Energy Reports 11 (2024) 4165–4176

Contents lists available at ScienceDirect

Energy Reports

journal homepage: www.elsevier.com/locate/egyr

Research paper

The effect of renewable energy aid and governance quality on environmental tax effort in Sub-Saharan Africa

Abdulai Enusah [a,b,*], Francis Aboagye-Otchere [a], Cletus Agyenim-Boateng [b]

[a] University of Ghana, Ghana
[b] University of Education- Winneba, Ghana

ARTICLE INFO

Keywords:
Renewable energy aid
Governance quality
Environmental tax effort
Sub-Saharan Africa

ABSTRACT

The literature on foreign aid and tax efforts largely overlooks the specific role of environmental aid and taxation. To fill this gap, we examine the effects of renewable energy development assistance (EDA) and governance quality on climate change tax effort, air pollution tax effort, and aggregate environmental tax effort in Sub-Saharan Africa (SSA). Utilizing panel data from 15 SSA countries over 20 years (2000–2019), the sample is divided into two groups based on income levels: seven low-income countries (LIC) and eight middle-income countries (MIC). The instrumental variable generalized method of moments (IV-GMM) regression technique is employed to estimate the parameters of the baseline model specifications. The study also uses the Smoothed Instrumental Variable Quantile Regression (SIVQR) technique to test the robustness of the baseline model. Among middle-income SSA countries, the findings suggest that renewable energy aid inflows reduce climate change tax efforts but increase air pollution and aggregate environmental tax efforts. However, among low-income SSA countries, renewable energy aid negatively impacts all three categories of environmental tax efforts. Governance quality tends to enhance all three categories of environmental tax effort in both low-income and middle-income SSA countries. The implications of these results are discussed.

1. Background

Environmental taxes on energy-related activities, such as emissions, fossil fuel consumption, or waste production, enhance sustainable development by creating incentives for cleaner energy sources and disincentives for carbon-intensive ones (Bashir et al., 2022; Sarpong et al., 2023; Abbas et al., 2023; Abokyi et al., 2019; Al Shammre et al., 2023; Bashir et al., 2022; Chien et al., 2023). This study explores how renewable energy development assistance (EDA) and governance quality (GOVQ) influence the environmental tax efforts of Sub-Saharan African countries (SSA).

EDA can be a double-edged sword. It could lead to a moral hazard where governments depend on donors for environmental objectives instead of mobilizing domestic resources through taxes (Ammendola, 2010; Combes et al., 2016; Crivelli & Gupta, 2017; Pham & Pham, 2019). Conversely, it could boost tax efforts by improving tax administration (Benedek et al., 2013; Mascagni & Timmis, 2017; Müller & Claar, 2021; Müller et al., 2021). Similarly, the quality of governance can play a crucial role in determining a country's environmental tax effort. Effective governance, characterized by transparency, accountability, and rule of law, can enhance environmental tax compliance by fostering trust between taxpayers and the government (Kaufmann et al., 2010; Damianos, 2021; Gnangnon & Brun, 2019). It can also improve the efficiency of tax administration, reducing evasion and avoidance (Damianos, 2021; Gnangnon & Brun, 2019; Benedek et al., 2013; Daude et al., 2013a). Therefore, governance quality can be a key factor for countries seeking to increase environmental tax effort and mobilize domestic resources for energy transition. In this study, we examine the effect of EDA and GOVQ on the energy-related environmental tax effort of SSA countries.

Climate change is a pressing global issue (Ivanova, 2020; Scott & Ku, 2018; Wunderling et al., 2023; Yuan et al., 2024; Girgibo et al., 2024) and energy transition is a key strategy to combat it as energy-related emissions contribute over 89% of global greenhouse gases (International Energy Agency, 2022). However, the high costs of renewable energy technologies and integration challenges have hindered their adoption in SSA (IMF/OECD, 2021; Oyedepo & Adaramola, 2020). Governments often resort to environmental taxation to fund energy transition investments and enhance energy efficiency (Ahmad et al., 2023; Bashir et al., 2022; Shamsi & Farzanegan, 2021). But in SSA, these taxes fall short in funding energy transition, making financing a significant hurdle to accelerating energy transition in the region (IMF/OECD, 2021; International Renewable Energy Agency, 2021; Oyedepo & Adaramola, 2020).

Developed countries and international organizations have extended

* Corresponding author at: University of Ghana, Ghana.
E-mail addresses: aenuah@uew.edu.gh, aenusah@uew.edu.gh (A. Enusah).

https://doi.org/10.1016/j.egyr.2024.03.038
Received 6 June 2023; Received in revised form 14 March 2024; Accepted 18 March 2024
Available online 11 April 2024
2352-4847/

financial and technical assistance to SSAs through renewable energy aid to support this transition (Finan & Kanie, 2018; Maruta & Banerjee, 2021). Yet, debates persist about foreign aid's impact on recipient countries' tax efforts. Renewable energy aid could either decrease environmental tax effort if seen as an easier source of revenue (Asongu & Jellal, 2016; Banerjee et al., 2021; Marineau, 2020; Thornton, 2014), or increase it if it enhances revenue administration or supports environmental tax policy reform (Benedek et al., 2013; Wen et al., 2023). The current understanding of this phenomenon is largely theoretical and anecdotal, underscoring the need for empirical study (Asongu & Jellal, 2016; Maruta & Banerjee, 2021; Thornton, 2014).

The current body of knowledge on the relationship between foreign aid and tax efforts has largely overlooked the specific impact of environmental aid and taxation (Maruta & Banerjee, 2021). This gap limits the potential for policy development to address environmental challenges. Our research aims to fill this void by examining the effect of renewable energy aid and governance quality on environmental tax efforts in Sub-Saharan Africa. We expand our research scope by categorizing environmental taxes into three categories: climate change tax, air pollution tax, and aggregate environmental tax, and investigating their interplay with renewable energy aid and governance quality. This enables us to concentrate on the drivers of environmental tax effort, an aspect often neglected in favor of studying the consequences of environmental taxation (Chien et al., 2023; Maruta & Banerjee, 2021; Shahzad, 2020).

From the foregoing, the study answers four research questions:

1. What is the effect of EDA on the air pollution tax efforts of SSA countries?
2. What is the effect of EDA on the climate change tax efforts of SSA countries?
3. What is the effect of EDA on the aggregate environmental tax effort of SSA countries?
4. What is the effect of governance quality on the environmental tax efforts of SSA countries?

To address these research questions, we employ the Instrumental Variable Generalized Methods of Moments Regression (IVGMM), and the Smooth Instrumental Variable Quantile Regression (SIVQR) techniques, which can address the endogeneity challenges faced by prior studies (Combes et al., 2016; Papies et al., 2017) and at the same time provide both linear and asymmetric estimates of the parameters. While some previous studies have tried to account for nonlinearity by including squared or interaction terms in their models (Benedek et al., 2013; Brun et al., 2008; Clist & Morrissey, 2011), these methods have been associated with heteroscedasticity, collinearity, and misspecification (Combes et al., 2016). Our study employs IV-GMM and SIVQR estimation techniques to address these issues.

Our results, based on panel data from 15 SSA countries (2000–2019), suggest that in middle-income SSA countries, EDA decreases climate change tax efforts but increases air pollution and aggregate environmental tax efforts. Conversely, in low-income SSA countries, EDA has a negative effect on all three categories of environmental tax efforts. Governance quality consistently improves all three categories of environmental tax effort in both low-income and middle-income SSA countries. The rest of our study is organized into five sections: a literature review, a description of our research methodology, a presentation and discussion of our empirical model estimates, a discussion on the policy implications of our findings, and a section addressing the limitations of our study.

2. Literature review

2.1. Renewable energy aid and environmental tax effort

The empirical evidence regarding the relationship between foreign aid and tax efforts is a subject of much debate. One school of thought, based on the aid dependency theory, posits that foreign aid can reduce tax effort (Asongu & Jellal, 2016; Combes et al., 2016; Crivelli & Gupta, 2017; Marineau, 2020; Pham & Pham, 2019). According to this paradigm, foreign aid may decrease the incentive and capacity of recipient governments to mobilize domestic resources as they become reliant on external sources of finance (Bräutigam & Knack, 2004; Cui & Hu, 2023; Remmer, 2004). The empirical literature suggests three ways foreign aid can negatively impact tax efforts. The first mechanism is the enforcement mechanism. This means that foreign aid allows recipients to avoid enforcing taxation while still being able to function and finance their operations. This is attractive to recipients because taxation is both operationally costly (e.g., funding the tax apparatus) and politically costly (i.e., taxing citizens makes them demand more representation and accountability) (Marineau, 2020; Morrison, 2015; Remmer, 2004).

The second mechanism is the substitution mechanism, based on the fiscal bargaining theory for tax compliance. According to this theory, tax compliance results from a bargaining process between the state and citizens in which the state provides services in exchange for taxes paid by citizens (Berenson, 2018; Marineau, 2020; Misra, 2019). However, the bargaining process breaks down if citizens can receive services from non-state actors without paying taxes. Thus, foreign aid can fund service delivery by non-state actors, substituting the state as a service provider. This reduces citizens' demands on the state, reducing the need to extract taxes (Bodea & LeBas, 2014; Combes et al., 2016; Deserranno et al., 2020; Dolan, 2020).

The third mechanism is the legitimacy mechanism. This means foreign aid can reduce citizens' perception of the state's legitimacy. When external resources are used to provide public services, citizens may doubt the government's ability to provide for their needs (Blair & Roessler, 2021; Marineau, 2020; Montinola et al., 2020). This can make the citizens question the state's legitimacy to tax, hence negatively impacting the tax effort of the state (Blair & Roessler, 2021; Bräutigam et al., 2008; Marineau, 2020; Prichard et al., 2014; Svensson, 2000).

Besides, Samaritan's Dilemma theory can explain the negative relationship between aid and tax. It explains that aid-recipient countries can strategically maintain suboptimal tax performance in order to continue receiving higher levels of foreign aid (Blair & Roessler, 2021; Marineau, 2020). This phenomenon is also referred to as the crowding-out effect of foreign aid.

The other school of thought suggests that foreign aid can increase tax efforts in recipient countries for several reasons. The fiscal capacity theory argues that the ability of a state to raise revenue from its citizens depends on its administrative and institutional capacity to enforce taxation and provide public goods and services (Besley & Persson, 2013; 2014; Ricciuti et al., 2019). According to this theory, foreign aid can increase tax efforts by enhancing the fiscal capacity of recipient countries through technical assistance, capacity building, and the improvement of tax administration (Bayale, 2020; Fjeldstad & Tungodden, 2003; Mascagni & Timmis, 2017; Moore et al., 2015; Morrison, 2015; Munyanyi et al., 2022). For instance, the aid can help the government train more tax officers, implement new tax reforms, and develop better information systems that stimulate tax efforts (Bayale, 2020; Fjeldstad & Tungodden, 2003; Moore et al., 2015; Morrison, 2015).

Additionally, other empirical studies have argued from the perspective of fiscal contract theory. Such studies have argued that taxation results from a social contract between the state and its citizens, whereby the state provides public goods and services in exchange for taxes paid by citizens (Huemer, 2013; Lenton et al., 2017; Mangoting & Sukoharsono, 2015; Timmons, 2005). Therefore, foreign aid can increase tax efforts by strengthening the fiscal contract between the state and its citizens through improved service delivery, accountability, and responsiveness.

2.2. Governance quality and environmental tax effort

Governance quality encompasses various dimensions, such as voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law, and control of corruption (Aluko, 2020; Benedek et al., 2013; Farooq, 2022; Kaufmann et al., 2010). Countries can collect higher taxes only if the tax collection process is efficient. Governance quality can affect environmental tax efforts through various channels, such as tax morale, public service delivery, fiscal transparency and accountability, and tax administration capacity (Benedek et al., 2013; Daude et al., 2013a; Damianos, 2021; Gnangnon & Brun, 2019). For instance, the perceptions and attitudes of taxpayers towards the government, public institutions, and public goods and services can affect tax morale (Daude et al., 2013a; Koumpias et al., 2020; Leonardo et al., 2017; Torgler et al., 2007).

