Received: 9 April 2023 | Revised: 21 August 2023 | Accepted: 1 September 2023
DOI: 10.1002/sd.2752

RESEARCH ARTICLE

Sustainable Development
WILEY

Natural resource dependence, policy and institutions for environmental sustainability and African welfare

Desmond Mbe-Nyire Mpuure[1] | Jennifer Dokbila Mengba[2,3]

[1]Department of Fundamentals of Economic Analysis, University of Alicante, Sant Vicent del Raspeig, Alicante, Spain
[2]Department of Planning, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[3]Department of Human Geography, Uppsala University, Uppsala, Sweden

Correspondence
Jennifer Dokbila Mengba, Department of Planning, Kwame Nkrumah University of Science and Technology, Ghana.
Email: mengbajennifer@yahoo.com

Abstract

In developing countries, particularly in Africa, dependence on natural resources poses a threat to development, leading to poor health, reduced productivity, and increased poverty among nations. This raises significant concerns for the prospects and welfare of Africa, given the rising environmental pollution. However, the literature on the mitigating effect of policies and institutions for environmental sustainability (PIES) on resource-dependent countries in Africa is scarce. As a result, this study explores the effects of natural resource dependence and the mediating effect of PIES on under-five mortality and human development in Africa. This novel hypothesis may contribute to the divergent differences in African welfare. Using a panel of 30 resource-dependent countries spanning 2005 to 2021 and employing the two-step dynamic generalized method of moments, the study provides evidence in support of the novel hypothesis. The findings show that dependence on natural resources can be either a blessing or a curse for African countries, depending on the degree to which environmental sustainability is embraced. Furthermore, a heterogeneous analysis demonstrates significant support for countries with high policies and institutions for environmental sustainability in mitigating the negative impacts of natural resource dependence on welfare. The study concludes that dependence on natural resources without environmental sustainability cannot guarantee a balance between the well-being of the economy and the environment. Therefore, environmental management should not be politically motivated so as to sustainably improve human well- being in Africa.

KEYWORDS
Africa, natural resource dependence, PIES, welfare

1 | INTRODUCTION

In developing countries, particularly in Africa, reliance on natural resources provides governments with a consistent source of revenue for investment in social services, such as electricity, water, sanitation, education, and health care (Noumba et al., 2022). This tends to resonate with Adam Smith's proposition that resource-rich countries can grow faster than those with poor resources if revenues obtained from trade are well-managed (Smith, 1975). Furthermore, the seminal work of Sachs and Warner (1995) indicates that resource-rich countries have the propensity to increase wealth, diversify investments, and gain purchasing power over imports through industrial development.

Despite the significance of natural resources for development, increasing economic dependence on them appears to impede growth and development in Africa. Persistent environmental degradation and discriminatory exploration of natural resources deteriorate the environment and could have a devastating impact on people's health, education, and standard of living (Barbier, 2021). The hazardous effects stemming from activities, such as minerals extraction (gold, coal, manganese, bauxite), oil extraction, felling of timber and others lead to pollution that significantly affects people's well-being (Oteng-Abayie et al., 2022). Evidently, the 2023 sustainable development progress report indicates that the depletion of productive and healthy land severely impacts food and water security, exacerbating famines and having a greater impact on livelihood (Bejaković, 2018). Similarly, increased dependence on natural resources provides avenues for multinational companies to invest and stimulate economic growth and development. The influx of these companies also subjects nations to environmental problems such as waste, oil spillage, methane, and carbon dioxide emissions (CO_2 emission), which are becoming imminent to human lives. Exposure to these pollutants poses significant health and developmental risks, especially for children under 5 years, leading to higher child mortality rates. For instance, the World Health Organization (WHO) report in 2019 revealed that the average mortality rate in sub-Saharan Africa in 2018 was 78 per 1000 live births, compared to the global average of 39 per 1000 live births (WHO, 2019). This concerning situation is not surprising, considering that the WHO states that a child born in Africa is 11 times more likely to die in the first month of life due to the prevalence of pneumonia, diarrhea, malaria, and hunger, compared to the developed world (WHO, 2020). In fact, approximately 6700 newborn deaths occur every day, accounting for 47% of all child deaths under the age of 5 years, an increase from 40% in 1990. Despite the global decline in mortality rates from 93 deaths per 1000 live births in 1990 to 37 in 2020, children in Sub-Saharan Africa (SSA) still face the highest rates of mortality in the world, with 74 deaths per 1000 live births. Specifically, Nigeria, DR Congo, Ethiopia, and Angola recorded the highest under-five mortality in 2020, with 844, 284, 173, and 91 deaths per 1000 live births, respectively (WHO, 2020). Notably, approximately 45% of deaths in children under five in Africa are primarily caused by nutrition- related factors, highlighting the urgent need to address environmental issues that can hinder human development. In response to these challenges, the United Nations has set Sustainable Development Goals (3, 6, 13) to be achieved by 2030. These goals aim to provide good health and well-being, ensure universal access to safe water and sanitation, and combat climate change, which are critical for improving the welfare of children and communities in Africa (United Nations, 2018).

