Assessing the Impact of Domestic Investments and CO2 Emissions on Economic Growth in Sub-Saharan Africa: A Comprehensive Study (1990-2022)

Bakari, Sayef

LIEI, Faculty of Economic Sciences and Management of Tunis, University of Tunis El Manar, Tunisia., Faculty of Legal, Economic and Management Sciences of Jendouba, University of Jendouba, Tunisia.

2024

Assessing the Impact of Domestic Investments and CO2 Emissions on Economic Growth in Sub-Saharan Africa: A Comprehensive Study (1990-2022)

Sayef Bakari

LIEI, Faculty of Economic Sciences and Management of Tunis, University of Tunis El Manar, Tunisia.

Faculty of Legal, Economic and Management Sciences of Jendouba, University of Jendouba, Tunisia.

Email: bakari.sayef@yahoo.fr

Abstract:

In the context of this study, we aim to assess the impact of domestic investments and carbon dioxide emissions on economic growth in 48 Sub-Saharan African countries over the period 1990-2022. By employing an estimation methodology based on static gravity models (fixed and random effects) as well as the Panel GMM model (fixed and random effects), our results significantly and positively indicate that domestic investments and CO2 emissions influence economic growth. We recommend that policymakers and stakeholders in Sub-Saharan African countries take these findings into consideration when formulating economic policies. The positive and significant implications of domestic investments and CO2 emissions on economic growth underscore the importance of promoting policies that encourage appropriate levels of domestic investment and sustainable management of CO2 emissions.

Keywords: CO2 Emissions, Domestic Investment, Economic Growth, Sub-Saharan African Countries.

1. Introduction

The intricate relationship among domestic investments, carbon dioxide (CO2) emissions, and economic growth is garnering increasing interest on a global scale. Understanding this dynamic is pivotal for crafting sustainable and effective economic policies. This study specifically focuses on sub-Saharan African countries, where economic and environmental challenges converge in a unique manner. The significance of this subject lies in the exploration of causal links between domestic investments, CO2 emissions, and economic growth. Grasping how these variables interact can enlighten decision-makers on measures to strike a balance between economic development and environmental preservation.

The selection of sub-Saharan African countries as a case study is motivated by their pivotal role in sustainability debates. These nations grapple with distinctive challenges, such as the need to foster economic growth while minimizing CO2 emissions. Understanding these challenges can offer valuable insights for other regions worldwide. Upon examining the current situation in these countries, an interconnection emerges between domestic investments, CO2 emissions, and economic growth. While domestic investments can act as catalysts for economic growth, they are often associated with an increase in CO2 emissions. Quantifying these relationships is essential for formulating policies that promote inclusive and sustainable economic growth. Numerical data on investments, CO2 emissions, and economic growth in sub-Saharan African countries will provide a robust foundation for analysis.

The added value and scientific contribution of this research lie in the in-depth understanding of the mechanisms underpinning the relationship between domestic investments, CO2 emissions, and economic growth in a specific context. By offering empirical insights, this study aims to guide decision-makers and researchers in developing policies that reconcile economic and environmental imperatives. The fundamental issue lies in finding a delicate balance between promoting economic growth and reducing carbon dioxide (CO2) emissions in sub-Saharan African countries. How can these nations maximize the benefits of domestic investments while mitigating adverse environmental effects? This question is of crucial significance, as current choices will have long-term repercussions on the sustainable development of the region. In this regard, this study will be structured as follows: in the second section, a literature review will be presented, highlighting research on the impact of domestic investments and CO2 emissions on economic growth, with a particular focus on recent studies. The third section will outline our empirical methodology, detailing the structure and characteristics of the database used. The fourth section will unveil the empirical results obtained. Finally, the conclusions and recommendations will be presented in the fifth section.

2. Literature Survey

The literature review presented in this section focuses on two key dimensions of economic development: the complex relationship between CO_2 emissions and economic growth, and the central role that domestic investment plays in promoting economic growth. Understanding the connection between these factors is of paramount importance for developing policies and strategies that align economic progress with environmental sustainability. The first paragraph of this section examines the complex interplay between CO_2 emissions and economic growth, exploring the challenges and opportunities associated with balancing economic development and environmental concerns. In the second paragraph of this section, emphasis is placed on the role of domestic investment as a catalyst for economic growth, highlighting its various facets and implications for sustainable development. This literature review aims to provide a comprehensive understanding of the existing research landscape, offering insights that can inform future studies and policy formulations at the intersection of economic growth, environmental sustainability, and investment dynamics.

2.1. CO_2 Emissions and Economic Growth

The emissions of carbon dioxide (CO_2) have a significant impact on economic growth due to the negative externalities associated with climate change. These emissions, primarily resulting from the use of fossil fuels and industrial processes, impose uninternalized social costs in economic transactions. The effects of climate change, such as natural disasters, alterations in weather patterns, and disruptions to ecosystems, entail substantial costs for society. Vulnerable sectors, such as agriculture and tourism, are particularly affected. Additionally, the need for adaptation and mitigation in the face of climate change generates direct costs for businesses and governments, although some argue that this transition to a low-carbon economy can also stimulate innovation and foster new economic opportunities. Thus, managing CO_2 emissions is crucial to mitigate financial risks, promote sustainability, and ensure long-term economic growth.