A higher quality of governance can increase tax morale by enhancing the trust and legitimacy of the government, improving the responsiveness and accountability of public officials, reducing corruption and rent-seeking, and ensuring a fair and efficient allocation of public resources (Daude et al., 2013a; Sebele-Mpofu, 2020). Also, public service delivery can influence tax efforts by affecting the cost-benefit analysis of taxpayers on the use of tax revenues (Gnangnon & Brun, 2019; Koumpias et al., 2020; Leonardo et al., 2017). A higher quality of governance can improve public service delivery, increasing the willingness to pay taxes and contribute to the public good, leading to a higher tax effort (Daude et al., 2013a; Gnangnon & Brun, 2019; Sebele-Mpofu, 2020).

Additionally, studies by Arif and Rawat (2018) and Kubler et al. (2020) suggest that the resilience of a country's tax system and its revenue performance are heavily influenced by the administrative superiority of its governance institutions. In situations where governance is inferior, there can be a corrosive impact on tax collection. However, good governance can enhance tax revenue by mitigating tax evasion, properly composing tax rates, and ensuring the fair inclusion of taxable revenue in tax reporting (Ajaz & Ahmad, 2010; Jones et al., 2017; Timmons & Garfias, 2015). Overall, it is evident from the literature that governance quality positively influences tax efforts (Ajaz & Ahmad, 2010; Arif & Rawat, 2018; Jones et al., 2017).

2.3. Control variables and environmental tax effort

Prior literature has analyzed trade openness, the size of the agricultural sector, GDP per capita, and the size of the shadow economy as control variables while examining the effect of foreign aid on tax effort (Combes et al., 2016; Marineau, 2020; Mascagni & Timmis, 2017; Wen et al., 2023). To this extent, it is expected that these variables may impact tax efforts, although they have not been empirically tested in the context of environmental taxes (Combes et al., 2016; Marineau, 2020; Mascagni & Timmis, 2017; Wen et al., 2023).

Trade openness can pressure governments to reduce environmental taxes to maintain competitiveness (Ekins & Speck, 1999; Levinson, 2003). This argument is predicated on the notion that higher environmental taxes can increase production costs and diminish a country's competitiveness in international markets, thereby reducing environmental tax efforts. Conversely, an alternative perspective posits that trade openness can enable governments to augment their environmental tax efforts (Barros et al., 2023; Gnangnon, 2021; Ho et al., 2023). This perspective is based on the notion that trade openness can incentivize governments to safeguard the environment as environmental standards become increasingly important in contemporary international trade. For instance, a country that imposes high environmental taxes may be perceived as more environmentally conscious, which can enhance its international reputation and attract investment (Bazillier et al., 2016; Bazillier et al., 2017; Le et al., 2012).

The size of the shadow economy, defined as the economic activities hidden from official authorities for monetary, regulatory, or institutional reasons, has significant implications for environmental tax efforts (Ajide, 2021; Alm et al., 2019). A large shadow economy reduces the tax base and undermines tax collections, while a smaller shadow economy is associated with higher tax effort and revenue (Alm et al., 2019; Awasthi & Engelschalk, 2018; Schneider et al., 2010). Additionally, a larger shadow economy reduces taxpayers' tax morale, negatively impacting tax effort (Dell'Anno & Davidescu, 2019; Horodnic & Williams, 2016; Luttmer & Singhal, 2014; Torgler et al., 2007). When taxpayers perceive that a large share of the economy is evading taxes, they may feel less obliged to pay their taxes or more resentful of the tax system. This can erode tax morale and increase the incentives to join the shadow economy, hence reducing tax efforts (Dell'Anno & Davidescu, 2019; Luttmer & Singhal, 2014).

Additionally, the literature suggests that a large agricultural sector reduces tax efforts in developing countries since agriculture is relatively difficult to tax (Gupta et al., 2021; Khan, 2001; Morrissey et al., 2016; Rajaraman, 2003). The agricultural sector can include activities such as subsistence farming, which may not be taxed, or informal sales of agricultural products that are not subject to tax (Chakraborty & Dash, 2017; Gnangnon, 2022). Moreover, a large agricultural sector can also lead to political pressure to maintain low tax rates or exemptions for the industry since it is a politically sensitive industry (Chakraborty & Dash, 2017; Gnangnon, 2022).

Tax effort is also expected to depend largely on the income level of a country (Barros et al., 2023; Besley & Persson, 2014; Empirical & Langford, 2016; Pessino & Fenochietto, 2010). Countries with higher incomes tend to have higher tax-to-GDP ratios, mainly because they may have a broader and more diverse tax base due to increased economic activities, more formal sectors, and more consumption and savings (Akitoby et al., 2020; De Mooij, 2020; Empirical & Langford, 2016). Also, higher-income countries may have better institutional quality and governance, which can improve tax administration, compliance, and enforcement. On the contrary, some studies arguing from the perspective of the environmental Kuznets hypothesis suggest that GDP can have a negative association with tax effort (Demissew Beyene & Kotosz, 2020; Leal & Marques, 2022).

3. Methodology

This study utilizes panel data from 15 Sub-Saharan African countries over 20 years (2000–2019), with sample selection based on data availability. The sample is divided into two groups based on income levels: seven low-income countries (LIC) and eight middle-income countries (MIC). Subdividing samples into homogeneous groups can help control for confounding factors specific to different income levels (Lin et al., 2018; Pourhoseingholi et al., 2012; Wang et al., 2017). Also, low- and middle-income countries often have distinct policy priorities and development challenges that may affect their environmental tax efforts. Dividing the sample allows for more specific results, targeted policy implications, and a more comprehensive understanding of the relationships between variables in different economic contexts (Lin et al., 2018; Pourhoseingholi et al., 2012; Wang et al., 2017).

3.1. Definition of variables

Environmental tax effort is the dependent variable of interest in this study and is defined as the ratio of environmental tax revenues to GDP (Combes et al., 2016; Crivelli & Gupta, 2017; Diaz-Sanchez et al., 2022). Within the OECD database, environmental taxes are classified by their tax base (i.e., energy, transport, pollution, and resources) and the environmental domain they relate to (i.e., air pollution, climate change, biodiversity, and the ocean). This study focuses on energy-related environmental taxes to produce results and policy recommendations specific to the energy sector. To provide a detailed analysis of the dependent variable, we decompose it into three environmental domains and run separate regression estimations for each of them. Thus, the decomposed dependent variables entail environmental taxes related to air pollution (APTE), environmental taxes on climate change (CCTE), and aggregate energy-related environmental taxes (AETE). For ease of interpretation, we use the terms climate change tax effort, air pollution tax effort, and aggregate environmental tax effort to represent the above-mentioned environmental tax categories. Due to the large amount of missing data, the study did not emphasize the other environmental tax domains (i.e., biodiversity and ocean).

The independent variables of interest are renewable energy development assistance (EDA) and governance quality (GQ). Data on EDA is obtained from the International Renewable Energy Agency (IRENA, 2022), while data on governance quality is obtained from the World Bank's World Development Indicators (WDI). Additionally, the study uses four control variables, all obtained from the WDI databases. These include (1) the size of the agricultural sector (SAgric), measured as the value added of agriculture, forestry, and fishing as a percentage of GDP; (2) trade openness (TOpenness), measured as the sum of a country's exports and imports as a share of that country's GDP; (3) GDP per capita (GDPPC); (4) the size of the shadow economy (Sshadow), compiled by Elgin et al. (2021) for the World Bank's Prospects Group. The natural logs of these variables were used for the analysis. To this extent, the effect of the independent variables on the dependent variables (i.e., AETE, CCTE, and APTE) is such that:

$$\text{AETE} = f(\text{EDA, GovQ, Sshadow, TOpenness, SAgric, GDPPC}) \quad (1)$$

$$\text{CCTE} = f(\text{EDA, GovQ, Sshadow, TOpenness, SAgric, GDPPC}) \quad (2)$$

$$\text{APTE} = f(\text{EDA, GovQ, Sshadow, TOpenness, SAgric, GDPPC}) \quad (3)$$

3.2. Model specification and estimation

The relationship between foreign aid and tax efforts has been challenging to analyze using regression due to endogeneity issues (Diaz-Sanchez et al., 2022; Thornton, 2014; Wen et al., 2023). Numerous empirical studies have shown that foreign aid is an endogenous variable that can bias regression estimates and reduce the efficiency and accuracy of regression models if not properly accounted for (Combes et al., 2016). In light of this, we have employed energy poverty and the share of renewable energy consumption as instrumental variables for EDA.

Energy poverty is a relevant instrument as it is a crucial motivator for donors to provide renewable energy aid to developing countries (Diaz-Sanchez et al., 2022; Thornton, 2014; Wen et al., 2023). The share of renewable energy consumption is also a relevant instrument as it reflects the recipient country's commitment to transitioning to renewable energy sources, which is a primary objective of foreign energy aid (Diaz-Sanchez et al., 2022; Thornton, 2014; Wen et al., 2023). Both variables are likely to be correlated with foreign energy aid but not directly with environmental tax effort, thus satisfying the requirements for instrumental variable regression. The data on energy poverty and the share of renewable energy is obtained from the WDI database.

Consequently, the instrumental variable generalized method of moments (IV-GMM) regression technique is employed to estimate the parameters of the baseline model specifications, as seen in Eqs. (3), (4), and (5).

$$AETE = \beta 0 + \beta 1EDA_{it} + \beta 2GovQ_{it} + \beta 3Sshadow_{it} + \beta 4TOpenness_{it} + \beta 5SAgric_{it} + \beta 6GPPC_{it} + \mu_{it} \tag{4}$$

$$CCTE = \beta 0 + \beta 1EDA_{it} + \beta 2GovQ_{it} + \beta 3Sshadow_{it} + \beta 4TOpenness_{it} + \beta 5SAgric_{it} + \beta 6GPPC_{it} + \mu_{it} \tag{5}$$

$$APTE = \beta 0 + \beta 1EDA_{it} + \beta 2GovQ_{it} + \beta 3Sshadow_{it} + \beta 4TOpenness_{it} + \beta 5SAgric_{it} + \beta 6GPPC_{it} + \mu_{it} \tag{6}$$

Eqs. (3), (4), and (5) specify the effect of the independent and control variables on climate change tax effort (CCTE), air pollution tax effort (APTE), and aggregate environmental tax effort (AETE), respectively. μ_{it} is the error term.

Endogeneity can happen because of reverse causality, measurement error, and missing variables, leading to spurious estimates (Muoneke et al., 2023; Papies et al., 2017). The IV-GMM has robust options to avoid these problems and give more reliable estimates. It also uses the orthogonality condition, which makes it robust to autocorrelation and heteroscedasticity (Muoneke et al., 2023). Besides, it has options that can produce consistent results amidst weak instruments.

Notwithstanding the strengths of IV-GMM, it does not capture heterogeneity and nonlinearity in the conditional distribution of the dependent variable. To address this, we also use the Smoothed Instrumental Variable Quantile Regression (SIVQR) technique to test the robustness of our baseline model. This allows us to estimate the asymmetric effect of independent variables at different quantiles of the dependent variable (Kaplan, 2022; Kaplan & Sun, 2017). SIVQR has the strengths of IV-GMM and captures heterogeneity and nonlinearity in the conditional distribution of the dependent variable. It estimates causal effects at different quantiles of the dependent variable, which may vary depending on unobserved heterogeneity.