Notwithstanding, the overreliance on natural resources for development could be a mirage without environmental policies that promote the protection and sustainable use of natural resources in Africa. The well-being of every country is intricately connected to the state of the environment, and addressing environmental challenges can directly impact the health and development of its people. Therefore, it is crucial to prioritize policies and institutions that promote environmental sustainability, ensuring the efficient use and management of resources. One key area to focus on is sustainable access to clean water and improved sanitation facilities, as this can directly reduce the incidence of waterborne diseases, diarrhea, malaria, cholera, and dysentery, which are major causes of child mortality in Africa (Ntajal et al., 2022; Tarrass & Benjelloun, 2012). Additionally, climate change has emerged as one of the most urgent global issues, exacerbating existing health challenges and leading to an increase in diseases, food insecurity (malnutrition), and natural disasters that disproportionately affect children in Africa (Khasnis & Nettleman, 2005). To mitigate the adverse effects of resource extraction, which contributes to climate change, poor sanitation, and unsafe water, it is vital to implement environmental sustainability policies that promote a healthier and more sustainable environment. This, in turn, will help reduce child mortality and enhance the development of human capital. Another important aspect is the financing of renewable energy, which must be given greater attention to promote sustainable development in Africa (Byaro et al., 2023; Kirikkaleli & Adebayo, 2021; Nchofoung & Ojong, 2023). Employing the revenue from natural resources into the provision of renewable energy will contribute to the achievement of Sustainable Development Goal 7 (Nchofoung & Ojong, 2023), which focuses on ensuring access to affordable, reliable, sustainable, and modern energy for all. Therefore, with proper policies and institutions for environmental sustainability (PIES), resources can be utilized in ways that not only support economic development but also promote environmentally friendly and sustainable practices. This is why the present study sought to answer the novel question: Will policies and institutions for environmental sustainability make a difference in African welfare among resource-dependent countries?

The increasing divergent and inconclusive findings on resource-dependent countries about the faith of current and future generations made this hypothesis relevant to propel measures and policy guidelines for sustainable development. Many studies have noted that dependence on natural resources hinders economic development. One such influential work is by Sachs and Warner (1995), who found an inverse relationship between dependence on natural resources and economic growth. They argue that resource-rich countries tend to experience lower economic growth, less democracy, and worse development outcomes than resource-poor countries, a phenomenon known as the "resource curse". As a result, numerous empirical investigations (Acemoglu et al., 2005; Asiamah et al., 2022; Lessmann & Steinkraus, 2019; Papyrakis, 2017; Van der Ploeg & Poelhekke, 2017) have validated this hypothesis and documented that the so-called "resource curse" is attributable to increasing income inequality, rent-seeking, and poor institutions as the main channels through which countries experience stunted growth and development. However, some scholars argue that dependence on natural resources can have a positive impact on economic growth (Dramani et al., 2022; Sharma & Paramati, 2022).

Despite the numerous studies on the subject matter, the present study departs from previous research to contribute to the existing literature on the "resource curse" hypothesis in Africa. First, the aim is to examine whether dependence on natural resources leads to welfare improvement, using mortality rates and the Human Development Index (HDI) as measures of welfare. The HDI assesses a country's development based on indicators such as life expectancy, education, and per capita income (UNDP, 2022). Most studies in the literature have used individual measures (Oduyemi et al., 2021; Sebri & Dachraoui, 2021). However, by using the composite measure as employed by Sinha & Sengupta, (2019) and Noumba et al., (2022), this study aims to capture the true measure of African welfare. As discussed above, pollution is an integral part of dependence on natural resources, which can make countries vulnerable to food and water insecurity and health-related problems increasing the level of poverty in countries. These consequences may make children malnourished and prone to diseases resulting in high mortality rates among African countries. Therefore, this study seeks to fill this gap by investigating the impact of natural resource dependence on child mortality (under 5) and human development in Africa.

Another strand in the literature is that most studies have focused on economic and political institutions as moderation variables while neglecting PIES which is cardinal to achieving sustainable development (Asiamah et al., 2022; Nchofoung & Ojong, 2023). Although economic and political institutions are essential and can significantly contribute to African development, they do not directly address how well natural resources are utilized and how effectively environmental pollution is managed. The only study related to the present research is by Oteng-Abayie et al. (2022), who investigated how natural resource abundance impacts environmental sustainability in Sub-Saharan Africa (SSA). However, they did not analyze whether African dependence on natural resources on child mortality and human development can be mitigated using PIES. Therefore, the use of PIES is novel, as it captures the degree to which environmental policies foster the management of pollution and protection of natural resources for sustainable use (WDI, 2022). Consequently, a comprehensive analysis of the complementary effect of PIES and the dependence of natural resources (total resource rent) on welfare is of great policy interest to governments and the United Nations for sustainable development.

This paper is divided into five sections. Section 1 is the introduction; Section 2 is the literature review; Section 3 highlights the methodology and approach; Section 4 presents the results and discussion and finally, Section 5 provides details on the study's conclusion.