The intricate interplay between economic growth, carbon dioxide (CO_2) emissions, and environmental sustainability has been a subject of extensive research, with scholars employing diverse methodologies to unravel the complex relationships among these variables. Mardani et al (2019) examined the relationship between CO_2 emissions and economic growth using the Web of Science database. They conducted a review of 175 articles published between 1995 and 2017, demonstrating that the link between CO_2 emissions and economic growth justifies policies aimed at reducing emissions while also imposing limits on economic growth. Their research revealed a bidirectional causality, indicating that economic growth influences CO_2 emissions and vice versa. Therefore, a potential reduction in emissions could have a negative impact on economic growth. Antonakakis et al (2017) examined the dynamic links between production, energy, and the environment using statistical analyses on energy consumption, carbon dioxide emissions, and real GDP data across 106 countries in different income groups from 1971 to 2011. The results indicate that the effects of energy consumption on economic growth and emissions vary among country groups. Additionally, the relationship between total economic growth and energy consumption is bidirectional, supporting the idea of mutual feedback. Azam et al (2016) investigated the impact of environmental degradation, measured by per capita CO_2 emissions, along with other factors such as energy consumption, trade, and human capital, on economic growth in high CO_2-emitting economies such as China, the United States, India, and Japan from 1971 to 2013. Employing the Fully Modified Ordinary Least Squares (FMOLS) method for parameter estimation, the empirical results revealed that both CO_2 emissions and energy consumption had significant negative effects on economic growth. Conversely, trade and human capital exhibited significantly positive impacts on growth. However, for individual countries, CO_2 emissions showed a positive significant relationship with economic growth in China, Japan, and the United States, while it was significantly negative for India. Acheampong (2018) used statistical methods such as Panel Vector Autoregression (PVAR) and the System-Generalized Method of Moments (System-GMM) to examine the relationship between economic growth, carbon emissions, and energy consumption in 116 countries over the period 1990-2014. The results indicate that economic growth does not lead to an increase in energy consumption at the global and regional levels. Economic growth has no direct impact on carbon emissions, except in the global region and the Caribbean-Latin America, where it has a negative effect. Carbon emissions stimulate economic growth, and energy consumption positively influences growth in sub-Saharan Africa but negatively in other regions such as the Middle East and North Africa (MENA), Asia-Pacific, and the Caribbean-Latin America. Finally, except in the MENA region and the global sample, carbon emissions do not contribute to an increase in energy consumption. The study conducted by Radmehr et al (2021) utilized spatial panel simultaneous equations models with the Generalized Spatial Two-Stage Least Squares method (GS2SLS) to analyze the complex relationships among economic growth, carbon emissions, and renewable energy consumption in European Union (EU) countries from 1995 to 2014. The study's findings reveal that the links between economic growth and carbon emissions, as well as between economic growth and renewable energy consumption, are bidirectional, indicating a mutual influence between these variables. Additionally, the results confirm that the relationship between economic growth and renewable energy consumption is unidirectional, suggesting a scenario where economic growth may influence renewable energy consumption, but not necessarily vice versa. Chontanawat (2020) investigated the dynamic relationship among energy consumption, CO_2 emissions, and economic production in ASEAN for the period 1971-2015 using cointegration and causality models. The empirical results suggest the presence of a long-term relationship and a causal link between these variables, highlighting a connection between energy consumption and production with CO_2 emissions. In their study focusing on Malaysia, Etokakpan et al (2020) delved into understanding the connection between carbon dioxide (CO_2) emissions and economic growth spanning the years 1980 to 2014. Employing diverse empirical methods to analyze the data, they reached the conclusion that there is a positive relationship between CO_2 emissions and long-term economic growth in Malaysia. This suggests that, according to their findings, an increase in CO_2 emissions is associated with positive effects on the country's economic growth over an extended period. The study provides insights into the dynamics of environmental impact and economic development in the context of Malaysia during the specified timeframe. The study conducted by Saidi and Rahman (2021) investigated the relationships between the environment, economic growth, and energy consumption in five OPEC countries (Algeria, Nigeria, Indonesia, Saudi Arabia, and Venezuela) from 1990 to 2014. The results revealed bidirectional long-term relationships between GDP and energy consumption for all countries, as well as between GDP and CO_2 emissions, except for Algeria. Bidirectional relationships were also observed between energy consumption and CO_2 emissions, except in Venezuela where the causality went from CO_2 to energy consumption. The impact of GDP on CO_2 emissions was highest in Saudi Arabia, followed by Venezuela, Nigeria, and Indonesia, while the effect of energy consumption on CO_2 emissions was most significant in Algeria, followed by Indonesia and Nigeria. Bouznit and Pablo-Romero (2016) examined the relationship between CO_2 emissions and economic growth in Algeria during the period 1970 to 2010. Employing an estimation based on cointegration analysis and the ARDL model, the empirical results provide evidence of a positive bidirectional relationship between CO_2 emissions and long-term economic growth. Odugbesan and Rjoub (2020) investigated the synergy between economic growth, carbon dioxide (CO_2) emissions, urbanization, and energy consumption in MINT countries (Mexico, Indonesia, Nigeria, and Turkey) over the period 1993-2017. Using the ARDL Bounds test approach, the study revealed that the energy growth hypothesis, assuming a unidirectional causality from energy consumption, held true for Nigeria and Indonesia. Conversely, Mexico and Turkey showed feedback, indicating a bidirectional relationship. Additionally, all MINT countries exhibited a long-term relationship between economic growth, energy consumption, CO_2 emissions, and urbanization. Raihan (2024) examined how foreign direct investments (FDI) and carbon dioxide (CO_2) emissions have influenced Vietnam's economic growth between 1990 and 2021. Using a methodology based on cointegration analysis and the ARDL model, the empirical results demonstrate that both foreign direct investments and CO_2 emissions have a positive impact on economic growth in both the short and long term.

In conclusion, the collective findings from these studies contribute significantly to our understanding of the intricate relationship between economic growth, CO2 emissions, and related factors across diverse regions and time periods. While some studies emphasize bidirectional causality and mutual feedback, others highlight the nuanced variations in these relationships within specific contexts. The challenge ahead lies in formulating policies that strike a delicate balance between fostering economic development and mitigating environmental degradation. The comprehensive insights provided by these studies underscore the need for tailored approaches, acknowledging regional disparities and dynamic influences, to pave the way for sustainable economic growth in the face of escalating environmental concerns. As we navigate the complex terrain of environmental sustainability and economic prosperity, these studies serve as crucial guides for policymakers and researchers alike.

2.2.Domestic Investment and Economic Growth

Domestic investments play a crucial role in the economic growth process of a country. In theory, these investments have a significant impact on various aspects of the national economy. Firstly, they boost productivity by enabling businesses to acquire new equipment, modernize their infrastructure, and adopt innovative technologies. This improvement in productivity leads to increased production, thereby creating jobs and raising incomes. Additionally, domestic investments enhance the competitiveness of businesses in international markets by fostering innovation and product quality. By encouraging the private sector to invest, governments can also generate tax revenues, which contribute to funding essential social programs and infrastructure projects. In summary, domestic investments are a vital engine for economic growth, promoting sustainable development and long-term prosperity.