Additionally, it relaxes the assumption that the error term is homoscedastic and uncorrelated with instruments, which may not always be true. Thus, the τ^{th} $(0 < \tau < 1)$ quantile of the conditional distribution of the dependent variable is specified for a set of given independent variables X_{it} as follows: $Qy_{it}(\tau|X_{it}) = X'_{it}\beta_{\tau}$, where $X'_{it} = (EDA, GovQ, Sshadow, TOpeness, SAgric, GDPPC)$. SIVQR has several advantages over traditional instrumental variable quantile regression. It requires less computing time and does not impose a location scale that can result in inconsistent estimates if the model is misspecified (Balasubramaniam, 2023; Baum et al., 2007; Kaplan, 2022; Kaplan & Sun, 2017).

3.3. Diagnostic tests

The Pesaran CD test, Breusch-Pagan LM test, and Pesaran scaled LM are used to assess the variables for cross-sectional dependence. These tests have a null hypothesis of no cross-sectional dependence. The results in Table 1 suggest the presence of cross-sectional dependency in both the LIC and MIC samples since the P-values were significant at 1%. However, both IV-GMM and SIVQR are robust against cross-sectional dependence. By using moment conditions that exploit the instrument relevance and orthogonality to the error term, IV-GMM and SIVQR provide consistent estimates of the parameters of interest while addressing both endogeneity and cross-sectional dependence (Balasubramaniam, 2023; Baum et al., 2007; Kaplan, 2022; Kaplan & Sun, 2017).

Additionally, slope homogeneity was assessed using Pesaran and Yamagata's (2008) test for slope homogeneity. The Pesaran and Yamagata (2008) tests failed to reject the null hypothesis of slope homogeneity for both LIC and MIC samples (see Table 1). By implication, the observed relationship between the dependent and independent variables is consistent (homogeneous) across all entities in the respective samples. Furthermore, Jochmans and Verardi's (2020) portmanteau test for serial correlation in panel models was used to examine the possibility of serial correlation. The tests follow the null hypothesis of no serial correlation (Table 1). For LIC and MIC samples, the chi-square statistic is 7 and 8 with corresponding P-values of 1 apiece, which means we cannot reject the null hypothesis at any conventional significance level. Therefore, there is no evidence of serial correlation in the panel data. Further, the LR test for heteroskedasticity rejected the null hypothesis of homoskedastic residuals. However, as elaborated earlier, both IV-GMM and SIVQR are robust against homoskedasticity problems.

In addition, two key post-estimation tests were used to assess the validity and reliability of instrumental variable analysis (Table 2).

Table 1
General Diagnostics Tests.

	LIC Sample			MIC Sample		
Test A: Cross-Sectional Dependence	Statistic	d.f.	Prob.	Statistic	d.f.	Prob.
Breusch-Pagan LM	56.499	21	0.000	71.28	28	0.000
Pesaran scaled LM	5.478		0.000	5.784		0.000
Pesaran CD	0.206		0.837	0.041		0.967
H0: No cross-section dependence (correlation) in residuals						
Test B: Heteroskedasticity LR Test						
	Value	df	Prob.	Value	df	Prob.
AETE	17.634	7	0.014	112.423	8	0.000
CCTE	25.937	7	0.000	85.48	8	0.000
APTE	37.845	7	0.000	2904.167	8	0.000
H0: Residuals are homoskedastic						
Test C: Jochman's portmanteau test for serial correlation						
		Chi-sq(189)	7	Chi-sq(189)		8
H0: No serial correlation		Prob > F	1.00	Prob > F		1.00
Test D: Slope heterogeneity (Pesaran, Yamagata)						
			Delta	P-Value	Delta	P-Value
			-0.328	0.743	1.408	0.159
		adj	-0.391	0.695	1.178	0.239
H0: Slope coefficients are homogenous						

Table 2
Instrumental Variable Diagnostic Tests.

Test A: Endogeneity (orthogonality conditions)				
			chi2(1)	P-Value
LIC Sample	GMM C statistic	4.42879		0.0353
MIC Sample	GMM C statistic	5.16921		0.023
H0: Variables are exogenous				
Test B: Overidentification restriction test				
			chi2(1)	P-Value
LIC Sample	Hansen's J		1.72964	0.1885
MIC Sample	Hansen's J		0.83485	0.3609
H0: the instrument is valid				

The Durbin-Wu-Hausman test was used to evaluate whether the endogenous regressor in the regression model is, in fact, exogenous (Table 2). The null hypothesis of this test is that the specified endogenous regressors can be treated as exogenous. The test is based on the assumption that the instruments are valid and uncorrelated with the error term. The test statistic is the C(difference-in-Sargan) statistic, which is a chi-squared distribution with degrees of freedom equal to the number of overidentifying restrictions. For the LIC sample, the test result in Table 2 shows that the C statistic is 4.42879 with a p-value of 0.0353. We can reject the null hypothesis that the variables are exogenous at the 5% significance level. Therefore, there is evidence of endogeneity in the model, hence justifying the inclusion of instrumental variables.

For the MIC sample, the value of the test statistic is 5.16921, and the p-value is 0.0230; hence, we can reject the null hypothesis and conclude that there is evidence that the variables are endogenous. This justifies the use of instrumental variable analysis.

Additionally, Hansen's J statistic was reported, which is a test of overidentifying restrictions (refer to Table 2). This test checks whether the instruments are valid, meaning that they are uncorrelated with the error term. The null hypothesis is that the instruments are valid. For both LIC and MIC samples, results in Table 2 reveal p-values above conventional significance levels of 0.05 (i.e., 0.3609 and 0.1885, respectively), proving the validity of instruments used in both models.

Finally, stationarity is essential because it ensures that the statistical properties of the data remain constant over time. If the data is non-stationary, it can lead to spurious regression results and other statistical problems. The study tests for stationarity using the Phillips–Perron test and the augmented Dickey–Fuller test, as shown in Table 3.

The test result in Table 3 reveals that the variables are stationary at level and thus do not have a unit root. This is true for the Phillips–Perron and augmented Dickey–Fuller tests. Following these diagnostic tests, the study estimates and discusses the empirical model.

4. Empirical results and discussion

4.1. Descriptive statistics

Table 4 presents the descriptive statistics of the sample data, and Fig. 1 and 2 contain the visual depictions. The statistics presented include the mean and the standard deviations of the variables based on the countries in the panel. For instance, looking at the middle-income sample in Table 4 and considering "SAgric" as an independent variable, the mean values of "SAgric" range from 1.022 in South Africa to 3.999 in Ghana.

The standard deviations (SD) associated with these means indicate the degree of dispersion or variability around the Mean. The SD values for "SAgric" range from 0.056 in Cameroon to 0.332 in Ghana. These statistics offer insights into the differences in agricultural-related indicators among the middle-income countries in the sample. Another variable of interest is "TOpenness," which pertains to economic or trade openness. The mean values for "TOpenness" range from 0.163 in Nigeria to 1.236 in Lesotho. The corresponding SD values range from 0.081 in Senegal to 0.431 in Lesotho. These statistics illustrate the varying levels of economic openness across the countries.

Additionally, Table 5 displays the correlation coefficients between multiple variables. Each entry in the table represents the correlation between two specific variables.

The coefficients range from −1–1 and indicate the strength and direction of the relationship between variables. From the first category of LIC sample (Table 5), the strongest correlation in this table is between the variables Sshadow and GDPPC, with a correlation coefficient of −0.487.

On the other hand, the weakest correlation occurs between EDA and GOVQ, with a correlation coefficient of −0.006. This indicates that there is almost no correlation between these two variables. The other pairwise correlations in Table 5 are interpreted in a similar manner.

Fig. 1 below visually depicts the mean values of the key variables.

Fig. 1 visually depicts the mean of the key variables used in the study, including AETE, CCTE, APTE, EDA, and GOVQ. The graph for each variable shows the mean trend line for the LMIC and LIC samples. The LMIC sample is represented by the red line, while the pink line represents the LIC sample.

On average, the trend lines in Fig. 1 shows that the LMIC sample generally has a greater environmental tax effort (i.e., AETE, APTE, and CCTE) compared to the LIC sample. For example, regarding AETE, the trend line shows that the LMIC sample has an overall mean greater than that of the LIC sample, especially during periods ranging from 2000 to 2007. During the 2009–2015 period, the average AETE of the LMIC sample sharply fell below that of the LIC sample and the post 2015–2019 periods shows that both sample groups had similar average AETE.

Similarly, the APTE graph shows a trend where LMIC's average APTE outpaces that of LIC by a wider gap during the 2000–2009 period. However, LMIC's APTE trend line sharply fell post 2009, closing the gap by which it outpaced the LIC sample. Contrary, the CCTE graph shows mixed trend lines. Thus, compared to LIC sample, the LMIC sample had higher average CCTE during 2001–2006 period. However, the LIC's average CCTE steadily rose by a small margin while that of LMIC sharply declined by a larger margin till it fell below the CCTE trend line of the LIC sample for periods ranging 2006 through to 2019.

Additionally, the graph shows that both LMIC and LIC samples received comparable amounts of EDA inflows during the 2000–2009 periods. Afterwards, the inflow of EDA to LICs became erratic, as EDA inflow could fell to zero in 2012 and rose in the next period to almost US$300 m. However, the EDA inflows to LMICs experienced a steady upward improvement post 2009,

Table 3
Stationarity.

Test A: Stationarity Test	LIC Sample				MIC Sample			
	Phillips–Perron test		Augmented Dickey-Fuller test		Phillips–Perron test		Augmented Dickey-Fuller test	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
AETE	0.000	0.000***	0.000	0.000***	0.000	0.0004***	0.127	0.0004***
Sshadow	0.000	0.014**	0.000	0.018**	0.276	0.0714*	0.276	0.0883*
GOVQ	0.003	0.000***	0.002	0.000***	0.000	0.000***	0.005	0.000***
TOpenness	0.000	0.000***	0.000	0.000***	0.000	0.0005***	0.142	0.0005***
EDA	0.000	0.000***	0.000	0.000***	0.000	0.0001***	0.000	0.0049**
GDPPC	0.000	0.008***	0.000	0.009***	0.055	0.0176**	0.046	0.0143*
APTE	0.000	0.000***	0.000	0.000***	0.088	0.0143**	0.073	0.012**
CCTE	0.000	0.000***	0.000	0.000***	0.000	0.0001***	0.000	0.000***
SAgric	0.000	0.003***	0.000	0.003***	0.000	0.0061***	0.042	0.0011***

H0: Variables have unit root
Note: * * *, **, and * denote 0.01, 0.05, and 0.1 rejection level, respectively.

Table 4
Descriptive Statistics.

