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The Nexus of Sustainability, Economic Growth and Government Effectiveness: A Post-Pandemic Perspective

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Abstract

This paper investigates the impact of economic growth and government effectiveness on sustainability in 106 developing and 122 developed regions, focusing on the post COVID-19 era. Using scatterplot graphics and robust panel data regression analysis, the findings suggest that economic growth has a significant effect on sustainability, with varying results within developing and developed countries. In both developing and developed regions, economic growth has both positive and negative effects on sustainability. Government effectiveness has positive, yet remarkably more negative, effects on sustainability in both developing and developed regions.

Keywords

Sustainability, Growth, Government Effectiveness, Regression Analysis

1. Introduction

The interplay between economic growth, government effectiveness, and sustainability has been gaining increased attention in recent years. With the impact of climate change becoming a more critical and existential global concern, it is crucial to understand the dynamics of sustainability in relation to other macroeconomic indicators. This will help better inform and shape more effective policies to address the current crisis and ensure the viability of resources for future generations. In this paper, sustainability is defined as policies and actions that foster the utilization of resources in a way that allows mankind to preserve the resources for future generations and, where possible, reverse detrimental effects on the resources. Economic growth, as measured by gross domestic product (GDP) per capita, is essential for improving living standards. It stimulates enterprises and businesses, improves the quality of education and infrastructure, and promotes innovation in countries and other social challenges. As economic growth increases, countries grow wealthier, and government funds increase. Countries are better able to implement policies and invest in fostering innovation and technology. GDP per capita is a reliable economic growth indicator which many governments—like the US—utilize to plan spending and tax policy.

Government effectiveness is crucial in ensuring the quality of public services, the capacity of civil services, and the quality of policy implementation. More effective governments are better equipped to absorb and utilize funds to design and coordinate policies that promote responsible practices. In this paper, government effectiveness is defined as the quality of public services, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Investigating and better understanding the relationships among these indicators is particularly important in the post-COVID-19 pandemic period, given the uneven and varying degrees to which economies are recovering from the unprecedented systematic shocks wrought by the pandemic across the globe. The strict government lockdowns, supply chain disruptions, reduced productivity, inflation, and drastic increases in unemployment caused a global economic recession and steep declines in economic activity. The pandemic also resulted in diversion of resources and policies focused on sustainability to COVID-response. The pandemic overall had a disproportionately negative effect on developing regions as compared to developed regions. Developed regions, which have better and more widespread access to resources than developing regions, were better able to adapt to the pandemic after the initial disruptions. Work became virtual, which maintained a number of jobs (albeit in subdued numbers), healthcare infrastructures were mostly capable of meeting population demands, and they were able to implement fiscal policy responses to help mitigate the effects for citizens. On the other hand, developing countries possessed fewer resources and weaker infrastructure than developed countries, which resulted in a greater struggle to deal with and meet the people's needs. Developing countries, given their limited access to wifi and technology, experienced higher unemployment, less ability to shift to virtual measures, greater increases in poverty, and greater strain on the already underdeveloped health systems. Indeed, many developing countries are yet to recover, and are still feeling the devastating effects of the pandemic. During the pandemic, with the immediate need to implement measures to stabilize health and well-being, sustainability policies were not a priority for governments. Governments prioritized investments in research to develop vaccines to save lives, and get economic systems back up and running. In the meantime, the gains made on the sustainability front suffered a setback with the reduced attention. In the post-pandemic era, economies are gradually recovering from the great recession and are better able to refocus their efforts on sustainable practices. It is thus important to assess how governments are doing now in addressing and shaping the sustainability dilemma.

The purpose of this study is to conduct an empirical investigation into the relationship between economic growth, government effectiveness, and sustainability in the post-pandemic era. Specifically, it aims to determine how GDP per capita growth and government effectiveness influence various indicators of sustainability, such as CO_2 emissions, forest area, combustible renewables and waste, and electricity consumption after the COVID-19 pandemic.

The main findings of this paper suggest that, in developing and developed regions, economic growth and government effectiveness are both positively and negatively associated with sustainability, depending on the sustainability indicator.

By assessing a total of 228 countries and territories divided into 106 developing and 122 developed from the years 2022 and 2023, this paper contributes to the existing literature in several ways. First, it extends the existing analysis by including and studying multiple proxies for sustainability, such as CO_2 emissions, forest area as a percentage of total land, combustible renewable energy as a percentage of total energy and waste, and electric power consumption (kWh) per capita. Second, this study differentiates between developed and developing countries, recognizing that the relationships between sustainability/growth and sustainability/government effectiveness may differ depending on the development levels and resources available in each country studied. Finally, this study examines data in the period after the COVID-19 pandemic, which has not been extensively studied in this context due to the unpredictable shocks with enduring devastating effects and its recency. The pandemic also had varying effects on each country depending on their levels of economic development. In order to provide a more robust and comprehensive analysis, this study uses an updated dataset that includes a wider range of variables than has been used to date in the existing literature, covering both economic and government dimensions. The paper also provides reliable evidence by utilizing many methodologies, such as scatterplot graphics, descriptive statistics, along with single and multiple regression analysis.

This paper proceeds as follows: Section 2 provides background information on existing literature on the subject, Section 3 sets out the empirical findings from the investigation, and Section 4 concludes the paper.

2. Literature Review

2.1. Methodologies

Various methodologies have been used and employed in the existing literature to investigate the relationship between GDP growth and sustainability, as well as government effectiveness and sustainability. Some examples of such methods are regression analysis (Gani, 2012; Hysa et al., 2020; Perrings & Ansuategi, 2000), panel data analysis (Wei et al., 2022; Sulaiman & Abdul-Rahim, 2022; Dehdar et al., 2022), Granger causality test (Jebli & Youssef, 2015; Zhou & Jamaani, 2023; Ali et al., 2021), co-integration analysis (Hassan et al., 2022; Jebli & Youssef, 2015; Zhou and Jamaani, 2023), VAR class model (Mezghani & Haddad, 2017; Carrera

& Vergara, 2012), scatterplot graphics (Juknys et al., 2018), GMM model (Carrera & Vergara, 2012; Sulaiman & Abdul-Rahim, 2022; Hao et al., 2019), and VECM model (Hassan et al., 2022).

2.2. Variables

The variables used in the existing literature varied widely. Many of the papers narrowly focused on one specific indicator of sustainability at a time: carbon dioxide emissions (Perrings & Ansuategi, 2000; Lu et al., 2024; Gani, 2012), forest area (Hao et al., 2019; Perrings & Ansuategi, 2000; Ellefson et al., 2007), combustible renewable energy and waste (Jebli & Youssef, 2015; Ali et al., 2021; Iorember & Yusoff, 2023), electricity production, consumption, and access (Zhou & Jamaani, 2023; Best & Burke, 2017; Hassan et al., 2022), access to drinking water (Perrings & Ansuategi, 2000), emissions of sulfur dioxide (Perrings & Ansuategi, 2000), sustainable development (Ward et al., 2016; Juknys et al., 2018), ecological footprint and biocapacity (Juknys et al., 2018), fiscal sustainability (Carrera & Vergara, 2012), recycling indicators (Hysa et al., 2020), and greenhouse gas emissions (Vasylieva et al., 2019).