The relationship between domestic investment, economic growth, and various influencing factors has been a subject of extensive research across different regions and periods. In the case of MENA countries, Bakari (2023) investigated the impact of unemployment on the relationship between domestic investment and economic growth from 1998 to 2022. Using the Static Gravity Model, empirical analysis confirmed that domestic investment positively affects economic growth. However, unemployment negatively affects economic growth. Additionally, the effect of domestic investment on economic growth appears to be negatively influenced by unemployment. Ben Yedder et al (2023) investigated the correlation between domestic investment, exports, and economic growth in Angola from 2002 to 2022. Employing cointegration analysis and the ARDL Model, the researchers discovered the absence of a causal relationship between exports, domestic investment, and economic growth in the long run. Yedder et al (2023) explored the influence of patents on the connection between domestic investment and economic growth in MENA countries from 1998 to 2022. Employing various panel data analysis methods such as Panel OLS, Panel OLS (Fixed Effect), Panel OLS (Random Effect), Panel GMM, Panel GMM (Fixed Effect), Panel GMM (Random Effect), Panel GLM, Panel 2SLS, Panel 2SLS (Fixed Effect), Panel 2SLS (Random Effect), and Panel RLS, the empirical analysis affirmed that domestic investment positively affects economic growth. However, patents were observed to have no impact on economic growth. Additionally, the study indicated that the relationship between domestic investment and economic growth remains unaffected by patents. Othmani et al (2023) explored the relationship between patents, domestic investment, and economic growth in the United States over the period 1980 to 2020. Utilizing cointegration analysis and the VECM Model, the researchers concluded that there is no causal relationship between these three variables in the long run. However, they identified that domestic investment and economic growth have a causative impact on patents in the short run. Akermi et al (2023) investigated the influence of final consumption, domestic investment, exports, and imports on economic growth in Albania from 1996 to 2021. Utilizing cointegration analysis, the VECM model, and the WALD test, the empirical analysis suggested that there is no causality relationship between final consumption, exports, domestic investment, imports, and economic growth in both the long run and the short run. Bakari (2022) examined the correlation between domestic investment, exports, and economic growth in Greece from 1970 to 2020. Utilizing cointegration analysis and the Vector Error Correction Model, the empirical findings suggested that there is no causality relationship between exports, domestic investment, and economic growth in the long run. In the short run, the results indicated that only exports have a causal impact on domestic investment. Bakari and El Weriemmi (2022) investigated the connection between domestic investment and economic growth in Arab countries from 1990 to 2020. Utilizing the Vector Error Correction Model, the empirical analysis revealed no relationship between domestic investment and economic growth in the long run. However, a bidirectional causality was identified between domestic investment and economic growth in the short run. In the context of G7 nations, Bakari (2021) investigated the influence of the Internet on the association between domestic investment and economic growth over the span of 1991–2018, utilizing panel data analysis. The empirical results established that domestic investment has a positive impact on economic growth, whereas the Internet shows no substantial effect on economic growth. Moreover, the Internet does not alter the impact of domestic investment on economic growth. Mkadmi et al (2021) conducted a study on the impact of tax revenues and domestic investments on social and economic well-being in Tunisia from 1976 to 2018. Utilizing co-integration analysis and the Vector Error Correction Model, the findings suggest that in the long run, domestic investment negatively impacts economic growth, while tax revenues have a positive influence on economic well-being. Additionally, the study indicates a positive reciprocal relationship between domestic investment, economic growth, and tax revenues. However, tax revenue and economic growth do not exhibit any significant impact on domestic investment over the long term. Fakraoui and Bakari (2019) explored the correlation among domestic investment, exports, and economic growth in India during the period 1960–2017. Through cointegration analysis and a vector error correction model, empirical investigations indicate the absence of a relationship between exports, domestic investment, and economic growth in the long run. However, it was observed that only exports have a causal effect on economic growth in the short run. Bakari (2018) explored the correlation between domestic investment and economic growth in Algeria from 1969 to 2015. Employing co-integration analysis and the Vector Error Correction Model, the empirical findings suggested that domestic investment has a negative impact on economic growth in the long run. However, in the short run, Granger Causality Tests revealed that domestic investment causes economic growth in Algeria. Bakari (2017) investigated the correlation between exports, imports, domestic investment, and economic growth in Egypt for the period between 1965 and 2015. Utilizing Johansen co-integration analysis of the Vector Error Correction Model to examine the long-run and short-run relationships between these variables, the empirical results suggested that in the long run, domestic investment and exports have a negative impact on economic growth, while imports have a positive effect on economic growth. In the short run, the empirical analyses indicated that only imports cause economic growth. Bakari (2016) examined the correlation between domestic investment and economic growth in Canada for the period between 1990 and 2015. Employing correlation analysis, Johansen co-integration analysis of the Vector Error Correction Model, and Granger-Causality tests, the findings revealed that there is no long-term relationship between the four variables. However, a weak relationship between domestic investment and economic growth was observed in the short run. Contrarily, the results of the Granger Causality test indicated no causal relationship between domestic investment and economic growth. The findings suggest that while domestic investment affects economic growth in the short run, it does not cause economic growth in Canada.

In conclusion, the diverse array of studies presented here underscores the multifaceted nature of the relationship between domestic investment, economic growth, and various influencing factors. While the impact of domestic investment on economic growth appears to vary across regions and timeframes, the intricate interplay with unemployment, exports, patents, and other variables adds layers of complexity to our understanding. The findings highlight the importance of context-specific analyses, recognizing that causal relationships and dynamics can differ significantly based on regional economic structures and policies. As policymakers and economists navigate the challenges of fostering sustainable economic growth, the insights gleaned from these studies offer valuable considerations for tailoring strategies to specific contexts. Overall, this body of research contributes significantly to the ongoing discourse on the intricate connections between domestic investment and economic growth, paving the way for further exploration and refinement of economic theories and policy frameworks.

3. Data and methodology

The selected countries adhere to the World Bank's ranking and analysis. The sample comprises Sub-Saharan African countries based on data availability, totaling 48 countries (Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.), with the estimation period spanning from 1990 to 2022. To investigate the impact of domestic investments and CO2 emissions on economic growth, we will apply linear panel data estimation, incorporating seven variables. This approach aims to elucidate and accurately determine this effect while allowing sufficient degrees of freedom for each variable to express itself effectively. The subsequent table defines the variables and their respective data sources.

Table n°1: Description of Variables

No	Variable	Indicator Name	Descriptions	Source
1	CO2	CO2 emissions (kt)	CO2 emissions	Climate Watch Historical GHG Emissions (1990-2020). 2023. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org/ghg-emissions
2	X	Exports of goods and services (constant 2015 US$)	Exports	World Bank national accounts data, and OECD National Accounts data files.
3	FCE	Final consumption expenditure (constant 2015 US$)	Final consumption expenditure	World Bank national accounts data, and OECD National Accounts data files.
4	Y	GDP (constant 2015 US$)	Economic growth	World Bank national accounts data, and OECD National Accounts data files.
5	DI	Gross fixed capital formation (constant 2015 US$)	Domestic investment	World Bank national accounts data, and OECD National Accounts data files.
6	M	Imports of goods and services (constant 2015 US$)	Imports	World Bank national accounts data, and OECD National Accounts data files.
7	L	Labor force, total	Labor	World Bank, World Development Indicators database. Estimates are based on data obtained from International Labour Organization and United Nations Population Division.

Source: built by authors

To determine the effect of impact of domestic investment and CO2 emissions on economic growth in our case, we will apply an estimate based on a production function that describes the situation of countries characterized by an open economy. The basic model is written and modeled as follows:

$$\mathbf{Y = F\,(DI, L; CO2\ FCE, X, M)} \quad \mathbf{(1)}$$

Equation (2) represents the augmented production function that incorporates these variables. In this equation, 'A' signifies the constant level of technology employed in the country. Returns to scale are linked to domestic investment (DI), labor force (L), CO2 emissions (CO2), final consumption expenditure (FCE), exports (X), and imports (M), denoted as β_1, β_2, β_3, β_4, β_5, and β_6, respectively.

$$\mathbf{Y_{it} = A\ DI^{\beta_1}\ L^{\beta_2}\ CO2^{\beta_3}\ FCE^{\beta_4}\ X^{\beta_5}\ M^{\beta_6}} \quad \textbf{(2)}$$

Equation (3) transforms all variables within the model by taking their logarithms. This conversion results in the nonlinear representation of the Cobb-Douglas production function in a linearized form. By applying logarithms to the variables, the relationship among them becomes additive, facilitating a linear interpretation of the Cobb-Douglas production function.