Countries	Stats	Middle Income Sample (T= 20 n= 8, N=160)								
		SAgric	**TOpenness**	**EDA**	**Sshadow**	**GOVQ**	**CCTE**	**APTE**	**AETE**	**GDPPC**
Cameroon	Mean	3.462	0.407	1.61	15.523	9.496	4.251	2.646	3.808	11.564
	SD	0.056	0.106	0.95	0.201	0.297	0.142	0.211	0.113	0.118
Ghana	Mean	3.999	0.951	1.496	16.486	11.146	3.374	4.659	5.003	11.676
	SD	0.332	0.199	0.896	0.181	0.374	0.506	1.119	1.019	0.368
Kenya	Mean	3.741	0.449	2.135	15.604	10.808	5.136	4.562	5.621	11.623
	SD	0.194	0.207	0.789	0.325	0.168	0.718	0.696	0.646	0.181
Lesotho	Mean	2.018	1.236	0.994	15.324	10.258	4.085	2.646	4.439	11.056
	SD	0.25	0.431	0.832	0.278	0.317	0.486	1.110	0.318	0.24
Namibia	Mean	2.608	1.121	0.763	15.264	11.691	3.692	3.227	3.468	13.402
	SD	0.175	0.127	0.659	0.288	0.403	0.499	0.452	0.76	0.263
Senegal	Mean	3.272	0.598	1.613	16.898	10.89	4.912	4.288	4.419	11.413
	SD	0.099	0.081	0.722	0.178	0.209	0.338	0.299	0.226	0.127
South Africa	Mean	1.022	0.543	2.129	14.915	12.194	5.865	4.248	5.52	13.971
	SD	0.153	0.097	1.17	0.338	0.616	0.475	0.471	0.357	0.157
Nigeria	Mean	3.886	0.163	1.94	17.937	9.401	3.029	2.646	3.636	12.398
	SD	0.201	0.266	1.083	0.374	0.537	0.433	0.411	0.968	0.307
		Lower Income Sample (T=20, n= 7, N=140)								
Burkina Faso	Mean	17.09	13.96	1.688	51.418	1.154	6.713	5.773	5.897	20.434
	SD	0.547	1.048	0.888	0.322	0.173	0.529	0.455	0.454	0.504
Congo DR	Mean	16.724	14.903	1.94	53.559	-1.472	6.159	4.947	6.126	19.355
	SD	0.916	1.393	1.115	0.664	1.017	0.556	0.904	1.185	0.49
Madagascar	Mean	18.037	14.809	1.488	52.108	0.834	7.86	5.499	6.836	19.838
	SD	0.58	0.699	0.759	0.558	0.281	0.609	1.034	0.53	0.13
Malawi	Mean	18.297	14.41	1.484	51.165	0.688	6.581	5.725	5.988	18.76
	SD	0.859	0.05	0.865	0.494	0.259	0.534	0.472	0.653	0.437
Mali	Mean	19.073	14.968	1.874	51.502	0.87	6.774	5.825	7.438	21.114
	SD	0.473	0.245	1.072	0.224	0.14	0.968	0.832	0.551	0.256
Rwanda	Mean	17.835	13.422	1.893	50.632	0.962	6.492	5.523	6.548	20.447
	SD	0.704	0.831	0.828	0.716	0.722	0.587	0.472	0.622	0.925
Uganda	Mean	17.426	13.478	2.327	51.825	1.234	4.952	7.418	7.98	21.271
	SD	0.681	0.506	1.255	0.462	0.144	0.252	0.615	0.638	0.644

Note: SD = standard deviation, T = number of time periods, n = number of panels, and N = number of observations.

and continued steadily until 2016, where a sharp rise in EDA inflows occurred.

Also, on the average, both samples reveal an adverse governance quality score. However, the LIC sample had the worst governance quality score, especially during the 2005 period.

These mean graphs of the variables reveal three key implications. First, countries' tax efforts may differ depending on the type of tax effort under consideration, justifying the need consider each tax effort before aggregating them in statiscal analysis. Second, it suggests that governance quality remains poor in the SSA countries, calling for more improvements. Third, it shows how erratic the supply of EDA can be, hence amplifying calls for less dependence on foreign aid and need to develop local capacity. It is noteworthy that the mean of the variables is descriptive and do not show statistical relationships. Therefore, the ensuing sections presents the statistical results obtained from estimating the empirical models in Eqs. 3, 4, and 5.

4.2. Baseline regression results: IV-GMM

The results of the IV-GMM parameter estimates are presented in Table 6. The corresponding discussions are presented below.

4.2.1. EDA and climate change tax effort

From the empirical results (Table 6), EDA has a significant negative influence on climate change tax efforts in both LIC and MIC, as established by prior studies (Combes et al., 2016; Diaz-Sanchez et al., 2022; Marineau, 2020; Thornton, 2014). This result can be explained from both positive and negative perspectives. On a positive note, the result could suggest that renewable energy aid reduces the need for climate change taxes by providing alternative sources of energy that are less carbon-intensive (Bashir et al., 2022; Nchofoung et al., 2023; Regueiro-Ferreira & Cadaval Sampedro, 2022). Conversely, the result could also suggest that renewable energy aid creates a moral hazard problem, whereby recipients have less incentive to implement or enforce environmental taxes while expecting more aid in the future. The former explanation seems less plausible as empirical evidence suggests low renewable energy adoption rates in Sub-Saharan African countries (Combes et al., 2016; Diaz-Sanchez et al., 2022; Morrissey, 2012). Thus, the most likely explanation is that renewable energy aid displaces climate change taxes by crowding out domestic resources or political will to mobilize environmental taxation, confirming the Samaritan dilemma theory. This could imply that renewable energy aid is substitutive and reduces climate change tax efforts in these countries.

4.2.2. EDA and air pollution tax effort

The results show that EDA has a significant positive influence on air pollution tax efforts among middle-income countries (MICs), while an insignificant negative relationship is reported among low-income countries (LICs). The finding suggests that renewable energy aid has a complementary effect on air pollution tax efforts in MICs, confirming other studies such as Machado (2010), Mascagni and Timmis (2017), and Wen et al. (2023). This could be due to several factors, such as using aid to facilitate knowledge transfer and capacity-building initiatives and enhancing technical expertise and institutional capacity. Similarly, Machado (2010) revealed that conditional aid, which requires recipient countries to meet specific requirements (e.g., improving tax capacity), could explain the positive link between foreign aid and tax effort.

On the other hand, the finding that EDA has an insignificant negative effect on air pollution tax effort in LICs may be explained by studies that suggest that low-income countries may not tax energy-related pollution due to the need to support poor households (Ohlendorf et al., 2021; Prasad, 2022; Spinesi, 2022). Thus, in low-income countries, fossil fuels are predominantly used for heating, cooking, and lighting, hence often taxed at low rates or subsidized. On such a premise, the decision to tax or not to tax environmental taxes may have little to do with EDA, since poverty eradication is prioritised over environmental protection. Therefore, the observed differential results across the MIC and LIC samples may be explained by the fact that low-income countries may have less incentive and capacity to implement environmental taxes than middle-income countries, especially if they face more urgent needs such as poverty reduction, healthcare, and education (Bhattacharya, 2019).

4.2.3. EDA and aggregate environmental tax effort

The results indicate that EDA positively impacts aggregate environmental tax efforts in MICs. However, in LICs, the effect is negative. This difference

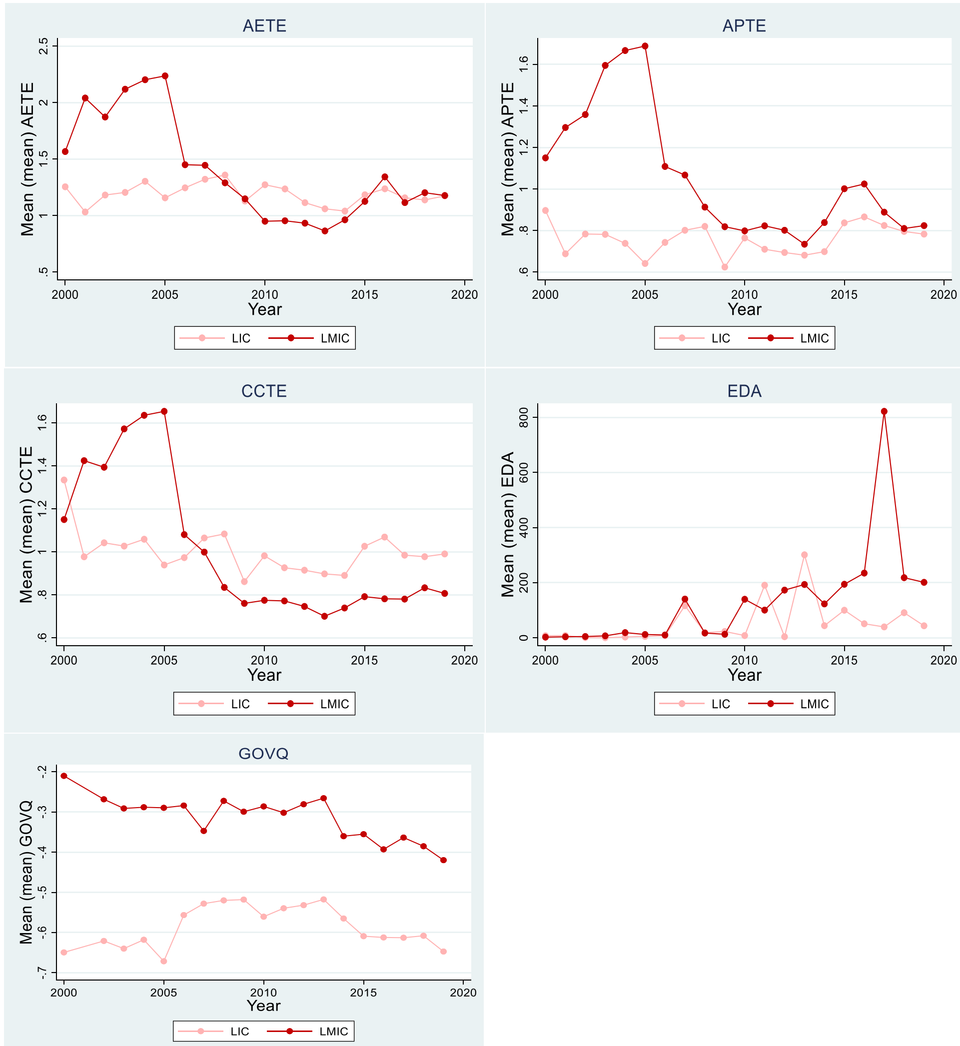

Fig. 1. Visualization of Mean values of Key Variables.

may be due to several factors. Energy foreign aid can affect the relative prices of fossil fuels and clean energy sources differently in different countries. For instance, if aid lowers the cost of renewable energy in MICs, it may reduce fossil fuel demand and increase the tax base for air pollution taxes. Conversely, if aid subsidizes fossil fuel consumption or production in LICs, it may increase fossil fuel demand and reduce the tax base for environmental taxes.

Additionally, Gomez-Echeverri (2018) suggests that MICs often have better institutional capacity and infrastructure than LICs, enabling them to effectively utilize energy-related foreign aid while avoiding its negative effect on environmental tax efforts. In contrast, LICs might face greater challenges due to limited resources, weak institutions, and inadequate infrastructure (Gomez-Echeverri, 2018; Wolf et al., 2013). Also, economic considerations and development priorities may explain the differential results. LICs often face more pressing economic needs and development priorities than MICs and may prioritise addressing poverty, basic infrastructure, and social development over environmental initiatives (Abdenur, 2023; Ben Mim et al., 2022; Painuly, 2001; Yang & Park, 2020). As a result, energy-related foreign aid might be diverted towards addressing these immediate development needs rather than focusing on environmental tax efforts.

The difference in results between climate change tax efforts and air pollution tax efforts may stem from their different scopes and objectives. Climate change tax is a global and long-term issue, usually based on the carbon content of fossil fuels and their contribution to global warming (Orru et al., 2017; Pearce, 1991; Zimmer & Koch, 2017). In contrast, air pollution taxation is based on emissions of local pollutants such as particulate matter, sulfur dioxide, and nitrogen oxides, which affect local air quality (Manisalidis et al., 2020; Orru et al., 2017). As a result, the effect of EDA on climate change and air pollution taxes may not be perfectly correlated since they have different scopes and designs.

4.2.4. *Governance quality and environmental tax effort*

Consistent with the existing literature (Daude et al., 2013b; Liu et al., 2023a; Sebele-Mpofu, 2020), we observe that governance quality has a significant positive effect on all three environmental tax effort categories (i.e., AETE, APTE, and CCTE), and this was true for both samples. Governance quality can influence the design and implementation of environmental taxes. For example, a country with high governance quality can set environmental tax rates that reflect the social cost of pollution and emissions, adjust them over time according to changing circumstances, and enforce them effectively and fairly (Daude et al., 2013b; Liu et al., 2023). Also, governance quality can influence public acceptance and support of environmental taxes. For example, a government with high governance quality can use environmental tax revenues for environmental and social purposes and ensure that the tax burden is equitably distributed among different groups (Sebele-Mpofu, 2020). Therefore, governance quality can positively affect environmental tax efforts by improving environmental taxation's performance, legitimacy, and coherence (Liu et al., 2023; Sebele-Mpofu, 2020).