2.3. Countries and Regions

The existing literature has analyzed various countries and regions in their reviews, but they focused on specific regions or geographies at a time, such as: OECD Countries (Juknys et al., 2018; Dehdar et al., 2022), European countries (Ali et al., 2021; Hysa et al., 2020; Vasylieva et al., 2019), African countries (Jebli & Youssef, 2015; Iorember & Yusoff, 2023; Sulaiman & Abdul-Rahim, 2022), G6 countries (Wei et al., 2022), China (Zhou & Jamaani, 2023; Hao et al., 2019), United States (Ellefson et al., 2007; Lu et al., 2024), Saudi Arabia (Mezghani & Haddad, 2017), developing and developed countries (Best & Burke, 2017; Perrings & Ansuategi, 2000).

2.4. Literature Review Findings

The existing studies reviewed have presented both positive and negative findings regarding the relationship between GDP per capita growth and sustainability. For example, Ward et al. (2016), using mathematical models analyzing data from 1980 to 2010, found a negative relationship between GDP growth and sustainability, where GDP growth was tied to higher unsustainable material and energy use. Similarly, Juknys et al. (2018), using scatterplot graphics and descriptive statistics, also support a negative relationship between GDP per capita growth and sustainability, finding that slower growth is associated with greater sustainability in developed countries. On the other hand, Hysa et al. (2020), studying European countries from 1950-2016 using Panel Data Analysis, found a positive relationship between growth and sustainability, summarizing that sustainable practices like recycling positively impacted economic growth in EU countries. Likewise, Ali et al. (2021), using the same methodology and also studying European countries from 1990-

2016, found a positive relationship between sustainability and growth, confirming that combustible renewable energy and waste consumption led to positive growth and reduced carbon emissions.

Government effectiveness also appeared as a critical determinant of sustainability, with major consensus in the literature suggesting that strong government effectiveness correlates with improved sustainability. Best and Burke (2017), in their study of developing countries using regression analysis on data up to 2012, reported that strong government effectiveness supports successful electrification, which is essential for meeting sustainable energy and development goals. Likewise, Iorember and Yusoff (2023), using FGLS and GMM models studying African countries between 1996 and 2018, emphasized that renewable energy use, income growth, and good government effectiveness significantly reduced carbon emissions. Correspondingly, Gani (2012), using regression analysis on data from 1996 to 2009, reported that good government effectiveness helped to reduce CO_2 emissions in developing countries, further accentuating the importance of strong environmental policies for sustainability.

The existing studies also highlight key differences in how economic growth and government effectiveness affect sustainability between developed and developing countries. In developed countries, Juknys et al. (2018) show that the relationship between economic growth and sustainability is negative, meaning that when economic growth is negative, sustainability and well-being are greater. They also propose that higher government effectiveness and wiser resource consumption would lead to greater sustainability, but in turn reduce GDP. Similarly, Perrings & Ansuategi (2000) suggest a negative correlation between GDP and sustainability in developed countries, positing that GDP growth does not ensure sustainability, and that wealthier communities may cause more environmental harm which poorer communities have to suffer from. Dehdar et al. (2022) also suggest a negative relationship between economic growth and sustainability, arguing that GDP growth and industrial activity contribute to higher carbon dioxide emissions in OECD countries. In contrast, studies on developing countries suggest the opposite relationship. Gani (2012) suggests that in developing countries, while trade and wealth increase emissions, political stability and good government effectiveness may be able to mitigate the environmental effects. Accordingly, Iorember and Yusoff (2023), studying African countries, posited that while income growth may increase CO_2 emissions, renewable energy use, lower corruption, and higher government effectiveness can serve to lower emissions. Jebli and Yussef (2015), studying North African countries, contributed to the argument that higher growth and higher sustainability are related in developing countries. They argued that combustible renewable energy use can increase economic growth while reducing emissions and reducing a country's reliance on fossil fuel energy. A strong theme throughout the literature suggests that in developed countries, growth is not the key determinant factor of sustainability, while in developing countries, economic growth can be an important factor towards sustainability. Meanwhile, in developed countries, government effectiveness can serve to increase sustainability but also have the adverse effect of reducing growth; but in developing countries, increased government effectiveness can maintain growth and increase sustainability.

An extensive literature review is presented in **Appendix**.

3. Empirical Evidence

3.1. Data and Methods

Appendix 1 presents various variables sourced from the World Bank World Development Indicators. The variables include: sustainability, which is measured by carbon dioxide emissions, forest area as a percentage of land area, combustible renewable energy and waste as a percentage of total energy, and electric power consumption (kWh) per capita; growth, which is the annual percentage growth rate of GDP per capita; and government effectiveness, which is the perception of the quality of public services, quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from approximately −2.5 to 2.5. The paper reduces omitted variable bias by integrating macroeconomic controls and assessing robustness across several sustainability proxies.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon_i \qquad \text{[Model 1]}$$

where Y_i is the dependent variable for observation i, which refers to sustainability. We used four different sustainability proxies for dependent variables as carbon dioxide (CO_2) emissions (total) excluding LULUCF (% change from 1990), forest area (% of land area), combustible renewables and waste (% of total energy), and electric power consumption (kWh per capita).

β_0 is the constant term, representing the expected value of the dependent variable when the independent variable is 0.

β_1 is the coefficient for the independent variable of growth. The coefficient shows how much sustainability changes when the corresponding independent variable changes by 1 unit.

β_2 is the coefficient for the independent variable of government effectiveness. The coefficient shows how much sustainability changes when the corresponding independent variable changes by 1 unit.

ε_i is the error term, which represents the difference between the actual value and the predicted value from the model.

The expected direction of each sustainability proxy is presented below:

- CO_2 Emissions: negative change = improvement (lower emissions = better sustainability).
- Forest Area: positive change = improvement (more forest = better sustainability).
- Combustible Renewables and Waste: positive share = improvement (more renewable use = better sustainability).

- Electricity Consumption: higher usage = lower environmental sustainability, but possibly higher social/economic sustainability.