2 | LITERATURE REVIEW

The argument that resource abundance and dependence may lead to slower economic growth is not new. The resource curse hypothesis is a phenomenon frequently associated with the "Dutch disease" effect caused by some exogenous influence, such as trade liberalization or a resource price boom (Gelb, 1988; Gylfason, 2001). According to Sachs and Warner (1995), dependence on natural resources negatively affects economic growth. This became evident when resource-rich countries such as Venezuela, Nigeria, and the Republic of Congo experienced lower growth; while countries with limited resources, such as Singapore, South Korea, and others experienced buoyant growth per capita (Lotfalipour & Salehnia, 2022). This discovery led to growing research into examining the effect of natural resources on economic growth (Dramani et al., 2022; Guilló & Perez-Sebastian, 2015; Kim & Lin, 2017; Rjoub et al., 2021). Using quantitative analysis to examine the neoclassical growth and the natural resource curse puzzles within 49 states in the United States of America, Guilló and Perez-Sebastian (2015) defined resource-rich and poor groups of states in different ways and found that 10% richest states on average, 1.39% points slower than the 10% resource-poor. They further find a resource curse of 0.26 points when calculated from below the first quartile and above the third quartile.

In line with this, we first examine the impact of natural resource dependence on African welfare. It is worth acknowledging that several studies have been done on the natural resources curse hypothesis and argued that overreliance on natural resources stifles economic growth and development (Daniele, 2011; Fosu & Gafa, 2019; James & Aadland, 2011). Other studies showed that natural resource dependence leads to more conflict, lower levels of democracy, more corruption, and lower institutional quality, thus leading to slower growth and development in these countries (Acemoglu et al., 2005; Andersen & Ross, 2014; Asiamah et al., 2022; Lessmann & Steinkraus, 2019; Papyrakis, 2017; Van der Ploeg & Poelhekke, 2017). Although some studies have investigated the impact of resource dependence on various measures of welfare in Africa, such as education, health, GDP per capita, income inequality and happiness (Oduyemi et al., 2021; Sebri & Dachraoui, 2021; Tadadjeu et al., 2020), not much is done on the Human Development Index (HDI) as an aggregate measure of welfare. Reference is made to Sinha and Sengupta (2019) and Noumba et al. (2022) in recent years who investigated the effect of natural resource dependence on HDI and found a detrimental effect on welfare. For example, Noumba et al. (2022) investigated the impact of globalization, natural resource rent, and human well-being in Africa using a two-step generalized method of moments (System GMM) covering the period of 2000–2017. They found that dependence on natural resources is a curse to human development. Tadadjeu et al. (2020) also examined natural resource access, water and sanitation, and found that resource-rich countries experienced a reduction in welfare given the adverse impact on access to safe drinking water and sanitation. This nexus on welfare shows that resource-dependent countries are battling with environmental quality, and, as a consequence, African welfare is at stake given the increasing degradation of the environment. In addition, Tadadjeu et al. (2021) examined the impact of natural resource rents on child mortality and governance quality and found that dependence on natural resources by resource-rich countries is detrimental to child health and thus increases child mortality.

Regarding the last strand, policies and institutions for environmental sustainability have gained international recognition and have become important instruments for countries to achieve sustainable development goals 3, 6, and 13. It is worth noting that Oteng-Abayie et al. (2022) investigated the impact of natural resource abundance on environmental sustainability (CO_2 and ecological footprint) in SSA, examining whether policies and institutions for environmental sustainability matter in the region. The authors found that resource-rich countries experience deterioration in environmental sustainability compared to non-resource countries in SSA. Related studies by Nchofoung & Ojong, (2023) focused on the pathway toward sustainable development by examining the role of governance in mediating the effects of natural resources on renewable energy. They found that African countries with efficient management of resources improved the development of renewable energy, depending on the type of natural resource used. The researchers recognized the importance of good governance in renewable energy financing, as it is one of the surest ways to promote economic development. Similarly, Byaro et al. (2023) and Kirikkaleli and Adebayo (2021) also found that renewable energy use reduces environmental degradation in SSA. They suggest that with proper strategies and good institutions, governments and policymakers can finance renewable energy to achieve sustainable development by reducing CO_2 emissions.

Based on the reviews, this study makes substantial contributions to the literature. First, not much has been done to analyze how dependence on natural resources influences under-five mortality and human capital development. The closest studies are Sinha and Sengupta (2019), and Noumba et al. (2022), which have used HDI as a measure of well-being and child mortality by Tadadjeu et al. (2021). However, none of these has attempted to analyze the mitigating role of PIES on the welfare of resource-dependent countries in Africa.

Second, to our knowledge, only Oteng-Abayie et al. (2022) have used PIES that focus on environmental quality. However, they did not use PIES as a mediating variable to examine the relationship between natural resource dependence on African welfare. This is a novel aspect of the work and has become necessary to understand the significance of policies and institutions for environmental sustainability on the under-five mortality rate and HDI in Africa.

Lastly, this study also adds to the limited knowledge of the heterogeneous analysis of PIES among the selected countries. Specifically, using the mean of PIES as a benchmark, countries with an average mean below that point are categorized as having low PIES, while those with an average mean above the benchmark are identified as having high PIES. By disaggregating the sample into high and low policies and institutions for environmental sustainability, it allows for a more accurate evaluation and recommendation of the true impact on welfare. Therefore, conducting a comprehensive analysis of the relationship between natural resource dependence, PIES, and welfare in Africa is necessary and worthwhile to investigate. This approach helps shed light on the nuanced effects and varying impacts on welfare depending on the level of environmental sustainability policies and institutions in each country. This elaborated review is not exhaustive, as some of the empirical reviews have been presented in a matrix form, as seen in Table 1.