4.2.5. *Control variables and environmental tax effort*

From Table 6, the relationship between the size of the agricultural sector and environmental tax effort varies by income level. In middle-income

Table 5
Pairwise Correlation.

	MIC Sample						LIC Sample					
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Aggregate Environmental Tax Effort Equation												
(1) AETE	1						1					
(2) EDA	-0.034	1					0.115	1				
(3) GOVQ	0.345	-0.071	1				0.287	-0.006	1			
(4) SAgric	-0.028	-0.007	0.239	1			0.108	0.028	-0.417	1		
(5) Sshadow	-0.003	0.004	-0.492	-0.2	1		-0.204	0.067	-0.475	0.4202	1	
(6) GDPPC	-0.291	0.22	0.472	-0.096	-0.386	1	-0.074	0.102	0.472	-0.487	-0.223	1
(7) TOpenness	0.089	-0.073	-0.174	-0.142	0.175	0.031	0.019	-0.403	0.32	-0.293	-0.401	-0.074
Air Pollution Tax Effort Equation												
(1) AETE	1						1					
(2) EDA	-0.049	1					0.231	1				
(3) GOVQ	0.328	-0.071	1				0.393	-0.006	1			
(4) SAgric	-0.018	-0.007	0.239	1			-0.487	0.028	-0.517	1		
(5) Sshadow	-0.104	0.004	-0.482	-0.2	1		-0.458	0.067	-0.475	0.502	1	
(6) GDPPC	-0.321	0.22	0.472	-0.096	-0.386	1	0.185	0.102	0.482	-0.554	-0.223	1
(7) TOpenness	0.231	-0.073	-0.174	-0.142	0.175	0.031	-0.138	-0.403	0.32	-0.293	-0.401	-0.074
Climate Change Tax Effort Equation												
(1) AETE	1						1					
(2) EDA	-0.184	1					0.04	1				
(3) GOVQ	0.038	-0.071	1				0.5	-0.006	1			
(4) SAgric	-0.153	-0.007	0.239	1			0.113	0.028	-0.517	1		
(5) Sshadow	-0.072	0.004	-0.482	-0.2	1		-0.06	0.067	-0.482	0.502	1	
(6) GDPPC	-0.196	0.22	0.472	-0.096	-0.386	1	-0.005	0.102	0.562	-0.554	-0.223	1
(7) TOpenness	0.352	-0.073	-0.174	-0.142	0.175	0.031	0.045	-0.403	0.32	-0.293	-0.401	-0.074

countries (MICs), the agricultural sector is not a significant factor for any of the three environmental taxes we examine, but it positively correlates with them. In low-income countries (LICs), the size of the agricultural sector has a significant negative effect on all three environmental tax categories. This agrees with Gnangnon (2022) and Barros et al. (2023), who showed that the agricultural sector is more likely to reduce tax efforts in less developed countries. Thus, individuals in LIC countries rely more on subsistence agriculture for their survival and income, especially in rural areas. Therefore, environmental taxes on agriculture could worsen poverty, food insecurity, and social instability, so governments in these countries might avoid imposing them (Besley & Persson, 2014; Gnangnon, 2022). Besides, the subsistence nature of agriculture in LICs makes it complex and challenging to tax (Besley & Persson, 2014; Gnangnon, 2022; Gupta et al., 2021; Morrissey et al., 2016). These may explain why the size of the agricultural sector reduces environmental tax effort in LICs.

We also report a significant positive effect of trade openness on the three categories of environmental taxes for the MIC sample. As mentioned earlier and in line with prior literature (Bazillier et al., 2016; Bazillier et al., 2017; Le et al., 2012), trade openness can create more opportunities for governments to raise their environmental tax efforts. The rationale is that trade openness can increase the motivation for governments to safeguard the environment, as environmental standards can affect international trade. For instance, a country that levies high environmental taxes may be perceived as more eco-friendly, enhancing its global image and attracting investment. Moreover, since higher trade openness is linked to higher economic growth rates, open economies may grow faster, and consequently, more environmental taxes can be collected with the expanding tax base (Fatima et al., 2023; Le et al., 2012).

Similarly, for the LIC sample, the results reveal that trade openness has a significant positive effect on climate change tax effort and aggregate environmental tax effort but not air pollution tax effort. Regarding the disparities in climate change and air pollution tax findings, low-income countries might face international pressure and commitments related to addressing climate change and reducing greenhouse gas emissions (Barros et al., 2023; Gnangnon, 2021; Ho et al., 2023). Thus, trade openness can lead to greater exposure to global environmental initiatives and international agreements, prompting these countries to implement climate change tax efforts. Conversely, air pollution tax efforts, primarily addressing local pollution issues, may not receive the same level of international attention or commitment.

Finally, the effect of gross domestic product per capita on the three categories of environmental tax efforts is negative and significant for both samples. One possible reason GDP per capita negatively affects environmental tax efforts in low- and middle-income countries is that these countries may have lower social demand for environmental protection than high-income countries (Barros et al., 2023; Besley & Persson, 2014). In LICs, people may prioritize other needs, such as food, health, or education, and be less willing to pay higher taxes for environmental purposes. Additionally, the environmental Kuznets hypothesis suggests that economic growth and environmental degradation in low- and middle-income countries are coupled (Demissew Beyene & Kotosz, 2020; Leal & Marques, 2022). However,

Table 6
Regression Estimates (IV-GMM).

	Middle Income Sample (MIC)			Low-Income Sample (LIC)		
	Climate Change Tax Effort	Air Pollution Tax Effort	Aggregate Environmental Tax Effort	Climate Change Tax Effort	Air Pollution Tax Effort	Aggregate Environmental Tax Effort
EDA	-0.213*	0.145*	0.431***	-0.098***	-0.023	-0.099*
	(-2.09)	(-2.39)	(-5.24)	(-3.70)	(-1.75)	(-2.42)
GOVQ	0.403***	0.542***	0.772***	0.293*	0.169***	0.358***
	(-4.63)	(-3.69)	(-7.19)	(-2.39)	(-3.66)	(-4.46)
SAgric	0.044	0.178	0.557	-0.719*	-0.473*	-0.470*
	(-0.11)	(-0.47)	(-0.98)	(-2.06)	(-2.24)	(-2.15)
GDPPC	-0.324***	-0.532***	-0.330***	-0.359**	-0.166*	-0.059
	(-4.52)	(-10.91)	(-3.86)	(-2.87)	(-2.05)	(-0.64)
TOpeness	0.720***	0.667***	0.500**	0.514***	0.023	0.167*
	(-4.61)	(-5.48)	(-2.84)	(-4.4)	(-0.57)	(-2.34)
Sshadow	-0.437***	-0.154***	-0.208**	-0.066***	-0.566**	- 0.637***
	(-8.86)	(-3.8)	(-3.13)	(-5.38)	(-2.58)	(-3.83)

Note: t-statistics in parentheses; * * *, **, and * denote 0.01, 0.05, and 0.1 rejection level, respectively.

Table 7
Smoothed Instrumental Variable Quantile Regression Estimates.

	Climate Change Tax Effort				Air Pollution Tax Effort				Aggregate Environmental Tax Effort			
MIC	q10	q25	q50	q75	q10	q25	q50	q75	q10	q25	q50	q75
EDA	-0.170***	-0.092***	-0.082***	-0.083***	0.201***	0.126**	0.065***	0.055***	0.184**	0.105***	0.093***	0.071***
	(-3.64)	(-3.52)	(-7.31)	(-5.14)	(-3.63)	(-3.03)	(-8.26)	(-3.8)	(-3.26)	(-3.8)	(-4.38)	(-4.4)
SAgric	0.079	0.076	0.076	0.066	0.084	0.006	0.028	0.084	0.090	0.107	0.066	0.0373
	(-0.84)	(-0.86)	(-0.80)	(-0.65)	(-1.22)	(-0.10)	(-1.02)	(-1.08)	(-1.28)	(-1.84)	(-0.65)	(-0.95)
TOpenness	0.499***	0.506***	0.506***	0.488***	*0.251***	0.206**	*0.153****	0.139***	0.184**	0.105***	0.135**	0.115*
	(-5.89)	(-6.03)	(-6.44)	(-4.77)	*(-3.29)*	(-2.79)	*(-5.31)*	(-4.33)	(-3.26)	(-3.8)	(-2.91)	(-2.04)
GOVQ	0.679***	0.657***	0.644***	0.643***	0.626***	0.329***	0.608***	0.542***	0.358***	0.580***	0.630***	0.751***
	(-3.64)	(-4.25)	(-3.77)	(-5.46)	(-3.94)	(-6.22)	(-4.12)	(-4.74)	(-4.91)	(-5.88)	(-5.27)	(-5.71)
GDPPC	-0.212**	-0.145**	-0.136***	-0.115**	-0.218*	-0.200*	-0.121***	-0.0737	-0.275***	-0.174***	-0.173***	-0.105**
	(-2.62)	(-2.65)	(-4.67)	(-3.09)	(-2.37)	(-2.21)	(-5.42)	(-1.56)	(-3.51)	(-3.53)	(-3.79)	(-3.29)
Sshadow	-0.474***	-0.473***	-0.473***	-0.388**	-0.0934***	-0.0717***	0.302**	-0.315**	-0.190***	-0.275***	-0.174***	-0.173***
	(-4.70)	(-4.44)	(-4.43)	(-2.78)	(-4.38)	(-4.4)	(-3.22)	(-2.91)	(-3.34)	(-3.51)	(-3.53)	(-3.79)
LIC												
EDA	-0.377***	-0.347**	-0.347**	-0.347**	-0.199*	-0.193	0.200	0.200	-0.189**	-0.317**	-0.237**	-0.330**
	(-4.40)	(-2.67)	(-2.73)	(-2.72)	(-2.08)	(-1.75)	(-1.92)	(-1.71)	(-3.29)	(-3.16)	(-2.67)	(-3.26)
SAgric	-0.341***	-0.350***	-0.332***	-0.332***	-0.379***	-0.405***	-0.372***	-0.372***	-0.371*	-0.372*	-0.372**	-0.377*
	(-3.48)	(-3.78)	(-3.42)	(-3.64)	(-4.38)	(-4.86)	(-4.30)	(-4.58)	(-2.45)	(-2.49)	(-2.83)	(-2.36)
TOpenness	0.387***	0.387***	0.387***	0.387***	0.208*	0.171	0.208*	0.208*	0.289*	0.259*	0.263***	0.0968
	(-4.2)	(-4.07)	(-4.39)	(-4)	(-2.57)	(-1.89)	(-2.48)	(-2.49)	(-2.28)	(-2.28)	(-3.81)	(-1.87)
GOVQ	0.553***	0.535***	0.580***	0.580***	0.435**	0.255*	0.437**	0.437**	0.619***	0.602**	0.627***	0.627***
	(-7.99)	(-6.94)	(-8.69)	(-8.15)	(-2.81)	(-2.16)	(-2.98)	(-3.06)	(-3.32)	(-2.95)	(-3.99)	(-4.22)
GDPPC	-0.183*	-0.172*	-0.332*	-0.372*	-0.180*	-0.249*	-0.181*	0.181*	-0.527***	-0.563**	-0.397**	-0.413**
	(-2.08)	(-2.09)	(-1.96)	(-2.01)	(-2.3)	(-1.99)	(-2.33)	(-2.29)	(-4.05)	(-3.18)	(-2.66)	(-2.77)
Sshadow	-0.155***	-0.113***	-0.157***	-0.101**	0.290**	-0.166*	0.291**	0.291*	-0.078***	-0.090***	-0.090***	-0.122***
	(-7.50)	(-4.36)	(-5.88)	(-2.69)	(-2.59)	(-2.05)	(-2.71)	(-2.46)	(-4.84)	(-5.65)	(-5.13)	(-5.92)

Note: t-statistics in parenthesis. * * *, **, and * denote 0.01, 0.05, and 0.1 rejection levels, respectively.

countries may have more resources to invest in environmentally friendly policies, such as tax efforts, as they become wealthier (Anwar et al., 2022; Demissew et al., 2020; Gill et al., 2018; Leal & Marques, 2022).