3.2. Descriptive Statistics

Table 1(a) provides descriptive statistics for sustainability, growth, and government effectiveness in developing countries. The sustainability (CO_2 Emissions) variable has 106 observations with a mean of 384.284 and a standard deviation of 774.8, ranging from a minimum of −71.035 to a maximum of 5211.955. The sustainability (Forest Area) variable observes 105 countries with a mean of 34.30903 and a standard deviation of 26.61527, ranging from the lowest value 0.0583942 to the highest value 94.52387. The (Combust) sustainability variable has 60 observations with a mean of 33.34398 and a standard deviation of 30.11392, ranging from 0.0227251 to 92.90407. The sustainability (Electric) variable features 62 observations with a mean of 3223.952 and a standard deviation of 7063.443, ranging from 14.46738 to 51258.76. The GDP per capita growth variable observes 106 countries with a mean of 3.185 and a standard deviation of 8.4, ranging from

Table 1. (a) Descriptive statistics for developing countries; (b) Descriptive statistics for developed countries.

(a)

Variable	Obs.	Mean	Standard Dev.	Min	Max
Sustainability (CO_2 Emissions)	106	384.284	774.8	−71.035	5211.955
Sustainability (Forest Area)	105	34.30903	26.61527	0.0583942	94.52387
Sustainability (Combust)	60	33.34398	30.11392	0.0227251	92.90407
Sustainability (Electric)	62	3223.952	7063.443	14.46738	51258.76
GDP Per Growth	106	3.185	8.4	−21.164	74.675
Government Effectiveness	102	−0.33	0.866	−2.225	1.555

This paper analyzes data from two years after the epidemic (2022-2023) to capture the immediate recovery from COVID-19. The short horizon limits long-term inference, but it provides a clear picture of how the government and economy responded to the systematic shock in the short term. Utilizing more than one sustainability proxy and comparing economies from across 228 regions makes the results more robust.

(b)

Variable	Obs.	Mean	Standard Dev.	Min	Max
Sustainability (CO_2 Emissions)	122	151.87	231.092	−82.662	1712.762
Sustainability (Forest Area)	120	29.25625	17.09986	0	73.7265
Sustainability (Combust)	117	18.023	20.605	0.003	87.485
Sustainability (Electric)	119	4498.77	4394.888	92.436	23373.47
GDP Per Growth	122	1.346	2.95	−8.877	15.218
Government Effectiveness	76	0.425	0.915	−1.39	2.317

This paper examines data from two years after the epidemic (2022-2023) to capture the immediate recovery from COVID-19. The short horizon limits long-term inference, but it provides a clear picture of how the government and economy responded to the systematic shock in the short term. Utilizing more than one sustainability proxy and comparing economies from across 228 regions makes the results more robust.

a minimum value of −21.164 to a maximum value of 74.675. Finally, the government effectiveness variable has 102 observations with a mean of −0.33 and a standard deviation of 0.866, ranging from −2.225 to 1.555.

Table 1(b) provides the same descriptive statistics for sustainability, growth, and government effectiveness for developed countries. The CO_2 Emissions variable has 122 observations with a mean of 151.87 and a standard deviation of 231.092, ranging from a minimum value of −82.662 to a maximum value of 1712.762. The (Forest Area) variable features 120 observations with a mean of 29.25625 and a standard deviation of 17.09986, ranging from a minimum of 0 to a maximum of 73.726. The sustainability (Combust) variable has 117 observations with a mean of 18.023 and a standard deviation of 20.605, ranging from 0.003 to 87.485. The sustainability (Electric) variable has 119 observations with a mean of 4498.77 and a standard deviation of 4394.888, from a minimum value of 92.436 to a maximum value of 23373.47. The GDP per capita growth variable observes 122 countries with a mean of 1.346 and a standard deviation of 2.95, ranging from -8.877 to 15.218. Lastly, the government effectiveness variable features 76 observations with a mean of 0.425 and a standard deviation of 0.915, ranging from −1.39 to 2.317.

4. Findings

Figure 1 presents the relationship between GDP per capita growth and sustainability in terms of carbon dioxide emissions. Greater CO_2 emissions indicate less sustainability. In Figure 1(a), representing developing regions, GDP per capita growth negatively correlates with CO_2 emissions. These results can be expected, given that when governments are experiencing economic growth, they are better able to invest in and implement sustainable energy sources while moving away from unsustainable sources. By contrast, Figure 1(b), representing developed regions, shows an interesting negative correlation between GDP per capita growth and sustainability. In this case, GDP per capita growth positively correlates with

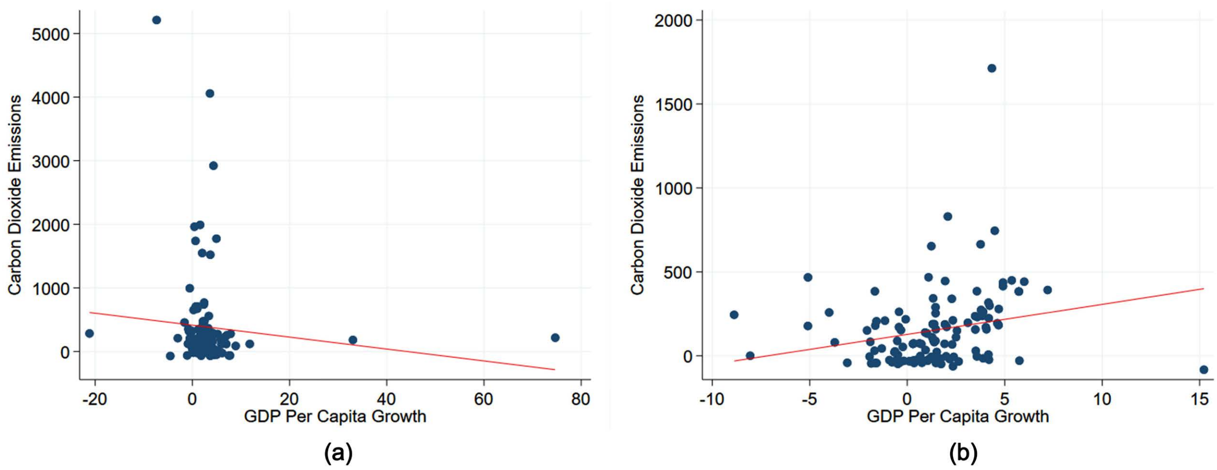

Figure 1. Scatter plot comparison between carbon dioxide emission & GDP per capita growth. (a) Developing regions; (b) Developed regions.

CO_2 emissions, suggesting that higher levels of GDP growth contribute to higher levels of carbon emissions. Developed economies, being more technologically advanced, in turn utilize high levels of fossil fuel energy for transportation, heating, and electricity. Fossil fuels are a reliable and cheap resource that these economies use in order to meet the high energy demand, which explains the positive connection between GDP per capita growth and carbon emissions.

Figure 2 displays the relationship between government effectiveness and carbon dioxide emissions. Both Figures 2(a)-2(b) show that higher government effectiveness contributes to lower carbon dioxide emissions. It is clear that government effectiveness positively correlates with sustainability in this sense in both developing and developed regions. This can be expected, given that more effective governments are more capable of implementing and enforcing environmental policies.