$$\mathbf{Log(Y_{it}) = Log(A) + \beta_1 Log(DI_{it}) + \beta_2 Log(L_{it}) + \beta_3 Log(CO2_{it}) + \beta_4 Log(FCE_{it}) + \beta_5 Log(X_{it}) + \beta_6 Log(M_{it}) + \varepsilon_{it}} \quad \textbf{(3)}$$

This logarithmic transformation is a common technique in econometrics, allowing for a more convenient and interpretable analysis of the underlying economic relationships. Finally, we maintain the technique unchanged, as shown in Equation (4).

$$\mathbf{Log(Y_{it}) = \beta_0 + \beta_1 Log(DI_{it}) + \beta_2 Log(L_{it}) + \beta_3 Log(CO2_{it}) + \beta_4 Log(FCE_{it}) + \beta_5 Log(X_{it}) + \beta_6 Log(M_{it}) + \varepsilon_{it}} \quad \textbf{(4)}$$

According to Othmani et al (2015), Bakari and Mabrouki (2017), Bakari and Mabrouki (2018), Bakari and Benzid (2021), Bakari (2022) Golovko and Sahin (2021), Li et al (2020), Jia et al (2020), Amidi and Fagheh Majidi (2020), Liang et al (2021) and You et al (2021), the static gravity model remains an eclectic model for empirical research on economic growth. In our case, the base model is written and modeled as follows:

$$\mathbf{log(Y)_{it} = \alpha_{1i} + \beta_{1i} log(CV)_{it} + \gamma_i + \varepsilon_t} \quad \textbf{(5)}$$

In this context, 'Y' represents the variable denoting economic growth, while 'CV' signifies the control variables. The parameter 'γ' captures the country-specific effect that remains unobserved, and 'ε' represents the error term in the model. The index 'i' corresponds to the individual dimension of the panel, referring to the country, and 't' corresponds to the temporal dimension, indicating time. Essentially, the equation encompasses the interplay of economic growth, control variables, country-specific effects, and error terms across both individual countries and time periods in a panel data analysis framework.

In the realm of panel data analysis, the theoretical quandary involves formulating equations that account for either fixed individual effects or random individual effects. Our primary objective doesn't entail delving into an exhaustive exploration of the myriad theories surrounding different forms of individual effects or norms within the context of panel data analysis. Instead, our focus is on elucidating the two predominant types of individual effects widely discussed in the literature: fixed effects and random effects. To navigate this challenge, the extensively used Hausman test emerges as a crucial tool, determining the suitability of employing either fixed effects or random effects estimates. This test is instrumental in identifying the most fitting model for a given dataset. In practical terms, if the probability resulting from the Hausman test is at least 5%, the fixed-effects model is considered significant and retained. Conversely, if the probability exceeds 5%, the random effects model is deemed significant and retained. This systematic approach aids in the judicious selection of the most appropriate model for the analysis of the panel data under consideration.

Introduced by Hansen (1982), Generalized Method of Moments (GMM) estimation has evolved into one of the most extensively applied methods for estimating models in economic and financial analyses. Notably, studies like Siddiqui and Ahmed (2013), Rahman et al (2019), Gnangoin et al (2019), Alege and Ogundipe (2014), Gunawan et al (2023), Gao and Fan (2023), Öztürk et al (2023), Khan et al (2023) and Ali et al (2023) have identified GMM as highly effective in empirical research focused on exploring the effects and determinants of international trade. In our model, GMM estimation is employed, necessitating the inclusion of additional lagged dependent variables to address endogeneity bias. Consequently, the GMM method equation is considered, and the regression equations take the following form:

$$\log(Y)_{it} = \alpha_{1i} + \beta_{1i}\log(Y)_{it-1} + \gamma_{1i}\log(CV)_{it} + \mu_i + \varepsilon_{it} \qquad (6)$$

In the context of our model, 'Y' symbolizes the variable representing economic growth, and 'CV' represents the control variables. The term $\log(Y)_{it-1}$ corresponds to the lagged variable of $\log(Y)_{it}$. The parameters to be estimated are denoted by α, β, and γ, with μ_i representing individual effects, 't' denoting time, and 'ε_{it}' signifying the model error term.

In the application of this methodology, we exclusively rely on GMM regression estimates. The GMM model equations are then formulated according to the panel data approach, incorporating either fixed single effects or random single effects. The subsequent step involves employing the Hausman test to determine the more appropriate of the two estimates, whether fixed effects or random effects. Specifically, if the probability resulting from the Hausman test is at least 5%, the fixed-effects GMM model is deemed significant and retained. Conversely, if the probability surpasses 5%, the GMM random effects model is considered significant and retained. Once we establish our empirical methodology and estimation strategy, we transition to the next section, presenting the empirical results derived from our analysis.

The selected countries, representing diverse economies, offer a comprehensive understanding of regional dynamics. The integration of key variables and a thorough exploration of estimation methods contribute to the credibility and significance of our findings. As we move forward, the outcomes of our empirical analysis are poised to enrich the discourse on economic growth in Sub-Saharan Africa, contributing valuable insights for policymakers, researchers, and stakeholders.

4. Empirical Results

In this section, we will unveil the results of estimating the impact of domestic investments and CO2 emissions on economic growth within the context of Sub-Saharan African countries spanning the period from 1990 to 2022. Before delving into the empirical estimations, it is imperative to underscore the foundational role of descriptive statistics in our analytical approach. Descriptive statistics play a fundamental role in the analytical process of data, serving as the crucial first step before the implementation of empirical estimations. These measures provide a comprehensive understanding of the behavior of the variables under study, unveiling trends, distributions, and key features of the data. By conducting descriptive analyses, we can identify patterns, spot potential outliers, assess the symmetry of distributions, and measure data dispersion. This in-depth exploration not only enhances our grasp of the intrinsic nature of variables but also guides the appropriate selection of empirical estimation methods by identifying data specifics.

Table n°2: Descriptives Statistics

	Y	FCE	DI	L	CO2	X	M
Mean	2.43E+10	1.95E+10	7.72E+09	6210231.	15429.86	8.14E+09	7.78E+09
Median	9.41E+09	7.11E+09	1.84E+09	3585375.	2606.200	2.68E+09	2.88E+09
Maximum	3.59E+11	3.05E+11	2.58E+11	55776848	448298.1	2.35E+11	1.20E+11
Minimum	5.00E+08	3.51E+08	3895173.	100655.0	68.70000	38851486	50193969
Std. Dev.	5.02E+10	4.08E+10	2.40E+10	7776570.	63684.53	2.19E+10	1.66E+10
Skewness	4.578361	4.733423	6.692701	2.556593	5.611540	5.865130	4.415257
Kurtosis	26.07973	27.85894	54.89949	12.23387	33.65279	44.68820	24.10908
Jarque-Bera	24224.08	27802.32	112874.2	4377.444	41867.28	73691.73	20571.99
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Source: Authors' calculations using EViews 12 software

Table 2 presents the results of descriptive statistics for the variables that will be considered in our estimation process. Across all variables, such as ‘Y’, ‘FCE’, ‘DI’, ‘L’, ‘CO2’, ‘X’, and ‘M’, we observe a significant variation between the maximum and minimum values of each variable. This disparity initially suggests a temporal fluctuation of the variables, thereby reinforcing the potential for their use in the context of panel data estimation. Furthermore, for all variables, it is noteworthy that the kurtosis test value exceeds that of the skewness test. This observation constitutes a second indication supporting the relevance of estimating our variables within the framework of panel data. Finally, Table 2 reveals that all variables exhibit statistically significant probabilities in the Jarque-Bera test, being less than 5%, with values equivalent to 0.0000. This finding confirms that the variables integrated into our model are suitable and ready to be estimated in the context of panel data.