4.3. *Asymmetric analysis and time-varying granger non-causality*

First, to establish the asymmetric effects of the independent variables at different quantile conditions of the dependent variables, we have adopted the smoothed instrumental variable panel quantile regression. Thus, we run a regression at each dependent variable's 10th, 25th, 50th, and 75th conditional quantiles. The estimated results are found in Table 7.

The results in Table 7 show the asymmetric quantile regression results. The impact of the independent variables on the dependent variables varies across different quantiles for each of the three dependent variables for both LIC and MIC samples. Notwithstanding, the observed relationships between the variables are qualitatively consistent with that obtained from the IV-GMM estimation.

For instance, the effect of renewable energy development assistance on climate change tax effort is negative across all conditional quantiles (i.e., 10th, 25th, 50th, and 75th) for both LIC and MIC samples. Similarly, governance quality has a positive significant effect on all categories of environmental taxes across all conditional quantiles, which is valid for both samples. The other variables also established relationships comparable to those obtained from the IV-GMM estimation, confirming the robustness of our findings.

Additionally, we investigated whether the predictor variables are together helpful in predicting the dependent variables using the time-varying Granger non-causality test proposed by Juodis et al. (2021). Juodis et al.'s (2021) tests for Granger non-causality can detect Granger non-causality even if it varies across units or over time. Moreover, it is robust against heteroskedasticity in the data as it relies on heteroskedasticity and autocorrelation consistent (HAC) estimation of the asymptotic variance.

The test is conducted under the null hypothesis that independent variables do not cause the dependent variable. From Table 8, the HPJ Wald test statistic and corresponding p-values of 0.00 for the three environmental tax categories suggest that the independent variables in all three regression models are relevant in predicting the dependent variables at a 1% significance level. This gives credence to the choice of independent variables regressed on environmental tax effort.

Table 8
Time-Varying Granger Non-Causality Test.

Dependent variable	Number of units	BIC Criteria	Number of lags	Wald HPJ	P Value
MIC Sample					
AETE	8	-398.1978	2	98.8994	0.000
CCTE	8	338.8789	2	61.4367	0.000
APTE	8	-461.2537	2	43.5399	0.000
LIC Sample					
AETE	7	-289.7937	2	102.8712	0.000
CCTE	7	-478.3377	2	113.3494	0.000
APTE	7	-349.3731	2	75.7549	0.000

5. Conclusion and policy implication

This study examined how renewable energy aid and governance quality affect different types of environmental tax efforts in Sub-Saharan African countries. Renewable energy aid, governance quality, and environmental taxation are key tools for promoting green growth and sustainable development globally. However, they need to be aligned and coordinated in a way that considers their varying impacts. The result provides reasonable basis to conclude that the effect of renewable energy aid on environmental tax effort is heterogenous, depending on the type of environmental tax effort being considered, as well as the income levels of countries involved. Notwithstanding, governance quality tend to improve all categories of environmental tax effort, regardless of the income levels of countries considered. These findings have policy implications, both for middle and low-income Sub-Saharan African countries.

5.1. *Low income SSA countries*

The results from low-income Sub-Saharan African (SSA) countries reveal that inflows of renewable energy aid reduce all three categories of environmental tax effort. However, the quality of governance improves all examined categories of environmental tax effort, namely Climate Change Tax Effort, Air Pollution Tax Effort, and Aggregate Environmental Tax Effort.

Given the prevalent challenges associated with weak governance structures in many low-income SSA nations, targeted strategies are necessary to enhance governance. This ensures the efficient utilization and management of aid funds, preventing them from undermining environmental tax efforts.

Notably, policymakers should focus on extensive institutional reforms. These reforms should aim to strengthen governance structures for both tax administration and efficient aid utilization. Addressing corruption, inefficiency, and lack of transparency within government agencies is vital for building trust in the governance system. Implementing anti-corruption measures, such as improved accountability mechanisms and transparent procurement processes, can help create an environment where aid funds are effectively directed towards their intended purposes. By improving the quality of governance, countries can establish a framework that encourages responsible fiscal management, ensuring that aid supports, rather than impedes, domestic tax efforts.

Also, the conditions attached to renewable energy aid should be carefully designed to encourage, rather than undermine, environmental tax efforts. Policymakers should establish clear and enforceable agreements that link the disbursement of aid to concurrent improvements in environmental tax frameworks. This may involve setting benchmarks for tax collection efficiency, regulatory enforcement, and the implementation of green fiscal policies. By aligning aid with enhanced environmental taxation, countries can strike a balance between promoting renewable energy and maintaining fiscal responsibility.

The Samaritan dilemma hypothesis suggests the need to encourage political will and commitment to mobilize domestic resources. Low-income countries should prioritize building political will and commitment to mobilize domestic resources for environmental protection, rather than relying solely on external aid. This requires a shift in mindset, where environmental protection is seen as a national priority and a moral obligation, rather than a means to attract foreign funding. Political leaders should champion this cause and work to build cross-sector alliances to drive change. By demonstrating a genuine commitment to environmental protection, low-income countries can build trust with international partners and attract support that is aligned with their own priorities and values. This approach helps to avoid the pitfalls of the Samaritan dilemma, where well-intentioned aid can sometimes perpetuate dependency and undermine local ownership. Instead, low-income countries can take control of their own environmental destiny, leveraging their own resources and capabilities to drive sustainable development.

5.2. Middle Income SSA Countries

For middle-income Sub-Saharan African (SSA) countries, renewable energy aid decreases the tax effort for climate change but increases it for air pollution and aggregate environmental tax efforts. However, the quality of governance enhances all three categories of environmental tax effort. Climate change has a global and long-term impact, while air pollution has more immediate and local effects. Consequently, more foreign aid is directed towards addressing climate change than air pollution. This large influx of climate change aid could substitute for domestic climate change tax efforts, disincentivizing the mobilization of domestic climate taxes.

To counteract the negative impact of foreign energy aid on climate change tax effort, middle-income SSA countries should consider customizing their environmental tax policies. Specifically, policymakers should explore the implementation of climate change taxes that directly link renewable energy aid funds to specific environmental projects. This ensures that the influx of foreign energy aid directly contributes to energy-related climate change initiatives, mitigating any adverse effects on environmental tax efforts.

In addition, middle income SSA countries should focus on strengthening their domestic efforts to mobilize climate change taxes through measures such as improving climate change tax administration and governance quality. For instance, governance quality is shown to have a positive association with environmental tax efforts, necessitating the development of a robust institutional governance framework tailored to energy transition. Such a framework is vital in curbing corruption, fostering transparency, and encouraging accountability in the utilization of energy aid and the generation of environmental tax revenues. Additionally, aid providers can play a crucial role in enhancing effective climate tax administration by making aid conditional upon recipient countries' efforts to improve their domestic tax systems and reduce aid dependency (Crivelli & Gupta, 2017).

On the other hand, the positive effect of renewable energy aid on air pollution and aggregate environmental tax effort in middle-income SSA countries reveals the complementary effect of aid on tax effort. The result is encouraging as it suggests that aid inflows do not crowd out domestic tax efforts for air pollution. However, we are not in a position to recommend that SSA countries should seek more conventional energy aid, as this may create aid dependency and undermine tax efforts later. Instead, this result reveals that SSA countries can potentially mobilize domestic environmental taxes towards mitigating air pollution and aggregate environmental tax effort. Therefore, foreign assistance should aim to harness this potential to the point where SSA becomes self-reliant in funding energy transition. One way to achieve this is to prioritize aid that takes the form of catalytic finance. Catalytic finance is a type of financing designed to catalyze additional investment in a particular sector or region. Catalytic finance from development assistance can promote energy transition by providing technical assistance to develop domestic tax capacity.

5.3. Research limitations

The study's sample focuses solely on the Sub-Saharan African region to allow for an in-depth discussion. However, other regions have not been explored and offer opportunities for further research. Additionally, the negative impact of renewable energy aid on climate change tax efforts warrants further investigation due to its positive and negative implications. On the one hand, it could indicate that renewable energy aid has helped transition to renewable energy and reduced the need for additional environmental tax efforts. On the other hand, it could suggest that renewable energy aid is displacing domestic revenue mobilization through taxes. Therefore, further studies are required to enhance knowledge on the subject. Finally, regulatory quality is a broad measure of governance. For detailed analysis, further studies may explore the specific dimensions of regulatory quality, such as voice and accountability, control of corruption among others.

Declaration of originality

We, the undersigned, declare that this manuscript is original, has not been published before, and is not currently being considered for publication elsewhere

Author statement

All the three authors involved in this study took part in the conceptualization, analysis, writeup, and review of the manuscript.

CRediT authorship contribution statement

Abdulai Enusah: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Cletus Agyenim-Boateng:** Writing – review & editing, Validation, Methodology, Formal analysis, Conceptualization. **Francis Aboagye-Otchere:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of Competing Interest

We have no known Conflict of Interest to disclose

Data Availability

Data will be made available on request.

References

Abbas, S., Ahmed, Z., Sinha, A., Mariev, O., Mahmood, F., 2023. Toward fostering environmental innovation in OECD countries: Do fiscal decentralization, carbon pricing, and renewable energy investments matter? Gondwana Research.

Abdenur A. (2023). What does Just Transition mean for Middle Income Countries? United Nation. https://www.un.org/en/climatechange/what-does-just-transition-mean-middle-income-countries.

Abokyi, E., Appiah-Konadu, P., Abokyi, F., Oteng-Abayie, E.F., 2019. Industrial growth and emissions of CO2 in Ghana: The role of financial development and fossil fuel consumption. Energy Rep. 5, 1339–1353.

Ahmad, M., Ahmed, Z., Riaz, M., Yang, X., 2023. Modeling the linkage between climate-tech, energy transition, and CO2 emissions: Do environmental regulations matter? Gondwana Research.

Ajaz, T., Ahmad, E., 2010. The effect of corruption and governance on tax revenues. Pak. Dev. Rev. 49 (4), 405–417.

Ajide, F.M., 2021. Shadow economy in Africa: how relevant is financial inclusion? J. Financ. Regul. Compliance *29* (3), 297–316.

Akitoby, B., Baum, A., Hackney, C., Harrison, O., Primus, K., Salins, V., 2020. Tax revenue mobilization episodes in developing countries. Policy Des. Pract. 3 (1), 1–29. https://doi.org/10.1080/25741292.2019.1685729.

Al Shammre, A.S., Benhamed, A., Ben-Salha, O., Jaidi, Z., 2023. Do environmental taxes affect carbon dioxide emissions in OECD countries? Evidence from the dynamic panel threshold model. Systems 11 (6), 307.

Alm, J., Martinez-Vazquez, J., Schneider, F., 2019. Taxing the shadow economy: The role of tax administration. Public Financ. Rev. 47 (6), 1027–1057.

Aluko, O.A., 2020. The foreign aid–foreign direct investment relationship in Africa: The mediating role of institutional quality and financial development. Econ. Aff. 40 (1), 77–84.

Ammendola, G., 2010. New York: Farrar, Straus & Giroux (2009), 24.00 Hardcover, 208 pages. In: Glenn Hubbard, R., William Duggan (Eds.), Dead Aid: Why Aid Is Not Working and How There Is a Better Way for Africa by Dambisa Moyo The Aid Trap: Hard Truths About Ending Poverty. Columbia Business School Publishing, NewYork.