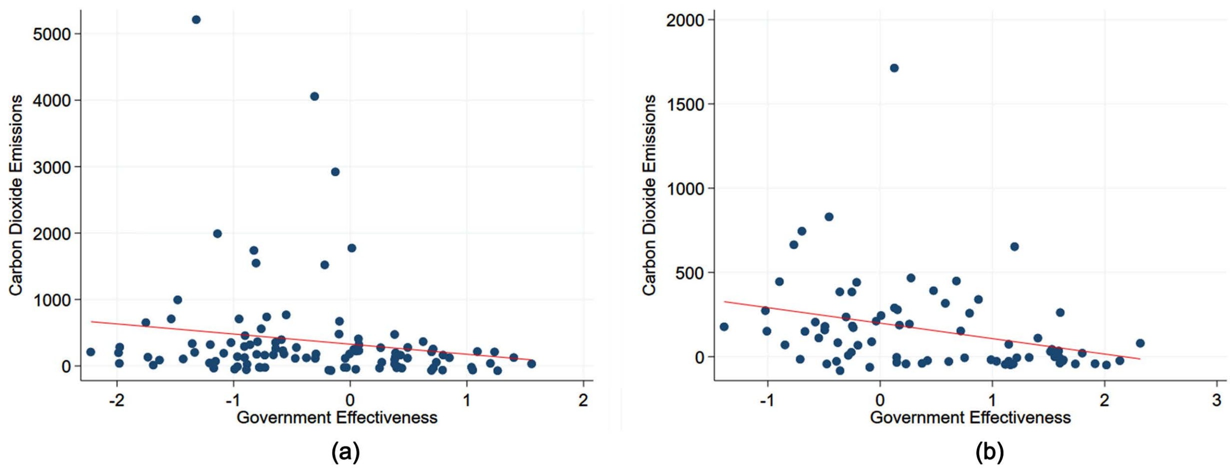

Figure 2. Scatter plot comparison between CO_2 emission & government effectiveness. (a) Developing regions; (b) Developed regions.

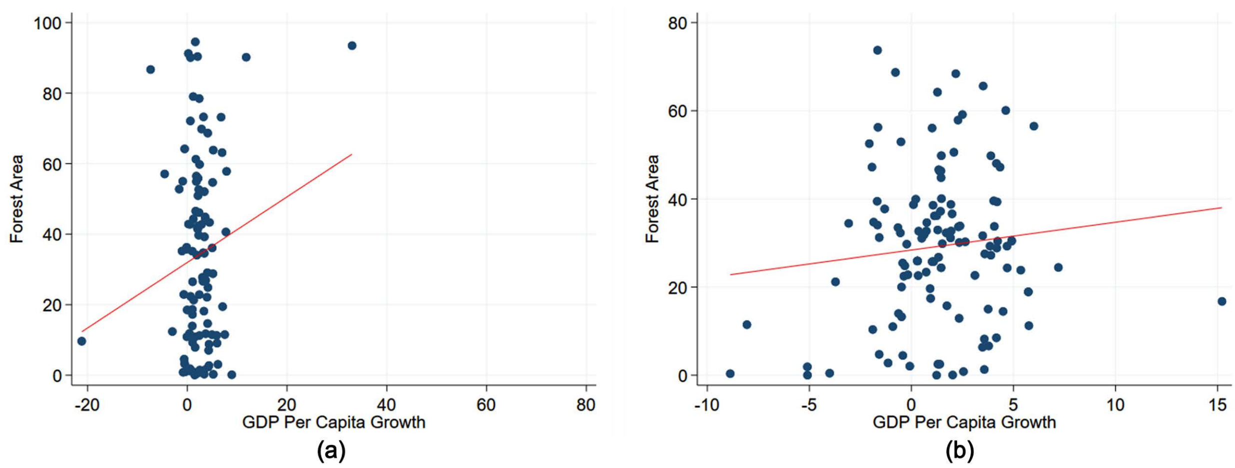

Figure 3. Scatter plot comparison between forest area & GDP per capita growth. (a) Developing regions; (b) Developed regions.

Figure 3 shows the connection between the sustainability indicator Forest Area and GDP per capita growth. In Figure 3(a), representing developing regions, GDP per capita growth has a significant positive correlation with forest area, suggesting that higher levels of GDP per capita growth contribute to a higher percentage of forest area in developing areas. This result can be expected, given that economic growth provides the funds necessary for afforestation efforts in order to counteract deforestation—a serious issue in developing areas. In Figure 3(b) for developed regions, the positive correlation, while still present, is not as strong as it is in developing areas. Regardless, this trend still supports the idea that increased economic growth tends to promote sustainability in terms of forest area, which can be seen in both developing and developed areas.

Figure 4 presents the relationship between government effectiveness and forest area. Figure 4(a) for developing regions shows only a slightly positive connection between government effectiveness and forest area. This is an interesting finding, given that GDP per capita growth and forest area had a far stronger positive relationship in developing areas. Figure 4(b) for developed regions shows a slightly stronger positive connection. This overall suggests that higher levels of government effectiveness contribute to a higher percentage of forest area in both developing and developed areas.

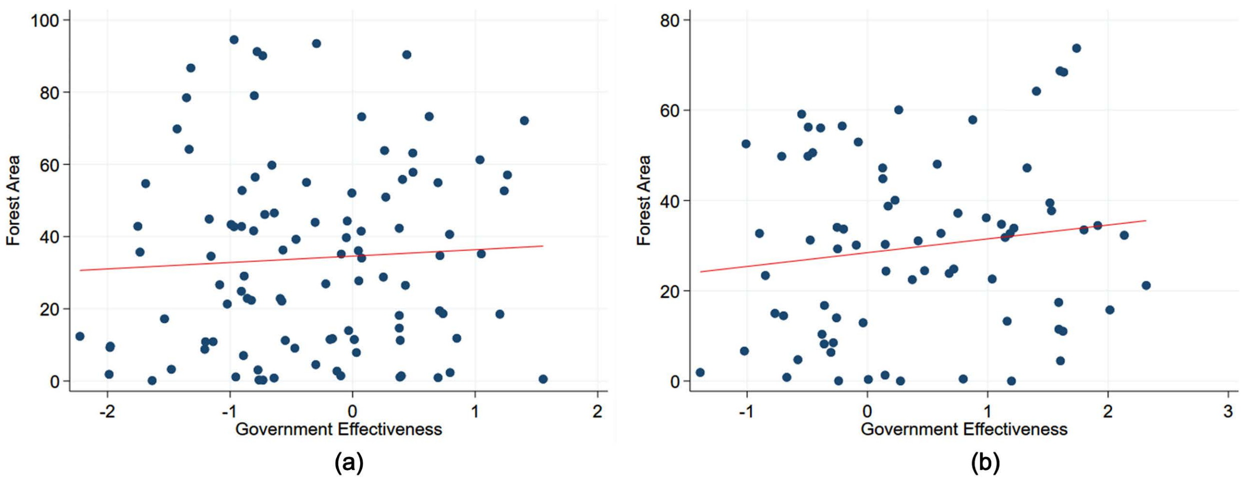

Figure 4. Scatter plot comparison between forest area & government effectiveness. (a) Developing regions; (b) Developed regions.