3 | METHODS

3.1 | Study setting

This study compiled data from a panel of 30 African countries from the years 2005 to 2021. The data was sourced from the United Nations Development Programme (UNDP, 2022) and the World Bank's Development Indicators (WDI) dataset (WDI, 2022). The selection of the study countries was based on two criteria: the richness of natural resources in a given country and the availability of data in the WDI dataset. Figure 1 depicts the map of the selected African countries for the study. However, the scope of analysis and the adopted periodicity is deeply influenced by the availability of data for the selected countries in achieving the study objectives.

3.2 | Variable description

3.2.1 | Dependent variable

The dependent variable of interest in this study is welfare, which is measured using two indicators: The Human Development Index (HDI) and the mortality rate represented by the under-five mortality rate per 1000 live births. In the literature, the most commonly used measure of welfare is GDP per capita, as it is known to reflect the living standard of people (Tadadjeu et al., 2021). However, human well-being is multidimensional and encompasses not only income but also aspects, such as health, education, and access to essential resources like water and sanitation, which are crucial for overall welfare. Therefore, to comprehensively capture the well-being of humans, this study adopts the HDI (UNDP, 2022). The HDI is composed of three key components: health, measured by life expectancy; education, measured by literacy rate and gross school enrollment; and GDP per capita, which reflects the standard of living (UNDP, 2022). Additionally, the study uses the mortality rate, specifically the under-five mortality rate per 1000 live births, as a proxy for welfare (WD1, 2022). This choice is based on the vulnerability of children under the age of five, as any environmental pollution can have a more devastating impact on their lives compared to adults. Given the indiscriminate pollution in African countries, this indicator is relevant for measuring welfare in the region.

3.2.2 | Independent variables

Furthermore, the explanatory variables of interest in this study are natural resource dependence and PIES. The paradox of plenty hypothesis has prompted the use of various measures to investigate countries rich in resources to either validate or invalidate the resource curse hypothesis. Some of these measures include the percentage of exports of the primary product in total exports by value and the percentage of exports of natural resources in GDP (Dietz et al., 2007; Sachs & Warner, 1995). However, these measures are potentially biased as they do not account for the domestic consumption of natural resources. To address this concern, the study adopts the total natural resource rents, which consists of the share of oil, natural gas, coal, minerals, and forest rents in GDP, as a measure of natural resource dependence that can impact human well-being (Ebeke et al., 2015). Therefore, the study expects resource-dependent

TABLE 1 Empirical summary (Matrix).

Author(s)	Title	Scope/periods	Method	Key findings
Zakari et al. (2022)	Are abundant energy resources and Chinese businesses a solution to environmental prosperity in Africa?	1992–2018	PDSE and S-GMM	There is a positive relationship between energy resources and environmental degradation.
Sharma and Paramati (2022)	Resource curse versus resource blessing: New Evidence from resources capital data	A large number of countries across the world (1995–2018)	FE-OLS; 2SLS	Natural capital is positive on development and resources are blessings, not curses
Noumba et al. (2022)	Globalization, resource rents and human well-being	African countries (2000–2017)	Two-step generalized method of moment (S-GMM)	Natural resources and human development are a curse. The population is positive, while the inflation rate is negative.
Lotfalipour and Salehnia (2022)	Natural resources: A curse on welfare?	2007–2020	Panel quantile regression	Dependence on natural resources on welfare is negative
Dramani et al. (2022)	Natural resource dependence, economic growth and threshold effects	Sub.Sahara Africa (SSA) (1990–2019)	FE, Panel Threshold Regression.	Below 6% and between 6% to 15% of GDP, aggregate natural resource rent exerts a significant negative effect on economic growth but is positive beyond 15% on GDP.
Tadadjeu et al. (2021)	Natural resources, child mortality and governance quality	African countries (1996–2018)	GMM	Natural resource rents have detrimental effects on child mortality
Rjoub et al. (2021)	Implications of governance, natural resources, and security and economic development	Evidence from SSA (2007–2020)	Dynamic heterogeneous panel level estimators (PMG and CS-ARDL)	There is a long-run causal effect of natural resources on economic development
Tadadjeu et al. (2020)	Natural resource dependence, access to water and sanitation	African countries (1995–2017)	GMM	Natural resource rents negatively affect access to water and sanitation.
Redmond and Nasir (2020)	Natural resource abundance, international trade and financial development in the economic development of selected countries	1990–2016	FE, DOLS, FMOLS	The abundance has a positive impact on growth, but a negative on human development. Trade harms economic development
Erdogan et al. (2020)	Natural resources abundance and dependence and environmental sustainability	Evidence from resource-based economies (1980–2016)	Continuously updated fully modified ordinary least squares	Both resource abundance and dependence put pressure on the environment. Urbanization deteriorates ecological conditions.
Lessmann and Steinkraus (2019)	The geography of natural resources, ethnic inequality, and civil conflicts	Geospatial data and country-level data	Panel FE	Different ethnic groups within the country breed inequalities, rent-seeking and conflicts
Fosu and Gafa (2019)	Natural resources, institutions and economic development in Africa	1966–2002 for Nigeria and 1976–2002 for Botswana	Distributed lag regression	Resource rents do not contribute to long-run growth and are associated with weak institutions
Kim and Lin (2017)	Natural resources and economic development: New panel evidence	1990–2012	DOLS, AMG	Resource abundance on average is detrimental to economic development.
Daniele (2011)	Natural resources and the 'quality' of economic development	1970–2006	OLS estimates. Heteroskedasticity-robust standard errors.	Dependence on natural resources is negatively linked to HDI. It is more correlated with countries with lower-quality institutions than those with higher institutional quality.
Sachs and Warner (1995)	Natural resource abundance and economic growth	1971–1989	IV estimator	Economies with higher ratios of natural resource exports of GDP than those with resource scarcity.