Table n°3: Estimation of Panel Static Gravity Model

Dependent Variable: Ln (Y)					
Static Gravity Model : Fixed Effect			**Static Gravity Model : Random Effect**		
Variable	**Coefficient**	**Prob.**	**Variable**	**Coefficient**	**Prob.**
C	5.043140	0.0000	***C***	5.528424	0.0000
Ln (FCE)	0.467369	0.0000	***Ln (FCE)***	0.527966	0.0000
Ln (DI)	0.106093	0.0000	***Ln (DI)***	0.115846	0.0000
Ln (L)	0.286494	0.0000	***Ln (L)***	0.139040	0.0000
Ln (CO2)	0.151354	0.0000	***Ln (CO2)***	0.180347	0.0000
Ln (X)	0.093523	0.0000	***Ln (X)***	0.094645	0.0000
Ln (M)	-0.111607	0.0000	***Ln (M)***	-0.117602	0.0000

Source: Authors' calculations using EViews 12 software

Table 3 presents the results obtained from estimating the static fixed-effects gravity model and the random-effects gravity model. Starting with the results of the static fixed-effects gravity model, it is observed that the variable representing final expenditure consumption (Ln (FCE)) has a positive and significant impact on the economic growth variable (Ln (Y)). An increase of 1% in Ln (FCE) results in a 0.467369% increase in economic growth. Similarly, domestic investments (Ln (DI)), the active population (Ln (L)), CO2 emissions (Ln (CO2)), and exports (Ln (X)) all demonstrate positive and significant effects on economic growth, with respective values of 0.106093%, 0.286494%, 0.151354%, and 0.093523% for a 1% increase in each variable. However, imports (Ln (M)) exhibit a negative and significant effect, leading to a 0.111607% decrease in economic growth for every 1% increase.

Moving on to the estimation of the random-effects gravity model in the same table, it is observed that final expenditure consumption (Ln (FCE)), domestic investments (Ln (DI)), the active population (Ln (L)), CO2 emissions (Ln (CO2)), exports (Ln (X)), and imports (Ln (M)) continue to demonstrate significant positive or negative effects on economic growth. The values associated with these effects vary slightly from the previous model, with respective increases of 0.527966%, 0.115846%, 0.139040%, 0.180347%, 0.094645%, and a decrease of 0.117602% for every 1% increase in the corresponding variables. These results reinforce the robustness of the conclusions drawn from both gravity models, underscoring the importance of the analyzed factors in explaining economic growth.

Table n°4: Estimation of Panel GMM

Dependent Variable: Ln (Y)					
Panel GMM: Fixed Effect			**Panel GMM: Random Effect**		
Variable	**Coefficient**	**Prob.**	**Variable**	**Coefficient**	**Prob.**
C	5.388099	0.0000	***C***	5.769693	0.0000
Ln (FCE)	0.462848	0.0000	***Ln (FCE)***	0.515626	0.0000
Ln (DI)	0.105586	0.0000	***Ln (DI)***	0.114677	0.0000
Ln (L)	0.261889	0.0000	***Ln (L)***	0.136346	0.0000
Ln (CO2)	0.169697	0.0000	***Ln (CO2)***	0.197593	0.0000
Ln (X)	0.089519	0.0000	***Ln (X)***	0.092188	0.0000
Ln (M)	-0.108110	0.0000	***Ln (M)***	-0.116558	0.0000

Source: Authors' calculations using EViews 12 software

Table n°4 presents the results of estimating the Fixed Effects GMM model and the Random Effects GMM model. Examining the results of the Fixed Effects GMM model first, it is observed that the variable representing final expenditure consumption Ln (FCE) has a positive and significant impact on the economic growth variable Ln (Y). A 1% increase in Ln (FCE) leads to a 0.462848% increase in economic growth. Similarly, the variable reflecting domestic investments Ln (DI) has a positive and significant effect on economic growth, with a 0.105586% increase for each 1% increase in Ln (DI). Likewise, the variable of the active population Ln (L) has a positive and significant effect on economic growth, increasing by 0.261889% for each 1% increase in Ln (L). CO2 emissions variable Ln (CO2) also has a positive and significant effect, resulting in a 0.169697% increase in economic growth for each 1% increase in Ln (CO2). Export variable Ln (X) has a positive and significant effect, increasing economic growth by 0.089519% for each 1% increase in Ln (X). Conversely, import variable Ln (M) has a negative and significant effect, leading to a 0.108110% decrease in economic growth for each 1% increase in Ln (M).

Moving on to the estimation of the Random Effects GMM model in the same table, the results indicate that the variable of final expenditure consumption Ln (FCE) continues to have a positive and significant impact on economic growth, with a 0.515626% increase for each 1% increase in Ln (FCE). Similarly, domestic investments variable Ln (DI) has a positive and significant effect on economic growth, increasing by 0.114677% for each 1% increase in Ln (DI). The active population variable Ln (L) also has a positive and significant effect, resulting in a 0.136346% increase in economic growth for each 1% increase in Ln (L). CO2 emissions variable Ln (CO2) has a positive and significant effect, increasing economic growth by 0.197593% for each 1% increase in Ln (CO2). Export variable Ln (X) has a positive and significant effect, increasing economic growth by 0.092188% for each 1% increase in Ln (X). Conversely, import variable Ln (M) has a negative and significant effect, leading to a 0.116558% decrease in economic growth for each 1% increase in Ln (M). These results suggest significant relationships between the variables studied and economic growth, taking into account both fixed and random effects.

Table n°5: Hausman Test and Diagnostics Tests

Hausman Test			
Panel Static Gravity Model			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	129.362620	6	0.0000
Panel GMM			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	117.068483	6	0.0000
Diagnostics Tests			
Panel Static Gravity Model			
R-squared	0.996862	F-statistic	6333.008
Adjusted R-squared	0.996705	Prob(F-statistic)	0.000000
Panel GMM			
R-squared	0.996851	J-statistic	573.5527
Adjusted R-squared	0.996693	Prob(J-statistic)	0.000000

Source: Authors' calculations using EViews 12 software

Table number 5 reveals the results of the Hausman test and associated diagnostics for each model. Concerning the Hausman tests, it is evident that the associated probabilities are below 5%, equivalent to 0.0000 in our case. This indicates that both the fixed-effects static gravity model and the random-effects Panel GMM model are statistically significant. Regarding diagnostics, we begin by evaluating the R^2 and adjusted R^2 coefficients. For both models, namely the fixed-effects static gravity model and the Panel GMM model, it is clear that the values of R^2 and adjusted R^2 exceed 0.60. This observation confirms the robustness and high quality of our model and estimations. Furthermore, for the fixed-effects static gravity model, the probability of the Fisher test is below 5%, reaching an equivalent value of 0.0000, reinforcing the credibility and robustness of our results. Similarly, the probability of the Hansen-J-statistic test for the Panel GMM model is below 5%, with an equivalent value of 0.0000, thus affirming the validity and credibility of the instrumental variables applied in our estimation. These results reaffirm the relevance of the chosen models and the robustness of the employed methodologies, enhancing confidence in the reliability of our conclusions.