Figure 5 presents the relationship between GDP per capita growth and the sustainability indicator combustible renewable energy and waste. More combustible renewable energy usage correlates with higher sustainability. In Figure 5(a) for developing regions, there is a significant negative correlation between the two. This negative relationship can be explained by developing countries' higher dependency on traditional energy sources since they are underdeveloped and not as technologically advanced as developed regions. Meanwhile, Figure 5(b) for developed regions shows only a slight negative correlation between GDP per capita growth and combustible renewables. Developed countries, being more technologically advanced, have broader access to diversified energy producers like solar panels and wind energy. There is not as much dependence on traditional energy sources, which may help to explain why there is not as strong a negative relationship as there is in developing regions.

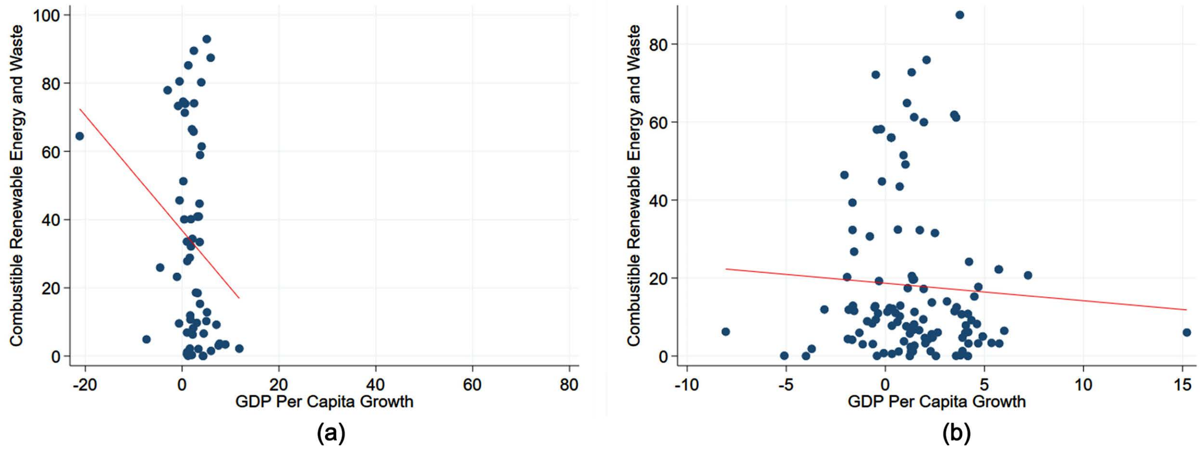

Figure 5. Scatter plot comparison between combustible renewable energy & GDP per capita growth. (a) Developing regions; (b) Developed regions.

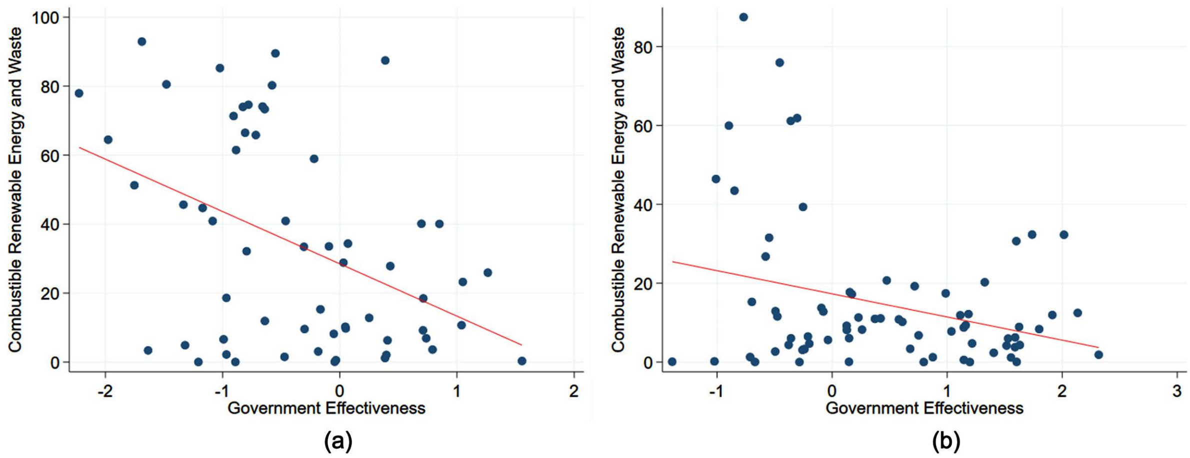

Figure 6. Scatter plot comparison between combustible renewable energy and waste & government effectiveness. (a) Developing regions; (b) Developed regions.

Figure 6 shows the relationship between government effectiveness and combustible renewable energy and waste. Figure 6(a) features a strong negative correlation in developing regions. This may indicate that, while still effective in other areas, these governments may not be implementing or properly enforcing renewable energy use policies. Interestingly, in the graphic, the less effective governments in developing areas seem to be better at implementing renewable energy policy, with higher levels of combustible renewable energy and waste. Figure 6(b) supports the negative relationship between government effectiveness and combustible renewables in developed regions, except that there is a weaker correlation. Given that combustible renewables are measured as a percentage of all energy, it seems that in developed areas, combustible renewables are a smaller portion of total energy than in developing areas. This figure supports a negative relationship between government effectiveness and sustainability in terms of combustible renewable energy and waste.

Figure 7 shows the relationship between GDP per capita growth and the sustainability indicator electric power consumption, where more electric usage indicates less sustainability. In Figure 7(a), there is a slightly positive correlation for developing regions. Electricity is a key indicator of economic activity, which shows that the higher the electricity consumption, the higher a country's productivity, technological advancement, and industrial expansion. This makes sense for developing countries—the more economic growth, the more electricity usage and development may occur. In contrast, Figure 7(b) displays a negative relationship between GDP per capita growth and electric power consumption in developed regions. Economic growth is becoming less energy intensive in more developed countries. Because of this, these economies tend to invest in more efficient technology to consume less electricity, which explains the negative correlation. This suggests that GDP growth correlates with more sustainable energy use in developed regions, but less sustainable energy usage in developing regions.