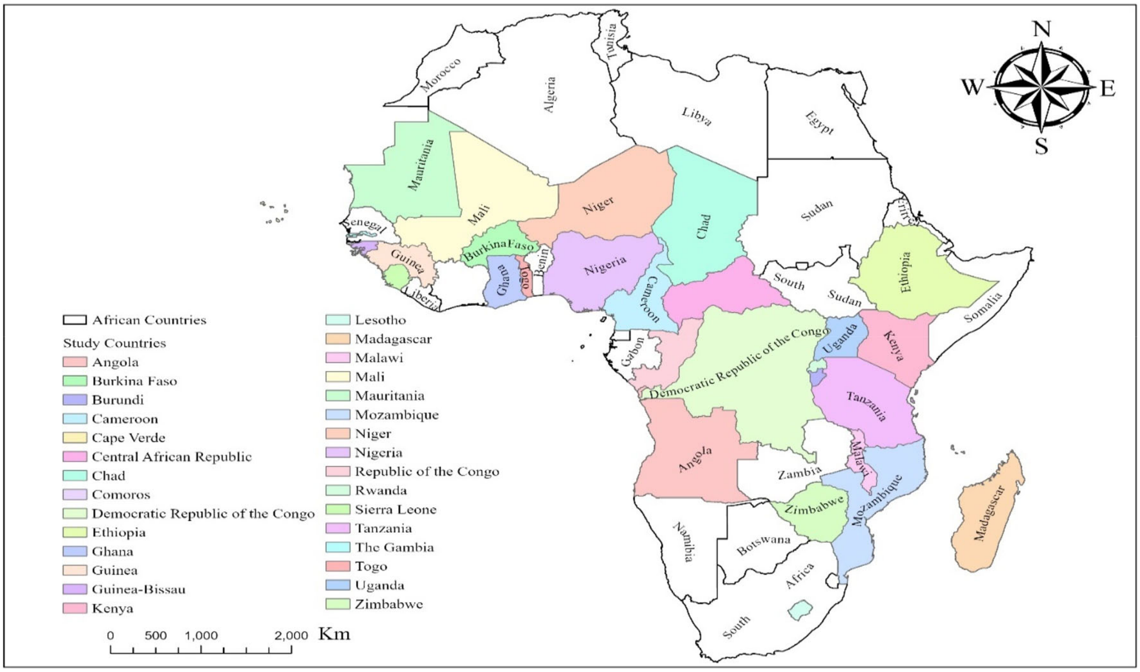

FIGURE 1 Map of Africa showing study countries.

countries to have an adverse effect on welfare. Furthermore, PIES measures how well countries foster and protect the use of natural resources and manage pollution. This indicator is a critical explanatory variable in investigating how sustainable African countries can improve welfare (WDI, 2022). PIES is an index variable with a rating ranging from 1 (indicating low policy and institutions for environmental sustainability) to 6 (representing high policy and institutions for environmental sustainability). The study expects that PIES will have a positive influence on African welfare.

3.2.3 | Control variables

This study has several determinants of welfare, which are primarily based on existing literature that are sourced from world development indicators (WDI, 2022). The gross domestic product per capita (GDP) is used to capture the standard of living, encompassing both the government's financing capacity and the effective demand of the population. As a result, we anticipate a positive impact of per capita income on welfare. Foreign direct investment (FDI) is recognized as a means of promoting economic growth and wage growth in developing countries. However, environmental pollution can become problematic if environmental policies are not enforced. Therefore, we expect FDI to have either a positive or negative influence on welfare. Similarly, due to the beneficial effects associated with trade openness, particularly on economic growth, the study expects a positive relationship between trade openness and welfare. On the other hand, inflation, measured by the consumer price index (CPI), reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. We anticipate that inflation may have an adverse impact on welfare. Urbanization, measured as the urban population percentage of the total population, is known to increase the pressure on food supply, provision of productive employment, and available economic and government social welfare spending, which can impact the quality of life of the people. Hence, we expect either positive or negative effects on welfare. For visualization purposes, we provide graphical representations of all the explanatory variables for each of the welfare measures (Figures 2 and 3).