In summary, Tables 3 and 4 offer comprehensive insights into the determinants of economic growth through static fixed-effects gravity models, dynamic Fixed Effects GMM models, and their random-effects counterparts. In both tables, positive and significant impacts on economic growth are consistently observed for final expenditure consumption (Ln (FCE)), domestic investments (Ln (DI)), active population (Ln (L)), CO_2 emissions (Ln (CO_2)), and exports (Ln (X)). Conversely, imports (Ln (M)) consistently exhibit a negative and significant effect. These robust and consistent findings underscore the pivotal role of these factors in explaining variations in economic growth across different model specifications.

5. Conclusions and recommendations

The present study was undertaken with the aim of assessing the impact of national investments and carbon dioxide emissions on the economic growth of 48 Sub-Saharan African countries over the period 1990-2022. By employing an estimation methodology based on static gravity models (fixed and random effects) as well as the Panel GMM model (fixed and random effects), our results significantly and positively indicate that national investments and CO_2 emissions influence economic growth. This finding suggests the imperative for policymakers and stakeholders in Sub-Saharan African countries to take these results into account when formulating economic policies. The positive and significant implications of national investments and CO_2 emissions on economic growth underscore the urgency of promoting policies that encourage appropriate levels of national investments and sustainable management of CO_2 emissions.

5.1.Interpretation and discussion

The results of this study, while offering positive perspectives from the standpoint of economic growth, raise significant concerns regarding the environmental repercussions inherent in the correlation between national investments, carbon dioxide (CO_2) emissions, and economic growth. This positive correlation, while capable of stimulating economic growth, poses substantial risks to the environment at various levels. Firstly, the observed positive impact on economic growth could be accompanied by a significant increase in CO_2 emissions. Carbon-intensive economic activities such as mining, industrial production, and transportation often generate substantial amounts of CO_2, contributing to climate change. These increased emissions can exacerbate issues related to climate change, including extreme weather events, alterations in precipitation patterns, and rising sea levels. Furthermore, the correlation between national investments and economic growth may lead to unsustainable exploitation of natural resources. Resource-intensive economic sectors, such as intensive agriculture, deforestation, and unregulated mining, can cause severe degradation of ecosystems. This translates into biodiversity loss, deforestation, habitat destruction, and reduced availability of vital resources such as water and fertile soil. Additionally, air quality may be severely compromised due to increased industrial activities and associated pollutant emissions. Fine particulate matter, volatile organic compounds, and other atmospheric pollutants can have detrimental effects on human health, causing respiratory and cardiovascular diseases. Therefore, it becomes imperative to carefully consider these potential drawbacks to ensure that economic growth does not occur at the expense of environmental preservation. This awareness underscores the urgent need to strike a delicate balance between promoting economic growth and implementing sustainable policies and practices to mitigate negative environmental impacts.

In the specific context of the countries under study, the conclusions of this research raise concerns about a potential intensification of pressure on natural resources. The results indicate that the increase in national investments, while capable of stimulating economic growth, also risks exacerbating unsustainable exploitation of natural resources, with alarming implications for environmental sustainability. The heightened pressure on natural resources could stem from various economic sectors, such as intensive agriculture, mining, and industry, which may require intensive use of land and natural resources. This overexploitation can lead to the degradation of local ecosystems, deforestation, loss of biodiversity, and a decline in essential ecosystem services. Simultaneously, an intensification of greenhouse gas emissions is also a major concern. Economic activities associated with increased growth, including the use of fossil fuels and industrial production, can contribute to a rise in CO_2 emissions and other greenhouse gases. This situation exacerbates challenges related to climate change, with potentially devastating consequences such as extreme weather events, alterations in climate patterns, and impacts on water resources. To mitigate these potential negative impacts, it is crucial to implement policies that support sustainable and environmentally-friendly economic growth. This could involve the adoption of stricter environmental regulations, the promotion of clean technologies, the implementation of tax incentives for eco-friendly practices, and the development of natural resource management programs. Environmental sustainability should be integrated at the core of economic policies, with a clear recognition of the importance of preserving ecosystems, maintaining biodiversity, and reducing greenhouse gas emissions. By fostering a holistic approach that balances economic growth with environmental protection, these countries can aspire to achieve sustainable development, preserving resources for future generations. In conclusion, the implementation of policies promoting sustainable and environmentally-respectful economic growth is of paramount importance to avoid adverse consequences on natural resources and environmental sustainability in these specific countries. This requires close collaboration among policymakers, economic stakeholders, and civil society to ensure a prosperous and balanced future that reconciles economic imperatives with the long-term preservation of the environment.

5.2.Recommendations

To address the concerns raised by the study's results, it is strongly recommended that policymakers adopt integrated approaches aimed at harmonizing economic growth with environmental sustainability. These approaches must be carefully designed to encourage economic practices that do not irreversibly impact natural resources and ecological balance.

Firstly, the implementation of tax incentives for environmentally friendly investments can play a crucial role. Measures such as tax reductions or credits would incentivize businesses to adopt environmentally friendly practices. This financial incentive could catalyze investments in clean technologies, carbon emission reduction, and the adoption of sustainable practices. Simultaneously, the establishment of stricter carbon emission standards is essential to regulate industrial and commercial activities. Stringent emission limits would encourage businesses to invest in cleaner technologies and reduce their impact on the climate. These regulations can also serve as a guide for transitioning to a greener economy.

Additionally, well-articulated awareness programs are indispensable. Raising awareness among businesses, workers, and consumers about environmental issues can promote the voluntary adoption of sustainable behaviors. These programs can also create a growing demand for environmentally friendly products and services, encouraging businesses to align with more sustainable practices. Finally, the promotion of public-private partnerships is crucial. Collaboration between the public and private sectors can stimulate innovation, facilitate access to necessary resources, and expedite the transition to sustainable economic models. These partnerships can play an essential role in designing and implementing effective policies tailored to each context.

These integrated measures are crucial for creating an environment conducive to sustained economic growth while minimizing negative impacts on the environment. However, it is crucial that these approaches are flexible and adapted to the specific realities of each country, considering potential obstacles such as economic resistances, financial constraints, and political challenges. A balanced and well-adjusted approach is necessary to ensure the success of the transition to more sustainable economic models.

5.3.Limits

It is essential to acknowledge the inherent limitations of this study, providing a critical perspective on its results. The statistical models employed, while effective in identifying trends and correlations, exhibit excessive simplifications of economic and environmental reality. Models, by their nature, rely on specific assumptions and parameters that may not fully capture the complexity of real interactions within economies and ecosystems.