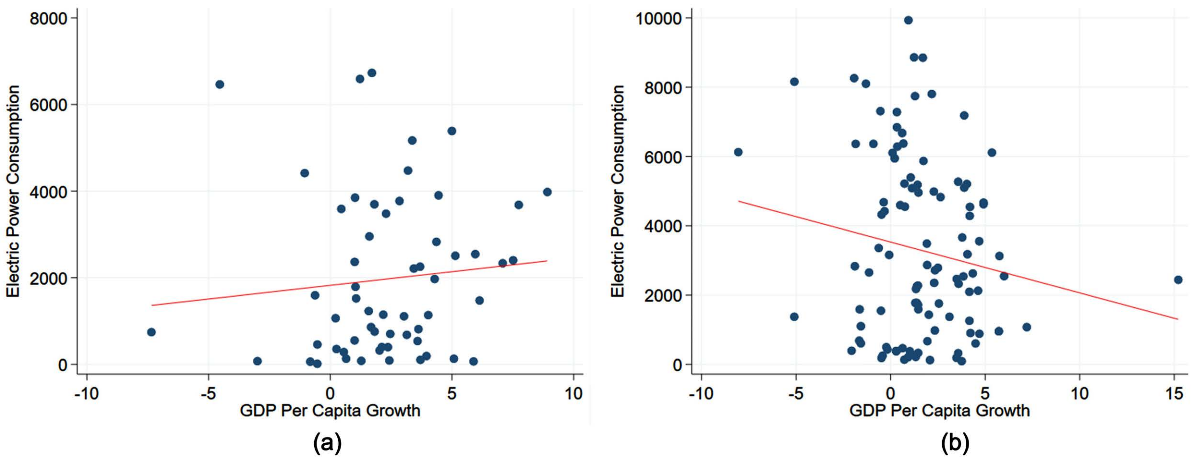

Figure 7. Scatter plot comparison between electric power consumption & GDP per capita growth. (a) Developing regions; (b) Developed regions.

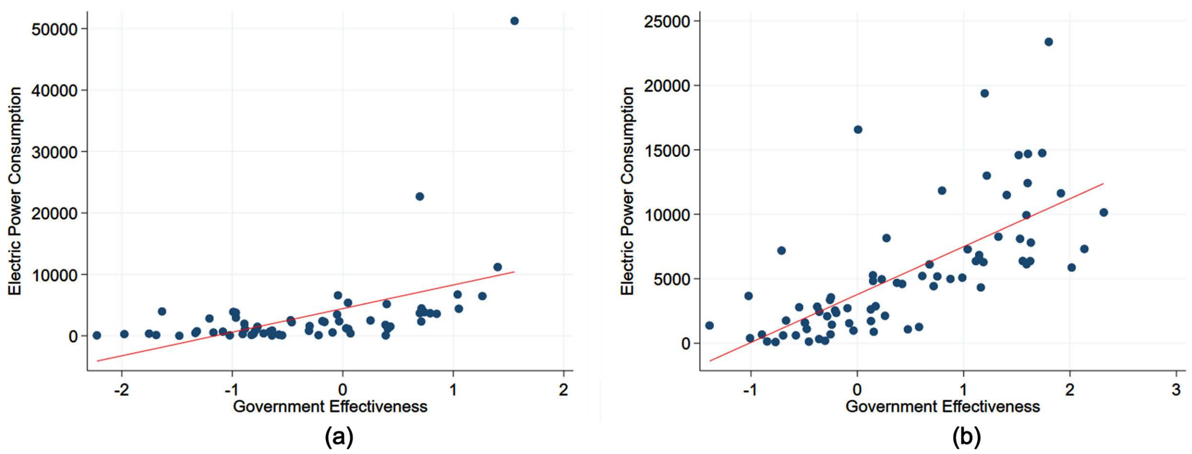

Figure 8. Scatter plot comparison between electric power consumption & government effectiveness. (a) Developing regions; (b) Developed regions.

Figure 8 shows the connection between government effectiveness and electric power consumption. In both Figure 8(a), Figure 8(b), there is a positive correlation. However, the reason why may differ between the two. Higher electricity consumption shows a developing region's improved productivity, technological advancement, and industrial expansion, so it makes sense that more effective governments of these regions would promote more electric power consumption. Interestingly, the positive relationship in Figure 8(b) contradicts the negative relationship between GDP per capita growth and electric power consumption as shown in panel 7b. It is reasonable, however, given that developed regions have higher energy demands due to wider technology and power usage. An effective government would be able to meet the needs of the people, which is what is represented in the graph. This positive relationship indicates that government effectiveness contributes to less sustainability in terms of electric power consumption in both developing and developed regions.

Table 2. Regression analysis for carbon dioxide emissions and forest area.

	(a). Developing Regions				(b). Developed Regions			
Variables	CO_2 Emissions		Forest Area		CO_2 Emissions		Forest Area	
GDP Per Capita	−9.380		0.930		17.884*		0.631	
	(8.580)		(0.608)		(9.481)		(0.586)	
Government Effectiveness		−152.116**		1.775		−91.686***		3.059
		(74.323)		(3.016)		(23.525)		(2.620)
Constant	414.161***	328.051***	31.980***	34.596***	127.796***	199.210***	28.398***	28.438***
	(90.969)	(63.564)	(2.979)	(2.730)	(18.894)	(36.033)	(1.808)	(2.494)
Observations	106	102	105	101	122	76	120	74
R-squared	0.010	0.029	0.026	0.003	0.052	0.095	0.012	0.020

Robust standard errors are in parentheses. $p < 0.01$, $p < 0.05$, $p < 0$.

Table 2 presents the regression analysis results for the dependent variable of sustainability—represented by CO_2 Emissions and Forest Area—in relation to the independent variables GDP per capita growth and government effectiveness among developing and developed regions. For the proxy of CO_2 emissions, a negative coefficient signifies a decrease in emissions and improved sustainability. For the forest area proxy, a positive coefficient signifies more forest area, and by extension, more sustainability. If the results are statistically significant at the one percent level, it is indicated by (); at the five percent level, it is indicated by (); and at the ten percent level, it is indicated by (). In Table 2(a), representing developing regions, economic growth does not significantly relate to lower carbon emissions, with a coefficient of −9.380. Also in Table 2(a), government effectiveness has a more significant negative relationship with carbon dioxide emissions, with a coefficient of −152.116. This indicates that while economic growth may not have a significant impact on reducing carbon emissions in developing countries, government effectiveness does. In **Table 2(b)**, representing developed regions, there is a somewhat significant relationship between economic growth and higher carbon dioxide emissions, with a coefficient of 17.884. In contrast, government effectiveness has a very significant impact on reducing carbon emissions, with a coefficient of −91.686. This suggests that while growth contributes to unsustainability, government effectiveness significantly increases sustainability in developed regions.

Existing literature is in accordance with the aforementioned results. Perrings and Ansuategi (2000), in their study using carbon dioxide and GDP per capita growth, and Ward et al. (2016), in their study of sustainability and GDP growth in both developing and developed countries, report a similar result that economic growth does not ensure sustainability and may be unsustainable in some cases. Gani (2012), in a study of carbon dioxide emissions and government effectiveness, and Dehdar et al. (2022), in a study using the same variables, detail that good government effectiveness helps to reduce carbon dioxide emissions.