3.3 | Model specification

The empirical model specification for this study is based on the Stochastic Impact Regression on Population, Affluence and Technology (STIRPAT) model by Dietz and Rosa (1994). The STIRPAT model, extensively applied in environmental and sustainability research to analyze the influence of human activities on the environment (Duodu et al., 2022; Iheonu et al., 2021), draws its foundation from the Environmental Kuznets Curve (EKC) hypothesis. This hypothesis proposes that environmental deterioration tends to rise initially with economic growth (affluence), but as societies become more prosperous and technologically advanced, it eventually declines. Following Dietz and Rosa (1994), this study modified the STIRPAT model to include natural resource rent and PIES to investigate the relationship between natural resource dependence, PIES, and African welfare. To understand the fitness of the model for this study, the study represents affluence as economic growth (GDP), urbanization as population, and then technology as trade openness and FDI. The use of FDI and trade openness is commonly employed as proxies for technology because they capture the influence of technological advancements on the

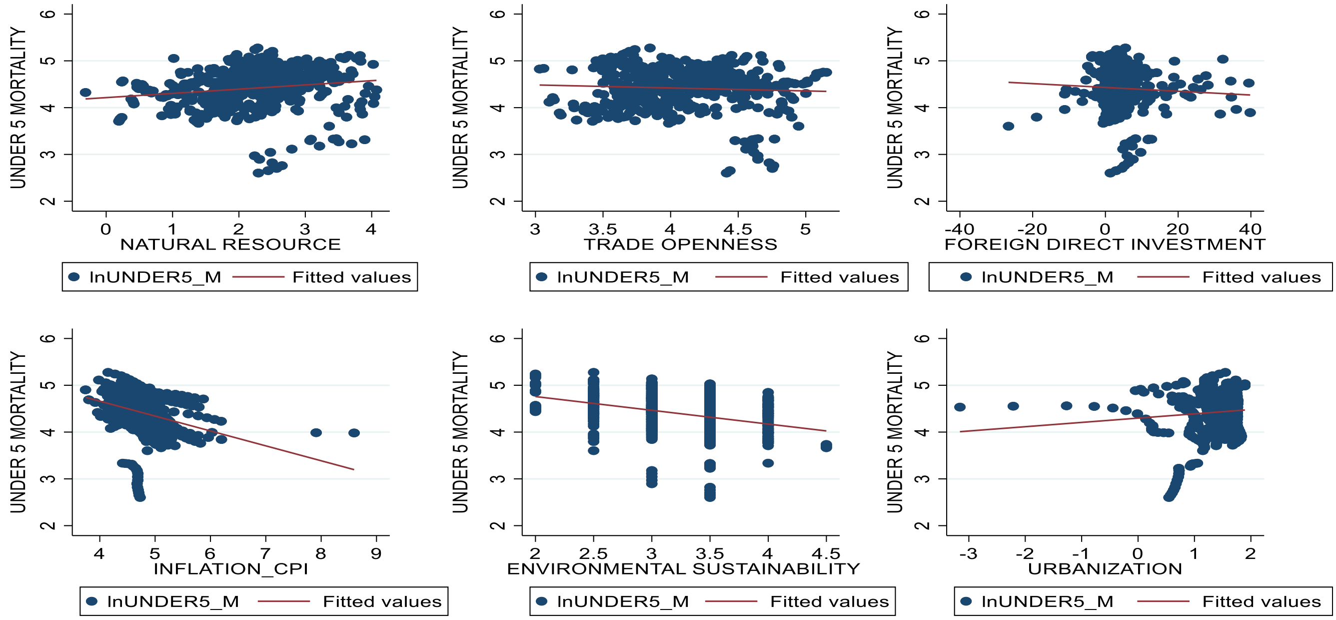

FIGURE 2 Explanatory variables and under 5 mortality rate.