Particularly, these models might overlook crucial factors influencing the relationship between national investments, CO_2 emissions, and economic growth. Unaccounted variables, such as major socio-economic events, natural disasters, or technological changes, could significantly impact the results. Therefore, the study's conclusions should be interpreted with caution, considering the simplified nature of the models used.

Furthermore, the specified time period for the study could represent a significant limitation. The dynamics of the relationships between national investments, CO_2 emissions, and economic growth may undergo substantial changes over the long term. Although the study's timeframe is sufficiently extended, it might not capture all nuances of structural changes and emerging trends. Consequently, phenomena manifesting over longer time cycles may not be entirely represented, leading to potentially biased or incomplete conclusions.

Prudence is warranted in interpreting the results of this study due to the inherent simplifications of the statistical models used and the temporal limitations of the analysis. It is recommended to complement these results with other methodologies and deepen research, considering the complexity and dynamics of interactions between national investments, CO2 emissions, and economic growth over more extended periods. This awareness of limitations is crucial to ensure a nuanced and realistic interpretation of the study's conclusions.

5.4.Prospects

Considering future perspectives, it is imperative to promote in-depth research focused on identifying specific mechanisms underpinning the influence of national investments and CO2 emissions on economic growth. While the results of this study provide a positive correlation between these variables, a profound understanding of causal mechanisms is essential to effectively guide public policies.

The first step in this direction would involve a detailed analysis of the channels through which national investments impact economic growth. This could entail a thorough assessment of specific economic sectors that benefit most from investments, as well as the value chains resulting from them. Understanding how these investments stimulate productivity, innovation, and job creation would enable the formulation of more targeted and effective policies. Similarly, a deeper exploration of the mechanisms through which CO2 emissions influence economic growth is necessary. This could involve evaluating direct impacts, such as costs related to combating climate change, as well as indirect consequences on sectors exposed to environmental risks. Grasping these ramifications would allow the design of policies that encourage less carbon-intensive practices.

Moreover, additional studies could delve into innovative strategies to reconcile economic growth with environmental sustainability. This might include exploring circular economic models, promoting circular economy initiatives, or integrating clean technologies into production processes. Seeking synergies between economic growth and environmental stewardship could lead to more holistic and balanced approaches.

By providing more precise guidance for public policies, these in-depth research efforts would contribute to formulating concrete measures tailored to the specific contexts of countries. This would enable decision-makers to design more effective strategies based on a thorough understanding of economic and environmental dynamics. In summary, investing in future research of this nature is essential to steer political actions towards sustainable development, reconciling economic prosperity with environmental preservation.

- ⇨ In conclusion, this study delves into the economic growth determinants of Sub-Saharan African countries, employing a robust methodology grounded in panel data analysis. By applying GMM estimation techniques and incorporating fixed and random individual effects, we strive to discern the nuanced impact of domestic investments and CO2 emissions on economic growth.

References

Acheampong, A. O. (2018). Economic growth, CO2 emissions and energy consumption: what causes what and where?. Energy Economics, 74, 677-692. https://doi.org/10.1016/j.eneco.2018.07.022

Akermi, N., Ben Yedder, N., & Bakari, S. (2023). Impact of Final Consumption, Domestic Investment, Exports, and Imports on Economic Growth in Albania (No. 118308). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/118308/

Alege, P. O., & Ogundipe, A. (2014). Foreign direct investment and economic growth in ECOWAS: A system-GMM approach. Covenant Journal of Business and Social Sciences, 5(2). https://dx.doi.org/10.2139/ssrn.2476365

Ali, E. B., Gyamfi, B. A., Bekun, F. V., Ozturk, I., & Nketiah, P. (2023). An empirical assessment of the tripartite nexus between environmental pollution, economic growth, and agricultural production in Sub-Saharan African countries. Environmental Science and Pollution Research, 30(27), 71007-71024. https://doi.org/10.1007/s11356-023-27307-4

Amidi, S., & Fagheh Majidi, A. (2020). Geographic proximity, trade and economic growth: a spatial econometrics approach. Annals of GIS, 26(1), 49-63. https://doi.org/10.1080/19475683.2020.1714727

Antonakakis, N., Chatziantoniou, I., & Filis, G. (2017). Energy consumption, CO2 emissions, and economic growth: An ethical dilemma. Renewable and Sustainable Energy Reviews, 68, 808-824. https://doi.org/10.1016/j.rser.2016.09.105

Azam, M., Khan, A. Q., Abdullah, H. B., & Qureshi, M. E. (2016). The impact of CO 2 emissions on economic growth: Evidence from selected higher CO 2 emissions economies. Environmental Science and Pollution Research, 23, 6376-6389. https://doi.org/10.1007/s11356-015-5817-4

Bakari, S. (2016). Does Domestic Investment Produce Economic Growth in Canada: Empirical Analysis Based on Correlation, Cointegration and Causality. International Academic Journal of Science and Engineering 5 (1), 56-72. https://doi.org/10.9756/IAJSE/V5I1/1810006

Bakari, S. (2017). The relationship between export, import, domestic investment and economic growth in Egypt: Empirical analysis. Euro Economica, 36(02), 34-43. https://www.ceeol.com/search/article-detail?id=723944

Bakari, S. (2018). The impact of domestic investment on economic growth new policy analysis from Algeria. Bulletin of Economic Theory and Analysis, 3(1), 35-51. https://doi.org/10.25229/beta.337367

Bakari, S. (2021). The Nexus Between Domestic Investment and Economic Growth in G7 Countries. Does Internet Matter?. Journal of Applied Economic Sciences (JAES), 16(72), 238-243. https://www.ceeol.com/search/article-detail?id=984111

Bakari, S. (2022). Do researchers affect economic growth?. Journal of Applied Economic Sciences (JAES), 17(78), 419-431. https://www.ceeol.com/search/article-detail?id=1086400

Bakari, S. (2022). On The Relationship Between Domestic Investment, Exports and Economic Growth: Evidence from Greece. Journal of Smart Economic Growth, 7(3), 13-34. https://jseg.ro/index.php/jseg/article/view/192

Bakari, S. (2023). The nexus between domestic investment and economic growth in MENA countries; Does unemployment matter? (No. 118349). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/118349/

Bakari, S., & Benzid, L. (2021). Modeling the Impact of Corruption, Degree of Freedom to Invest and Democracy on Domestic Investment: Evidence from MENA Countries. Studies and

Scientific Researches. Economics Edition, (33). http://dx.doi.org/10.29358/sceco.v0i33.486

Bakari, S., & El Weriemmi, M. (2022). Causality between Domestic Investment and Economic Growth in Arab Countries (No. 113077). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/113077/

Bakari, S., & Mabrouki, M. (2017). The effect of agricultural exports on economic growth in South-Eastern Europe: An empirical investigation using panel data. Journal of Smart Economic Growth, 2(4), 49-64. https://www.jseg.ro/index.php/jseg/article/view/32

Bakari, S., & Mabrouki, M. (2018). The Impact of Agricultural Trade on Economic Growth in North Africa: Econometric Analysis by Static Gravity Model (No. 85116). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/85116/