Looking back to **Table 2** for developing and developed regions, both economic growth and government effectiveness do not seem to significantly correlate with forest area. In **Table 2(a)**, GDP per capita growth and forest area have a coefficient of 0.930, while government effectiveness and forest area have a coefficient of 1.775. In **Table 2(b)**, GDP per capita growth and forest area have a coefficient of 0.631, while government effectiveness and forest area have a coefficient of 3.059. Although the correlation is not very significant, growth and government effectiveness in developing and developed regions have positive correlations with forest area.

In terms of economic growth, existing literature seems to suggest an inverse relationship between economic growth and forest area. Hao et al. (2019) account that better forest preservation policies may increase growth, rather than economic growth increasing forest area. On the other hand, the literature seems to be consistent with the results for government effectiveness. Sulaiman and Abdul-Rahim (2022) suggest that government effectiveness can help to reduce deforestation, which would in turn increase forest area.

Table 3 presents the regression analysis results for the dependent variables combustible renewable energy and waste, and electric power consumption as proxies of sustainability. Positive levels of sustainability are indicated by a positive coefficient for combustible renewables and a negative coefficient for electricity consumption. Statistical significance is, again, represented by () for the one percent level, () for the five percent level, and () for the ten percent level. In **Table 3(a)** representing developing regions, there is a significant negative correlation between GDP per capita growth and combustible renewables, with a coefficient of -1.686. Government effectiveness has a more significant negative impact on combustible renewable energy consumption and waste, with a coefficient of −15.167*. This indicates that both economic growth and government effectiveness have a significant negative relationship with sustainability in terms of combustible renewables and waste. Meanwhile, in **Table 3(b)** representing developed regions, economic growth does not have a significant negative relationship with combustible renewables, with a coefficient of −0.450. Government effectiveness, though, has a more significant negative correlation with combustible renewables, with a coefficient of −5.874**. These results suggest that both economic growth and government effectiveness have adverse effects on sustainability (as represented by combustible renewable energy and waste) with varying significance.

Table 3. Regression analysis for combustible renewable energy and electric power consumption.

	(a). Developing Regions				(b). Developed Regions			
Variables	Combust		Electric		Combust		Electric	
GDP Per Capita	−1.686**		13.373		−0.450		−483.129***	
	(0.671)		(89.716)		(0.510)		(134.286)	
Government Effectiveness		−15.167***		3842.918**		−5.874**		3716.899***
		(3.632)		(1765.155)		(2.642)		(486.714)
Constant	36.801***	28.483***	3198.598***	4441.016***	18.685***	17.311***	5140.979***	3775.047***
	(4.002)	(3.318)	(952.407)	(1314.820)	(2.109)	(2.984)	(482.081)	(357.884)
Observations	60	59	62	62	117	73	119	75
R-squared	0.058	0.185	0.000	0.226	0.004	0.088	0.107	0.487

Robust standard errors are in parentheses. $p < 0.01$, $p < 0.05$, $p < 0$.

Existing literature seems to implicate an inverse relationship between economic growth and combustible renewable energy and waste. Ali et al. (2021), in their study of European countries, suggest that combustible energy and waste consumption can lead to boosts in economic growth and increasing sustainability. In accordance, Jebli and Youssef (2015), studying North African countries, concur that combustible renewables and waste can increase economic growth while improving sustainability. Literature studying government effectiveness tends to differ from these findings. Wei et al. (2022) suggest that good government effectiveness paired with good waste practices should have a positive correlation with sustainability in G6 countries. The findings of Iorember and Yusoff (2023) similarly emphasize that green energies and good government effectiveness should have positive effects on sustainability in African countries.

Looking back to **Table 3(a)**, GDP per capita growth has a positive but not very significant impact on electric power consumption in developing regions, with a coefficient of 13.373. Government effectiveness has a substantially greater and more significant impact on electric power consumption, with a coefficient of 3842.918. These findings indicate that in developing regions, both economic growth and government effectiveness tend to increase electric power consumption. While this may be an indicator of reduced ecological sustainability, increased electric power consumption in developing countries can be an indicator of greater social sustainability and increased technological expansion. In **Table 3(b)**, GDP per capita growth has a very significant negative correlation with electric power consumption, with a coefficient of −483.129*. The relationship between government effectiveness and electric power consumption is the opposite, having a very significant positive correlation with a coefficient of 3716.889***. These divergent findings suggest that economic growth correlates with greater sustainability, and that government effectiveness correlates with less sustainability in terms of electricity consumption in developed regions.

The literature findings seem to differ from the results. Hassan et al. (2022), studying growth and electric power consumption, emphasize that clean energy investment and usage help support sustainable economic growth, while this study found that economic growth correlates with less electricity consumption. A reason for this could be that developed economies are trying to cut down on unsustainable electricity consumption for more efficient and sustainable methods. That could help explain why the relationship was negative, and also goes in accordance with the literature's findings.

For government effectiveness and electric power consumption, the literature tends to agree with the data presented. Best and Burke (2017) report that strong government effectiveness provides broader access to electricity—with greater electricity production leading to greater consumption in developing countries.

5. Conclusion

This study illustrates the interplay between economic growth and government effectiveness in shaping sustainability in developing regions as compared to developed regions. In developing regions, economic growth did not have an overall consistently significant impact on sustainability. In the cases of CO_2 emissions and forest area, economic growth had a positive correlation with sustainability, while in the cases of combustible renewables and energy consumption, economic growth had a negative correlation with sustainability. In developed regions, economic growth had a more significant impact on sustainability. Growth had a positive correlation with sustainability from the perspective of forest area and electric power consumption, and had a negative correlation with sustainability when looking at CO_2 emissions and combustible renewables. Government effectiveness had a fairly significant correlation with sustainability in both developing and developed regions. It was significant in the proxies of CO_2 emissions, combustible renewables, and electric power consumption, with forest area being the only proxy that did not have a significant correlation. In developing regions, government effectiveness had a positive correlation with CO_2 emissions and forest area, and a negative correlation with combustible renewables and electricity consumption. Developed regions, in contrast, only had a positive correlation in forest area, with negative correlations in CO_2 emissions, combustible renewables, and electricity consumption.

The findings of this paper suggest that economic growth does not necessarily have a significant correlation with sustainability, which is consistent with previous research conducted in the pre-pandemic era. The findings also suggest that government effectiveness does not always have a direct correlation with positive progress on sustainability, other than in the proxy of CO_2 emissions. While reduced carbon emissions are important and positive, they are not the only unsustainable practices that need to be addressed and monitored. It is recommended that governments continue designing and implementing effective fossil fuel and carbon emission policies to foster more progress on the sustainable use of resources. Governments should additionally focus their efforts on introducing more policies and investing funds in afforestation efforts, which would help to mitigate the effects of carbon dioxide emissions; investing in and incentivizing institutions to implement more renewable energy sources, which would result in a more secure economy that is not at risk of losing the nonrenewable fossil fuels; and increasing investments in research and development for access to more efficient energy, which would ultimately help reduce costs and promote a more sustainable world.

