037190**	**0.0000**	0.032562	0.0000
LOG(IN)	0.003962	0.4339	**-0.008385**	**0.3839**	0.003962	0.4221
LOG(I)	-0.017372	0.0767	**-0.011030**	**0.2733**	-0.017372	0.0694
LOG(FCE)	0.802239	0.0000	**0.828412**	**0.0000**	0.802239	0.0000
Diagnostics Tests	***R^2***	0.995395	***R^2***	0.996236	***R^2***	0.995395
	Adjusted R^2	0.995038	***Adjusted R^2***	0.995286	***Adjusted R^2***	0.995038
	S.E. of regression	0.079028	***S.E. of regression***	0.077028	***S.E. of regression***	0.079028
	F-statistic	2788.458	***F-statistic***	1049.162	***F-statistic***	2788.458
	Prob(F-statistic)	0.000000	***Prob(F-statistic)***	0.000000	***Prob(F-statistic)***	0.000000
Hausman Test						
Test period random effects						
Test Summary	***Chi-Sq. Statistic***		***Chi-Sq. d.f.***		***Prob.***	
Period random	21.867646		10		0.0158	

Source: Authors' calculations using Eviews 12 software

Regarding the diagnostic tests of the estimation of the static gravity model, it is clear to us that the coefficient of determination R^2 and the adjusted coefficient of determination R^2 adjusted are greater than 60% with values respectively equal to 99.6236% and 99.5286 %. This means that the quality of our estimate is robust and well processed. Similarly, we notice that the probability of the Fisher test is less than 5% with a value equal to 0.0000, which confirms the credibility of the estimation of the static gravity model.

In general, the results of the estimation of the static gravity model confirm that domestic investments, exports, natural resources and final consumption are a source of economic growth in the economies of African countries. Similarly, the results confirm that the labor force, energy imports and consumption, CO2 emissions, innovation and digitalization have an adverse effect on economic growth in the case of African countries. We conclude that domestic investments, exports, natural resources and final consumption are a source of economic growth in the economies of African countries. Similarly, results confirm that the labor force, energy imports and consumption, CO2 emissions, innovation and digitalization have an unfavorable effect on economic growth.

4. Conclusion

As a new contribution of empirical analysis of the determinants of economic growth, the objective of this article is to study the impact of natural resources, CO2 emissions, energy consumption, domestic investment, of innovation, trade and digitization on economic growth in the case of 52 African countries. To achieve our objective, we used annual data from 52 African countries for the period 1996 to 2021 which were estimated using a random effects model, a fixed effects model and a Hausman test. The empirical results indicate that domestic investment, exports, natural resources, and final consumption expenditure have a positive impact on economic growth. Additionally, we found that labor, imports, and energy consumption have a negative effect on economic growth. However, we found that CO2 emissions, innovation and Internet use have no effect on economic growth. We conclude that domestic investments, exports, natural resources, and final consumption are a source of economic growth in the economies of African countries. Similarly, results confirm that the labor force, energy imports and consumption, CO2 emissions, innovation and digitalization have an unfavorable effect on economic growth.

This study contributes to the literature on economic growth and natural resources, economic growth and CO2 emissions, economic growth and energy use, economic growth and domestic investment, economic growth and innovation, economic growth and trade, and economic growth and digitalization by providing new empirical evidence on how economic activities relate to the determinants of economic growth in the case of African countries. The results of our study are important for decision makers, in terms of promoting innovation, stimulating economic growth, managing natural resources, using energy well, fighting against CO2 emissions, improve domestic investment and fine-tune the management of trade openness.

Therefore, policymakers should focus more on improving the quality of science and research institutions, the quality of education, university-industry research collaboration, encouraging domestic investors, allocating the use of natural resources and energies, attention to the structure of tax revenues and the nature of domestic investment, the orientation of national investments towards more productive and intelligent projects in order to promote economic growth, the improvement of good governance policies in order to reduce institutional inefficiencies, the elimination of risks and uncertainty associated with capital investments, the refinement of administrative management using the tools of digitalization, facilitating export procedures and imports by applying smart strategies and encourages the agricultural sector and the green economy to combat the negative effects of CO2 emissions.

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