Anwar, M.A., Zhang, Q., Asmi, F., Hussain, N., Plantinga, A., Zafar, M.W., Sinha, A., 2022. Global perspectives on environmental kuznets curve: A bibliometric review. Gondwana Research 103, 135–145.

Arif, I., Rawat, A.S., 2018. Corruption, governance, and tax revenue: evidence from EAGLE countries. J. Transnatl. Manag. *23* (2-3), 119–133.

Asongu, S., Jellal, M., 2016. Foreign aid fiscal policy: theory and evidence. Comp. Econ. Stud. *58* (2), 279–314.

Awasthi, R., Engelschalk, M., 2018. Taxation and the shadow economy: How the tax system can stimulate and enforce the formalization of business activities. World Bank Policy Research Working Paper No. 8391.

Balasubramaniam, D., 2023. Child. `S. Linear Growth Mother`S. Educ. India.: Do Pathw. Have A Role Play?.

Banerjee, R., Mishra, V., Maruta, A.A., 2021. Energy poverty, health and education outcomes: evidence from the developing world. Energy Econ. *101*, 105447.

Barros, V., Jalles, J.T., Sarmento, J.M., 2023. Drivers of the tax effort: evidence from a large panel. Comp. Econ. Stud. *65* (1), 96–136.

Bashir, M.F., Ma, B., Bashir, M.A., Radulescu, M., Shahzad, U., 2022. Investigating the role of environmental taxes and regulations for renewable energy consumption: evidence from developed economies. Econ. Res. -Èkon. Istraživanja 35 (1), 1262–1284.

Baum, C.F., Schaffer, M.E., Stillman, S., 2007. Enhanced routines for instrumental variables/generalized method of moments estimation and testing. Stata J. *7* (4), 465–506.

Bayale, N., 2020. Foreign aid and fiscal resources mobilization in WAEMU countries: Ambiguous effects and new questions. Afr. J. Econ. Rev. 8 (2), 17–38.

Bazillier, R., Hatte, S., Vauday, J., 2016. Is Reputation At Stake When Environmentally Responsible Multinationals Invest Abroad? An Empirical Investigation (No. 2315). Orleans Economics Laboratory/Laboratoire d'Economie d'Orleans (LEO). University of Orleans.

Bazillier, R., Hatte, S., Vauday, J., 2017. Are environmentally responsible firms less vulnerable when investing abroad? The role of reputation. J. Comp. Econ. 45 (3), 520–543.

Ben Mim, S., Hedi, A., Ben Ali, M.S., 2022. Industrialization, FDI and absorptive capacities: evidence from African Countries. Econ. Change Restructuring 1–28.

Benedek, D., Crivelli, E., Gupta, S., Muthoora, P., 2013. Foreign aid and revenue: still a crowding-out effect? Public Financ. Anal. 70 (1), 67–96 doi:10.1628/001522114×679156.

Berenson, M., 2018. From a Coercive to a Modern Tax State. In Taxes and Trust: From Coercion to Compliance in Poland, Russia and Ukraine. Cambridge University Press, Cambridge, pp. 1–11. https://doi.org/10.1017/9781108333580.001.

Besley, T., Persson, T., 2013. Taxation and development. In: In *Handbook of public economics*, Vol. 5. Elsevier, pp. 51–110.

Besley, T., Persson, T., 2014. Why do developing countries tax so little? J. Econ. Perspect. *28* (4), 99–120.

Bhattacharya, M., 2019. The Environmental Kuznets curve: a critical review of earlier literature. Environ. Kuznets Curve (EKC) 9–14.

Blair, R.A., Roessler, P., 2021. Foreign aid and state legitimacy: Evidence on Chinese and US aid to Africa from surveys, survey experiments, and behavioral games. World Polit. 73 (2), 315–357. https://doi.org/10.1017/S004388712000026X.

Bodea, C., LeBas, A., 2014. The origins of voluntary compliance: attitudes toward taxation in urban Nigeria. Br. J. Political Sci. 46 (1), 215–238. DOI:10.1017/S000712341400026X.

Bräutigam, D., Fjeldstad, O.H., Moore, M., 2008. Taxation and state-building in developing countries: capacity and consent. Cambridge University Press.

Bräutigam, D.A., Knack, S., 2004. Foreign aid, institutions, and governance in sub-Saharan Africa. Economic development and cultural change 52 (2), 255–285.

Brun, J.F., Chambas, G., Guérineau, S., 2008. *Off. Dev. Assist. Tax. Mobilization*.

Chakraborty, P., Dash, B.B., 2017. Why tax effort falls short of capacity in Indian states: A stochastic frontier approach. Public Financ. Rev. 45 (2), 232–259.

Chien, F., Zhang, Y., Li, L., Huang, X.C., 2023. Impact of government governance and environmental taxes on sustainable energy transition in China: fresh evidence using a novel QARDL approach. Environ. Sci. Pollut. Res. *30* (16), 48436–48448.

Clist, P., Morrissey, O., 2011. Aid and tax revenue: signs of a positive effect since the 1980s. J. Int. Dev. *23* (2), 165–180.

Combes, J.L., Ouedraogo, R., Tapsoba, S.J.A., 2016. Structural shifts in aid dependency and fiscal policy in developing countries. Appl. Econ. *48* (46), 4426–4446.

Crivelli, E., Gupta, S., 2017. Does conditionality mitigate the potential negative effect of aid on revenues? J. Dev. Stud. *53* (7), 1057–1074.

Cui, N., Hu, Y., 2023. Foreign aid and fiscal policy in a small-open economy with a non-market sector. Foreign Trade Review 58 (1), 144–175.

Damianos, S., 2021. Aid diversion, accountability and questions unanswered: contextualizing the World Bank working paper on offshore capture of foreign aid. J. Money Laund. Control 24 (3), 633–646.

Daude, C., Gutierrez, H., Melguizo, A., 2013a. What drives tax morale? A focus on emerging economies. Rev. Public Econ. *207* (4), 9–40.

Daude, C., Melguizo, A., Neut, A., 2013b. Fiscal policy in Latin America: Better after all? Emerg. Mark. Financ. Trade 49 (4), 127–139.

De Mooij, R.A., 2020. Tax policy and inclusive growth. IMF Work. Pap. 20 (271), 1–41. ⟨https://www.elibrary.imf.org/view/journals/001/2020/271/article-A001-en.xml⟩.

Dell'Anno, R., Davidescu, A.A., 2019. Estimating shadow economy and tax evasion in Romania. A comparison by different estimation approaches. Econ. Anal. Policy *63*, 130–149.

Demissew Beyene, S., Kotosz, B., 2020. Testing the environmental Kuznets curve hypothesis: an empirical study for East African countries. Int. J. Environ. Studies 77 (4), 636–654.

Deserranno, E., Nansamba, A., Qian, N., 2020. The unintended consequences of NGO-provided aid on government services in Uganda (No. w26928). National Bureau of Economic Research.

Diaz-Sanchez, J.L., Tagem, A.M., Mota, J., 2022. Tax revenue effort and aid in fragile states: the case of Comoros. South Afr. J. Econ. 90 (2), 175–195.

Dolan, L.R., 2020. Rethinking foreign aid and legitimacy: views from aid recipients in Kenya. Stud. Comp. Int. Dev. *55*, 143–159.

Ekins, P., Speck, S., 1999. Competitiveness and exemptions from environmental taxes in Europe. Environ. Resour. Econ. 13 (4), 369–396[1].

Elgin, C., Kose, M., Ohnsorge, F., Yu, S., 2021. DP16497 Understanding Informality', CEPR Discussion Paper No. 16497. CEPR Press, Paris & London. ⟨https://cepr.org/publications/dp16497⟩.

Empirical, A., Langford, B., 2016. Tax Revenue Potential and Effort. J. Int. Growth 2 (3), 1–30.

Farooq, U., 2022. Foreign direct investment, foreign aid, and CO 2 emissions in Asian economies: does governance matter? Environ. Sci. Pollut. Res. 1–16.

Fatima, N., Yanting, Z., Guohua, N., 2023. Role of environmentally related technologies and revenue taxes in environmental degradation in OECD countries. Environ. Sci. Pollut. Res. 1–16.

Finan, T., Kanie, N., 2018. Financing sustainable development? The role of foreign aid in Southeast Asia's energy transition. Sustain. Dev. 26 (4), 369–378. https://doi.org/10.1002/sd.2231.

Fjeldstad, O.H., Tungodden, B., 2003. Fiscal corruption: a vice or a virtue? World Dev. *31* (8), 1459–1467.

Gill, A.R., Viswanathan, K.K., Hassan, S., 2018. The Environmental Kuznets Curve (EKC) and the environmental problem of the day. Renew. Sustain. Energy Rev. 81, 1636–1642.

Girgibo, N., Hiltunen, E., Lü, X., Mäkiranta, A., Tuomi, V., 2024. Risks of climate change effects on renewable energy resources and the effects of their utilisation on the environment. Energy Rep. 11, 1517–1534.

Gnangnon, S.K., 2021. Tax reform, trade openness and export product diversification in developing countries. CESifo Econ. Stud. 67 (2), 210–234.

Gnangnon, S.K., 2022. Tax revenue instability and tax revenue in developed and developing countries. Appl. Econ. Anal. 30 (88), 18–37.

Gnangnon, S.K., Brun, J.F., 2019. Trade openness, tax reform and tax revenue in developing countries. World Econ. *42* (12), 3515–3536.

Gomez-Echeverri, L., 2018. A review of the nature of foreign aid to the energy sector over the last two decades. Aid effectiveness for environmental sustainability 125–184.

Gupta, A., Mello, L., Sharan, V., 2021. Determinants of tax revenue efforts in developing countries. Int. J. Econ. Financ. 13 (8), 1–16[3].

Ho, T.T., Tran, X.H., Nguyen, Q.K., 2023. Tax revenue-economic growth relationship and the role of trade openness in developing countries. Cogent Bus. Manag. 10 (2), 2213959.

Horodnic, I.A., Williams, C.C., 2016. An evaluation of the shadow economy in Baltic States: a tax morale perspective. Int. J. Entrep. Small Bus. 28 (2-3), 339–358.

Huemer, M., 2013. The Traditional Social Contract Theory. The Problem of Political Authority. Palgrave Macmillan, London. https://doi.org/10.1057/9781137281661_2.

IMF/OECD (2021), Tax Policy and Climate Change: IMF/OECD Report for the G20 Finance Ministers and Central Bank Governors, September 2021, Italy, ⟨www.oecd.org/tax/tax-policy/imf-oecd-g20-report-tax-policy-and-climate-change.htm⟩.

International Energy Agency, 2022. CO2 Emissions in 2022 – analysis. ⟨https://www.iea.org/reports/co2-emissions-in-2022⟩.

International Renewable Energy Agency, 2021. The Renewable Energy Transition in Africa. ⟨https://www.irena.org/publications/2021/March/The-Renewable-Energy-Transition-in-Africa⟩.

Ivanova, M., 2020. Everyone, everywhere: the global challenge of climate change. Nature.

Jochmans, K., Verardi, V., 2020. A portmanteau test for serial correlation in a linear panel model. Stata J. *20* (1), 149–161.

Jones, S., Tarp, F., Addison, T., 2017. Aid, growth and development: Have we come full circle? J. Glob. Dev. 8 (1), 1–27.

Juodis, A., Karavias, Y., Sarafidis, V., 2021. A homogeneous approach to testing for Granger non-causality in heterogeneous panels. Empir. Econ. *60* (1), 93–112.

Kaplan, D.M., 2022. Smoothed instrumental variables quantile regression. Stata J. *22* (2), 379–403. https://doi.org/10.1177/1536867×221106404.