Ben Yedder, N., El Weriemmi, M., & Bakari, S. (2023). Boosting Economic Growth in Angola: Unveiling the Dynamics of Domestic Investments and Exports (No. 119480). Indian Journal of Applied Business and Economic Research. 4(2), 125-146. https://DOI:10.47509/IJABER.2023.v04i02.01

Bouznit, M., & Pablo-Romero, M. D. P. (2016). CO2 emission and economic growth in Algeria. Energy Policy, 96, 93-104. https://doi.org/10.1016/j.enpol.2016.05.036

Chontanawat, J. (2020). Relationship between energy consumption, CO2 emission and economic growth in ASEAN: Cointegration and causality model. Energy Reports, 6, 660-665. https://doi.org/10.1016/j.egyr.2019.09.046

Etokakpan, M. U., Solarin, S. A., Yorucu, V., Bekun, F. V., & Sarkodie, S. A. (2020). Modeling natural gas consumption, capital formation, globalization, CO2 emissions and economic growth nexus in Malaysia: Fresh evidence from combined cointegration and causality analysis. Energy Strategy Reviews, 31, 100526. https://doi.org/10.1016/j.esr.2020.100526

Fakraoui, N., & Bakari, S. (2019). Tie Among Domestic Investment, Exports And Economic Growth: Empirical Analysis From India. Journal of Smart Economic Growth, 4(1), 1-15. https://jseg.ro/index.php/jseg/article/view/55

Gao, X., & Fan, M. (2023). The effect of income inequality and economic growth on carbon dioxide emission. Environmental Science and Pollution Research, 30(24), 65149-65159.

https://doi.org/10.1007/s11356-023-27009-x

Gnangoin, Y. T. B., Du, L., Assamoi, G., Edjoukou, A. J., & Kassi, D. F. (2019). Public spending, income inequality and economic growth in Asian countries: A panel GMM approach. Economies, 7(4), 115. https://doi.org/10.3390/economies7040115

Golovko, A., & Sahin, H. (2021). Analysis of international trade integration of Eurasian countries: Gravity model approach. Eurasian Economic Review, 11, 519-548. https://doi.org/10.1007/s40822-021-00168-3

Gunawan, A., Triansyah, F. A., Karlina, R., Yusuf, G., Dinantika, A. R., & Wahyudi, A. (2023). Econometric Model of Economic Growth In Indonesia Using Dynamic Panel Data Using the FD-GMM Arellano-Bond and SYS-GMM Blundell-Bond Approaches. Kontigensi: Jurnal Ilmiah Manajemen, 11(1), 208-213. https://doi.org/10.56457/jimk.v11i1.344

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. Econometrica: Journal of the econometric society, 1029-1054. https://doi.org/10.2307/1912775

Jia, F., Huang, X., Xu, X., & Sun, H. (2020). The effects of economic policy uncertainty on export: a gravity model approach. Prague Economic Papers, 29(5), 600-622. https://www.ceeol.com/search/article-detail?id=903613

Khan, H., Weili, L., Khan, I., & Zhang, J. (2023). The nexus between natural resources, renewable energy consumption, economic growth, and carbon dioxide emission in BRI countries. Environmental Science and Pollution Research, 30(13), 36692-36709. https://doi.org/10.1007/s11356-022-24193-0

Li, E., Lu, M., & Chen, Y. (2020). Analysis of China's importance in "belt and road initiative" trade based on a gravity model. Sustainability, 12(17), 6808. https://doi.org/10.3390/su12176808

Liang, L., Chen, M., Luo, X., & Xian, Y. (2021). Changes pattern in the population and economic gravity centers since the Reform and Opening up in China: The widening gaps between the South and North. Journal of Cleaner Production, 310, 127379. https://doi.org/10.1016/j.jclepro.2021.127379

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., & Khoshnoudi, M. (2019).

Carbon dioxide (CO_2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. Science of the total environment, 649, 31-49. https://doi.org/10.1016/j.scitotenv.2018.08.229

Mkadmi, J. E., Bakari, S., & Othmani, A. (2021). The Impact of Tax Revenues and Domestic Investments on Economic Growth in Tunisia (No. 108387). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/108387/

Odugbesan, J. A., & Rjoub, H. (2020). Relationship among economic growth, energy consumption, CO_2 emission, and urbanization: evidence from MINT countries. Sage Open, 10(2), 2158244020914648. https://doi.org/10.1177/2158244020914648

Othmani, A., Ben Yedder, N., & Bakari, S. (2023). The Cointegration Relationship between Patent, Domestic Investment and Economic Growth in United States of America (No. 118245). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/118245/

Othmani, A., Slimani, S., & Bakari, S. (2015). Les Effets de la Corruption sur le Commerce Extérieur de la Tunisie: Une Approche du Modèle de Gravité Statique durant la Période 1999-2012 (No. 80894). University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/80885/

Öztürk, S., Han, V., & Özsolak, B. (2023). How do renewable energy, gross capital formation, and natural resource rent affect economic growth in G7 countries? Evidence from the novel GMM-PVAR approach. Environmental Science and Pollution Research, 1-11. https://doi.org/10.1007/s11356-023-27958-3

Radmehr, R., Henneberry, S. R., & Shayanmehr, S. (2021). Renewable energy consumption, CO_2 emissions, and economic growth nexus: a simultaneity spatial modeling analysis of EU countries. Structural Change and Economic Dynamics, 57, 13-27. https://doi.org/10.1016/j.strueco.2021.01.006

Rahman, M. M., Rana, R. H., & Barua, S. (2019). The drivers of economic growth in South Asia: evidence from a dynamic system GMM approach. Journal of Economic Studies, 46(3), 564-577. https://doi.org/10.1108/JES-01-2018-0013

Raihan, A. (2024). Influences of foreign direct investment and carbon emission on economic growth in Vietnam. Journal of Environmental Science and Economics, 3(1), 1-17.

https://doi.org/10.56556/jescae.v3i1.670

Saidi, K., & Rahman, M. M. (2021). The link between environmental quality, economic growth, and energy use: new evidence from five OPEC countries. Environment Systems and Decisions, 41, 3-20. https://doi.org/10.1007/s10669-020-09762-3

Siddiqui, D. A., & Ahmed, Q. M. (2013). The effect of institutions on economic growth: A global analysis based on GMM dynamic panel estimation. Structural Change and Economic Dynamics, 24, 18-33. https://doi.org/10.1016/j.strueco.2012.12.001

Yedder, N. B., El Weriemmi, M., & Bakari, S. (2023). The Nexus Between Domestic Investment and Economic Growth in Middle East and North Africa Countries. Do Patents Matter? Journal of Applied Economic Sciences, Volume XVIII, Fall, 3(81), 247 – 259. https://doi.org/10.57017/jaes.v18.3(81).08

You, Z., Zhao, T., Song, C., & Wang, J. (2021). Analyzing China's coal-related carbon emissions from economic growth perspective: Through decoupling and decomposition model. Environmental Science and Pollution Research, 28, 3703-3718. https://doi.org/10.1007/s11356-020-10734-y