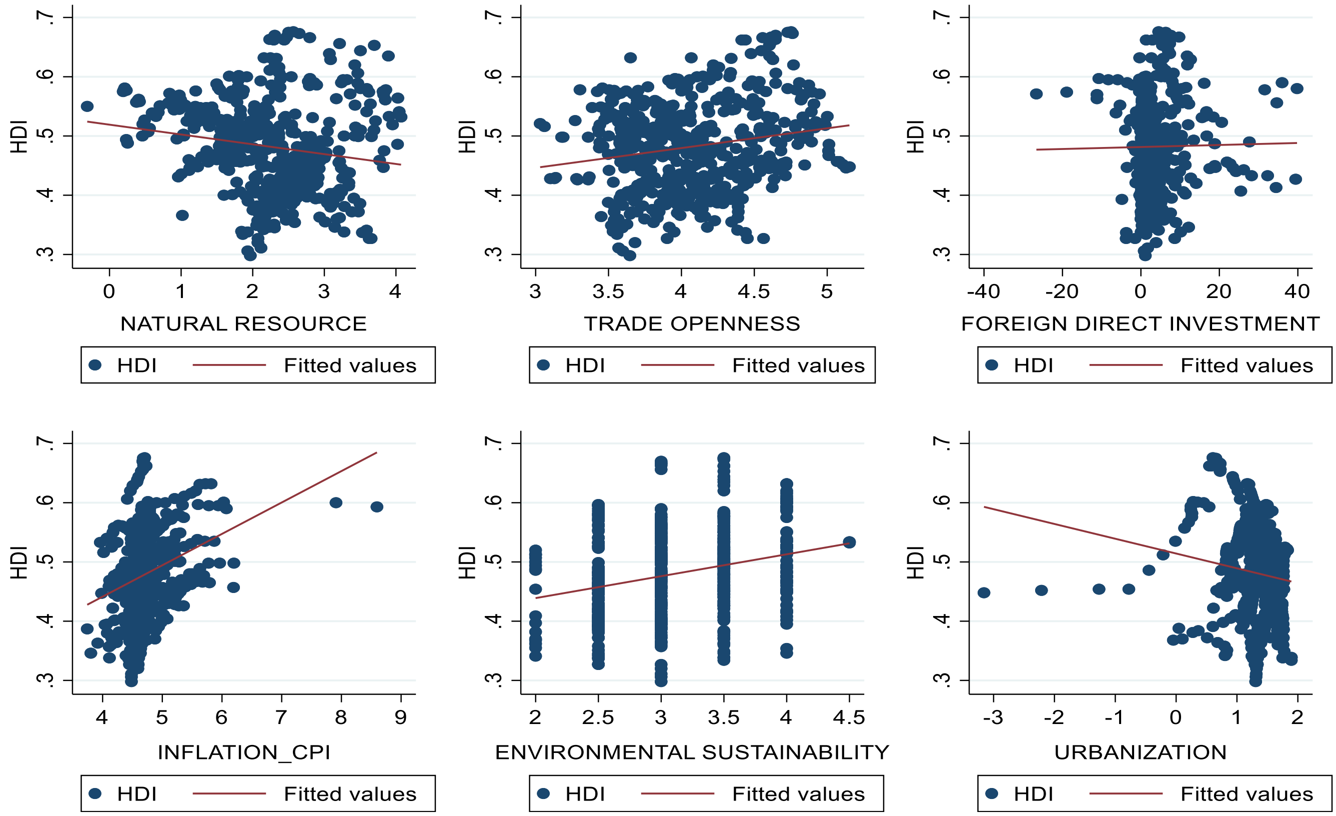

FIGURE 3 Explanatory variables and Human Development Index (HDI).

environment, thus impacting the welfare of people in Africa (Duodu et al., 2022; Duodu & Mpuure, 2023). Since FDI and trade openness are associated with economic development, the adoption of more advanced and environmentally friendly technologies becomes necessary, aligning with the theoretical framework of the STIRPAT model. The modified STIRPAT model is expressed below.

$$W_{it} = \alpha TNR_{it}^{\beta_1} PIES_{it}^{\beta_2} GDP_{it}^{\beta_3} URB_{it}^{\beta_4} T_{it}^{\beta_5} CPI_{it}^{\beta_6} \epsilon_{it} \tag{1}$$

where W, TNR, PIES, GDP, URB, T and CPI represent welfare (measured as under five mortality rates, HDI), total natural resource rent, policy and institutions for environmental sustainability, GDP per capita, Technology (trade openness, FDI) and inflation, respectively. Equation (1) is then expressed in functional form in Equation (2).

$$W = f(TNR, PIES, FDI\,GDP, URB, TO, CPI) \tag{2}$$

In the econometric specification, we transformed Equation 1 into its panel logarithmic estimable form to facilitate ease of interpretation in elasticities and to address potential outliers in the measurement of variables (Ayesu et al., 2022), as shown in Equation 3.

$$\begin{aligned} lnW_{it} = {} & \alpha + \beta_1 lnTNR_{it} + \beta_2 lnPIES_{it} + \beta_3 lnGDP_{it} + \beta_4 lnURB_{it} + \beta_5 lnTO_{it} \\ & + \beta_6 lnFDI_{it} + \beta_7 lnCPI_{it} + \varphi_i + \gamma_t + \epsilon_{it} \end{aligned} \tag{3}$$

where φ_i *and* γ_t capture the individual specific effect, and period fixed effect, respectively. The ε denotes the stochastic error term, i, cross-section, t, time, α, constant and the β_1………β_7 are the respective parameter coefficients to be estimated. To capture the indirect effect of natural resources and PIES, we augmented Equation 3 to include the interaction term of PIES and TNR to obtain the complementarity effect on welfare, as shown in Equation 4.

$$\begin{aligned} lnW_{it} = {} & \alpha + \beta_1 lnTNR_{it} + \beta_2 lnPIES_{it} + \delta(PIES * TNR)_{it} + \beta_3 lnGDP_{it} \\ & + \beta_4 lnURB_{it} + \beta_5 lnTO_{it} + \beta_6 lnFDI_{it} + \beta_7 lnCPI_{it} + \varphi_i + \gamma_t + \epsilon_{it} \end{aligned} \tag{4}$$

From Equation (4), PIES* TNR captures the complementary effect with δ representing the interaction coefficient. It is worth noting that the introduction of the interactive term shows that the impact of natural resource rents on African welfare is dependent on policies and institutions for environmental sustainability. Following Oteng-Abayie et al. (2022), we have mean-centered the PIES and TNR indicators for ease of interpretation.