Kaplan, D.M., Sun, Y., 2017. Smoothed estimating equations for instrumental variables quantile regression. Econom. Theory 33, 105–157. https://doi.org/10.1017/S0266466615000407.

Kaufmann, D., Kraay, A., Mastruzzi, M., 2010. The worldwide governance indicators: methodology and analytical issues. Hague J. Rule Law 3 (2), 220–246.

Khan, M.H., 2001. Agricultural taxation in developing countries: a survey of issues and policy. Agric. Econ. 24 (3), 315–328.
Koumpias, A.M., Leonardo, G., & Martinez-Vazquez, J. (2020). Trust in government institutions and tax morale.
Kubler, D., Litschig, S., Zamboni, Y., 2020. Governance quality and tax compliance in developing countries. J. Public Econ. 190, 104241.
Le, T.M., Moreno-Dodson, B., Bayraktar, N., 2012. Tax capacity and tax effort: Extended cross-country analysis from 1994 to 2009, 6252. World Bank Policy Research Working Paper.
Leal, P.H., Marques, A.C., 2022. Is globalization a driver for energy efficiency and sustainable development? Energy-Growth Nexus in an Era of Globalization. Elsevier, pp. 257–285.
Lenton, P., Masiye, M., & Mosley, P. (2017). Taxpayer's dilemma: how can 'fiscal contracts' work in developing countries?. Sheffield Economics Research Papers (SERPS), 201700 (2017004).
Leonardo, G., Koumpias, A.M., & Martinez-Vazquez, J. (2017, January). How Do Governments around the World Shape Tax Morale?. In Proceedings. Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association (Vol. 110). National Tax Association.
Levinson, A., 2003. Environmental regulatory competition: a status report and some new evidence. Natl. Tax. J. 56 (1), 91–106[2].
Lin, S., Liu, X., Yao, B., Huang, Z., 2018. Controlling for confounding factors and revealing their interactions in genetic association meta-analyses: a computing method and application for stratification analyses. Oncotarget 9 (15), 12125–12136. https://doi.org/10.18632/oncotarget.24335.
Liu, H., Zafar, M.W., Sinha, A., Khan, I., 2023. The path to sustainable environment: do environmental taxes and governance matter? Sustain. Dev.
Luttmer, E.F., Singhal, M., 2014. Tax morale. J. Econ. Perspect. *28* (4), 149–168.
Machado, R., 2010. Aid and fiscal policy in Nicaragua: a fiscal response analysis. J. Int. Dev.: J. Dev. Stud. Assoc. *22* (4), 483–502.
Mangoting, Y., Sukoharsono, E.G., 2015. Developing a model of tax compliance from social contract perspective: mitigating the tax evasion. Procedia-Soc. Behav. Sci. *211*, 966–971.
Manisalidis, I., Stavropoulou, E., Stavropoulos, A., Bezirtzoglou, E., 2020. Environmental and health impacts of air pollution: a review. Frontiers in public health 8, 14.
Marineau, J., 2020. Aiding dependency: a cross-national analysis of foreign aid and tax compliance. Stud. Comp. Int. Dev. 55, 228–256.
Maruta, A.A., Banerjee, R., 2021. Does energy aid improve energy efficiency in developing countries? Empir. Econ. *61*, 355–388.
Mascagni, G., Timmis, E., 2017. The fiscal effects of aid in Ethiopia: evidence from CVAR applications. J. Dev. Stud. 53 (7), 1037–1056.
Misra, F., 2019. Tax compliance: theories, research development and tax enforcement models. Int. J. Bus. Manag. Invent. 8 (10), 1–11.
Montinola, G.R., Taylor, T.W., Largoza, G.L., 2020. Foreign Aid, Government Spending, and Contributions toward Public Goods: Experimental Evidence from the Philippines. Studies in Comparative International Development 55, 204–227.
Moore, M., Fjeldstad, O.H., Isaksen, J., Lundstøl, O., McCluskey, R., & Prichard, W. (2015). Building tax capacity in developing countries.
Morrison, K.M., 2015. Nontaxation and representation. Cambridge University Press.
Morrissey, O., 2012. Aid and Fiscal Behaviour in Zambia: An Empirical Investigation. J. Dev. Stud. 48 (4), 526–542. https://doi.org/10.1080/00220388.2011.621820.
Morrissey, O., Von Haldenwang, C., Von Schiller, A., Ivanyna, M., Bordon, I., 2016. Tax revenue performance and vulnerability in developing countries. J. Dev. Stud. 52 (12), 1689–1703.
Müller, F., Claar, S., 2021. Auctioning a 'just energy transition'? South Africa's renewable energy procurement programme and its implications for transition strategies. Rev. Afr. Political Econ. 48 (169), 333–351.
Müller, F., Neumann, M., Elsner, C., Claar, S., 2021. Assessing African energy transitions: renewable energy policies, energy justice, and SDG 7. Polit. Gov. *9* (1), 119–130.
Munyanyi, M.E., Churchill, S.A., Mallick, H., 2022. Foreign aid and energy poverty: Sub-national evidence from Senegal. Energy Econ. 108, 105899 https://doi.org/10.1016/j.eneco.2022.105899.
Muoneke, O.B., Okere, K.I., Egbo, O.P., 2023. Does political conflict tilt finance-renewable energy dynamics in Africa? Accounting for the multi-dimensional approach to financial development and threshold effect of political conflict. Heliyon 9 (3).
Nchofoung, T.N., Fotio, H.K., Miamo, C.W., 2023. Green taxation and renewable energy technologies adoption: a global evidence. Renew. Energy Focus 44, 334–343.
Ohlendorf, N., Jakob, M., Minx, J.C., Schröder, C., Steckel, J.C., 2021. Distributional impacts of carbon pricing: A meta-analysis. Environ. Resour. Econom. 78, 1–42.
Orru, H., Ebi, K.L., Forsberg, B., 2017. The interplay of climate change and air pollution on health. Curr. Environ. Health Rep. 4, 504–513.
Oyedepo, S.O., Adaramola, M.S., 2020. Renewable energy consumption in Africa: the role of economic well-being and economic freedom. Energy, Sustain. Soc. 10 (1), 1–14. https://doi.org/10.1186/s13705-020-00264-3.
Painuly, J.P., 2001. Barriers to renewable energy penetration; a framework for analysis. Renew. Energy 24 (1), 73–89.
Papies, D., Ebbes, P., Van Heerde, H.J., 2017. Addressing endogeneity in marketing models. Advanced methods for modeling markets 581–627.
Pearce, D., 1991. The role of carbon taxes in adjusting to global warming. Econ. J. 101 (407), 938–948.
Pesaran, M.H., Yamagata, T., 2008. Testing slope homogeneity in large panels. J. Econometrics 142 (1), 50–93.
Pessino, C., Fenochietto, R., 2010. Determining Countries' Tax Effort. Public Economics: Taxation.
Pham, N., Pham, T., 2019. Foreign aid, recipient government's fiscal behavior, and economic growth. Econ. Bull. 39 (4), 2457–2466.
Pourhoseingholi, M.A., Baghestani, A.R., Vahedi, M., 2012. How to control confounding effects by statistical analysis. Gastroenterol. Hepatol. Bed Bench 5 (2), 79.
Prasad, M., 2022. Hidden benefits and dangers of carbon tax. PLOS Clim 1 (7), e0000052. https://doi.org/10.1371/journal.pclm.0000052.
Prichard, W., Salardi, P., Segal, P., 2014. Taxation, non-tax revenue and democracy: new evidence using new cross-country data. ICTD Working Paper 23.
Rajaraman, I., 2003. Tackling Agriculture in a Developing Country: A Proposal for India (No. paper0322). International Center for Public Policy, Andrew Young School of Policy Studies, Georgia State University.
Regueiro-Ferreira, R.M., Cadaval Sampedro, M., 2022. Renewable energy taxes and environmental impacts: a critical reflection from the wind tax in Spain. *Energy Environ.* X221083249.
Remmer, K.L., 2004. Does foreign aid promote the expansion of government? Am. J. Political Sci. *48* (1), 77–92.
Ricciuti, R., Savoia, A., Sen, K., 2019. How do political institutions affect fiscal capacity? Explaining taxation in developing economies. J. Institutional Econ. 15 (2), 351–380.
Sarpong, K.A., Xu, W., Gyamfi, B.A., Ofori, E.K., 2023. Can environmental taxes and green-energy offer carbon-free E7 economies? An empirical analysis in the framework of COP-26. Environ. Sci. Pollut. Res. *30* (18), 51726–51739.
Schneider, F., Buehn, A., Montenegro, C.E., 2010. New estimates for the shadow economies all over the world. Int. Econ. J. 24 (4), 443–461.
Scott, S.V., Ku, C., (Eds.), 2018. Climate Change and the UN Security Council.
Sebele-Mpofu, F.Y., 2020. Saturation controversy in qualitative research: Complexities and underlying assumptions. A literature review. Cogent Soc. Sci. 6 (1), 1838706.
Shahzad, U., 2020. Environmental taxes, energy consumption, and environmental quality: theoretical survey with policy implications. Environ. Sci. Pollut. Res. *27* (20), 24848–24862.
Shamsi, S.F., Farzanegan, M.R., 2021. Investigating the role of environmental taxes and environmental technologies on renewable energy consumption in OECD countries. J. Environ. Econ. Policy. https://doi.org/10.1080/1331677X.2021.1962383.
Spinesi, L., 2022. The environmental tax: Effects on inequality and growth. Environ. Resource Econ. 82 (3), 529–572.
Svensson, J., 2000. Foreign aid and rent-seeking. J. Int. Econ. 51 (2), 437–461.
Thornton, J., 2014. Does foreign aid reduce tax revenue? Further evidence. Appl. Econ. *46* (4), 359–373.
Timmons, J.F., 2005. The fiscal contract: States, taxes, and public services. World Polit. *57* (4), 530–567.
Timmons, J.F., Garfias, F., 2015. Revealed corruption, taxation, and fiscal accountability: Evidence from Brazil. World Dev. 70, 13–27.
Torgler, B., Schneider, F., & Schaltegger, C.A. (2007). With or against the people? The impact of a bottom-up approach on tax morale and the shadow economy (No. 2007-04). CREMA Working Paper.
Wang, B., Zhu, J., Pierson, E., Ramazzotti, D., Batzoglou, S., 2017. Controlling for confounding effects in single cell RNA sequencing studies using both negative and positive control genes. Sci. Rep. 7 (1), 13295. https://doi.org/10.1038/s41598-017-13665-w.
Wen, J., Farooq, U., Tabash, M.I., El Refae, G.A., Subhani, B.H., 2023. Governance and tax revenue: does foreign aid matter? Int. Rev. Adm. Sci. 89 (1), 273–291.
Wolf, C., Wang, X., Warner, E., 2013. China's foreign aid and government-sponsored investment activities: Scale, content, destinations, and implications, viii. Rand Corporation, Santa Monica, CA.
Wunderling, N., Winkelmann, R., Rockström, J., Loriani, S., Armstrong McKay, D.I., Ritchie, P.D., Donges, J.F., 2023. Global warming overshoots increase risks of climate tipping cascades in a network model. Nat. Clim. Change 13 (1), 75–82.
Yang, S., Park, S., 2020. The effects of renewable energy financial incentive policy and democratic governance on renewable energy aid effectiveness. Energy Policy 145, 111682.
Yuan, J., Jiao, Z., Xiao, X., Emura, K., Farnham, C., 2024. Impact of future climate change on energy consumption in residential buildings: a case study for representative cities in Japan. Energy Rep. 11, 1675–1692.
Zimmer, A., Koch, N., 2017. Fuel consumption dynamics in Europe: Tax reform implications for air pollution and carbon emissions. Transp. Res. Part A: Policy Pract. 106, 22–50.