It is recommended that future research should further investigate the relationship between GDP growth, government effectiveness, and additional sustainability indicators such as water usage, ecosystem restoration, raw materials, and other greenhouse gas emissions. The research could explore these relationships on a smaller regional scale, rather than on the broad global scale, to obtain a more comprehensive understanding of local dynamics and idiosyncratic factors in specific regions that may be affecting economic growth and government effectiveness. Finally, this paper does not comprise a comparative analysis of the pre- and post-pandemic era. It is recommended that further research may compare the correlation between economic growth, government effectiveness, and sustainability, comparing pre- and post-COVID-19, to gain a sense of what changed between the two time periods and to properly understand the pandemic's significance on these economic indicators.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix

Appendix 1. Source of Data

Indicator Name	Variable	Definition	Source
Sustainability (CO_2 Emissions)	Carbon dioxide (CO_2) emissions (total) excluding LULUCF (% change from 1990)	Change of emissions (as %) of the current year with respect to emissions in the baseline year 1990 emissions of carbon dioxide (CO_2), one of the six Kyoto greenhouse gases (GHG), from the agriculture, energy, waste, and industrial sectors, excluding LULUCF. The measure is standardized to carbon dioxide equivalent values using the Global Warming Potential (GWP) factors of IPCC's 5th Assessment Report (AR5). Negative values indicate that the emission level for that year is lower than the emissions level in 1990.	WDI World Bank
Sustainability (Forest Area)	Forest area (% of land area)	Forest area (% of land area) is the share of total land area that is under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.	WDI World Bank
Sustainability (Combust)	Combustible renewables and waste (% of total energy)	Combustible renewables and waste comprise solid biomass, liquid biomass, biogas, industrial waste, and municipal waste, measured as a percentage of total energy use. The indicator expresses the share of the total energy supply.	WDI World Bank
Sustainability (Electric)	Electric power consumption (kWh per capita)	Electric power consumption measures the production of power plants and combined heat and power plants, less transmission, distribution, and transformation losses, and own use by heat and power plants.	WDI World Bank
GDP Per Growth	GDP per capita growth (annual %)	Annual percentage growth rate of GDP per capita based on constant local currency.	WDI World Bank
Government Effectiveness	Government Effectiveness: Estimate	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e., ranging from approximately −2.5 to 2.5.	WDI World Bank

Appendix 2. Summary of Literature Review

Author(s)	Year	Key Variables	Methods	Key Findings	Period	Region(s)
Ward et al.	2016	GDP, Sustainability	Mathematical Model	GDP growth is unsustainable and a poor measure of well-being.	1980-2010	Global
Perrings and Ansuategi	2000	GDP, CO_2, SO_2, deforestation	Descriptive Stats, Regression	Economic growth does not ensure sustainability.	1975-1992	Global (Developed and Developing)
Juknys et al.	2018	GDP, PPP, Sustainability	Scatterplot, Descriptive Stats	Sustainability and well-being are not dependent on GDP growth in developed countries.	1961-2015	OECD

Continued

Carrera and Vergara	2012	GDP, Debt, Exchange Rate, Sustainability	Regression, GMM, VAR	Devaluation increases debt pressure.	1999-2007	Latin America
Hysa et al.	2020	GDP, Environmental Tax, Recycling, Circular Economy,	Panel Regression	Circular economy practices positively impact economic growth.	1950-2016	EU
Vasylieva et al.	2019	GDP, GHG Emissions, Renewables, Corruption	Quadratic Model, Panel Test,	Boosting sustainability and reducing corruption can lead to growth.	2000-2016	EU and Ukraine
Fei Lu et al.	2024	GDP, CO_2 Emissions	MIDAS Model	Transportation and industrial emissions are strong indicators of growth.	1989-2023	USA
Gani	2012	CO_2 Emissions, Trade, Government Effectiveness, Corruption	Regression	Good governance helps reduce CO_2 emissions in developing countries.	1996-2009	Global
Dehdar, et al.	2022	CO_2 Emissions, GDP, Fossil Fuel Consumption, Environmental Tax	Panel Regression	Growth and fossil fuel use increase CO_2 emissions; good governance reduces them.	1994-2015	OECD
Sulaiman and Abdul-Rahim	2022	Forest, Income, Corruption, Government Effectiveness, Trade	GMM, Panel Regression	Strong government effectiveness and control of corruption help to reduce deforestation.	2005-2013	Sub-Saharan Africa
Ellefson et al.	2007	Forestry, Agency	Descriptive	Most states regulate private forest practices, but they are less effective than non-regulatory ones.	2003	USA
Hao et al.	2019	Timber Afforestation, GDP, Trade, Urbanization	GMM	Industrial upgrades, improved land use, and forest policies may increase growth.	2002-2015	China
Ali et al.	2021	Combustible Energy, Waste, CO_2 Emissions, GDP	Co-integration, Panel Regression, Granger Test	Combustible energy and waste consumption boost GDP and reduce emissions; effects are improved with a circular economy.	1990-2019	Europe
Jebli and Youssef	2015	Combustible Renewables, Waste, CO_2 Emissions, GDP	Co-integration, Granger Test	Combustible renewables, waste, and CO_2 emissions boost economic growth; increased renewable use supports growth, and reduced emissions.	1971-2008	North Africa
Iorember and Yusoff	2023	Renewables, CO_2 Emissions, Income, Government Effectiveness	OLS, GMM	Green energy and strong governance reduce emissions in Africa.	1996-2018	African Countries

Continued

Wei et al.	2022	Waste, Urbanization, GDP, Renewable Energy	Panel Regression, Co-integration	Strong governance and good waste practices improve sustainability.	1996-2020	G6 Countries
Shahid et al.	2022	Growth, Labor Force, Electric Power Consumption,	Panel Co-integration, VECM,	Clean energy investments support sustainable economic growth.	1972-2020	Europe
Mezghani and Haddad	2017	GDP, Electricity, CO_2 Emissions	TVP-VAR Model	Investing in renewable energy and efficiency supports sustainable growth and reduces emissions.	1971-2010	Saudi Arabia
Best and Burke	2017	Electricity capacity, Quality, Government effectiveness	Panel & Cross-sectional Regression	Good governance is critical for improving electricity access and quality.	up to 2012	Developing Countries
Zhou and Jamaani	2023	Education Expenditures, Electricity Production, Eco Innovation, GDP, Government Effectiveness	Regression, Granger Test	Improved governance, education spending, and innovation support growth.	2000-2021	China