3.4 | Estimation strategy

3.4.1 | Cross-sectional dependence and panel unit root tests

Given the increasing interdependence and integration of countries, it is essential to consider the possibility of cross-sectional dependence (CSD) since its presence can potentially invalidate the findings. Therefore, the Pesaran (2015) CSD test is utilized. To control for the existence of CSD in the analysis, panel unit root tests are adopted using both the first and second generations to explicitly capture the presence of CSD. The Im, Pesaran, and Shin's (IPS) unit root test (Im et al., 2003), and Pesaran's cross-sectionally augmented IPS (CIPS) unit root test (2007) are employed to test for the stationarity of variables. Rejection of the null hypothesis in these tests indicates the absence of a unit root, suggesting that the variables are stationary.

3.4.2 | Estimation technique

The pooled ordinary least squares (OLS) with the Driscoll and Kraay (1998) standard error estimation technique is utilized as the baseline model to account for autocorrelation, heteroskedasticity, and cross-section (CD) effects in the data. This approach is suitable for both short and long periods of analysis. However, it is important to note that the D-K estimator does not control for potential endogeneity. To address this concern and avoid inconsistent and biased estimations, the study employs the two-step system generalized method of moment (system-GMM) estimation, which is capable of overcoming such issues. Following the approach used by Oteng-Abayie et al. (2022) and Duodu and Mpuure (2023), the estimable system-GMM specification is presented below:

$$\begin{aligned} lnW_{it} - lnW_{it-1} = {} & \delta_0(lnW_{it-1} - lnW_{it-2}) + \delta'(lnA_{it} - lnA_{it-1}) + (\gamma_t - \gamma_{t-1}) \\ & + (\varepsilon_{it} - \varepsilon_{t-1}) \end{aligned} \tag{5}$$

where, A_{it} represents a vector of all sample variables as shown in Equation (3). It is worth noting that Equation (4) is estimated twice for each of the welfare measures. First, we estimated the direct effect of natural resource rents on welfare indicators without PIES and the interaction term. Then, we re-estimated Equation (5) by including PIES and the interaction term to capture the indirect effect on welfare indicators. The decision to adopt the GMM technique in our specification is motivated by the following reasons. First, the system-GMM technique developed by Arellano and Bover (1995) and Blundell and Bond (1998) assumes that all explanatory variables are endogenous. In this study, we adopt the "gmmstyle" approach for predetermined variables, treating years as strictly exogenous. Second, it is important to note that the number of cross-sections for this study ($N = 30$) is greater than the number of time series observations ($T = 17$), implying that $N > T$. Lastly, there is a high correlation between welfare variables and their corresponding first-lagged values, which is worth considering in the analysis.

It is worth emphasizing that in the GMM estimation, issues of reverse causality and exclusion restrictions are likely to be prevalent, and they may impact the outcomes of this study. For instance, considering the variable PIES, it may affect welfare, and at the same time, welfare could also influence the rate at which PIES is adopted for development. Similarly, assuming PIES improves human capital development (welfare) in Africa, the improvement in human development could equally influence the demand for stronger institutions for environmental sustainability. To address these econometric issues, reliable instruments are required. However, obtaining valid and reliable instruments can be challenging.

Nevertheless, according to Holtz-Eakin et al. (1988) and Arellano and Bond (1991), valid instruments can include lags of the dependent, explanatory, or endogenous variables. Utilizing the potency of the two-step system GMM strategy, we can adequately address issues of reverse causality and potential endogeneity by using the lags of the regressors as instruments. We assume that the lag of the regressor directly impacts the endogenous variable in question without affecting the outcome variable of interest. For example, the lag of natural resource rents (TNR_{it-1}) should only influence welfare through natural resource rents (TNR) to satisfy the exclusion restriction condition. As a consequence, we used the second lag of the regressors as an instrument for the endogenous variable. To avoid instrument proliferation, which the System GMM is prone to, we used the "collapse" routine in Stata to ensure that the number of instruments is less than the number of groups. Following Arellano and Bond (1991) AR(2) test for the serial correlation properties and the Hansen *J*-test of over-identifying restrictions, we assess the validity of the instruments.

Importantly, system GMM does not directly capture cross-section dependence in panel models. As a result, we follow the estimation strategy by Pesaran & Xie, (2021) to predict the residuals using the GMM estimations to test the error term to see whether there exists weak cross-sectional dependence among economies. Again, to assess the complete relationship between natural resource dependence, PIES, and welfare, the study derives the marginal effects of PIES on welfare given total natural resource rents. Following Noumba et al. (2022), the marginal effects for the true effect of natural resource rents are calculated as $\left[\frac{\partial \ln W_{it}}{\partial TNR_{it}} = \beta_1 + \delta PIES\right]$.

4 | RESULTS AND DISCUSSION

4.1 | Summary statistics

Table 2 presents the summary statistics, and the results reveal that the welfare measures, such as under-five mortality (U_5M) and human development index (HDI), have averages of 89.75 deaths per 1000 births and a rate of 0.48, respectively. The U_5M, representing the number of children who die before reaching the age of five per 1000 live births, shows that the selected African countries still experience high child mortality, with values reaching as high as 195.5 deaths per 1000 live births. This could be attributed to the fact that resource-dependent countries face a high incidence of diseases originating from poor environmental conditions.

Furthermore, it is not surprising that the mean value of HDI is 0.48, indicating that, on average, these countries have low human development capacities. Additionally, the average mean of policy and institutions for environmental sustainability (PIES) is 3.17, suggesting that, on average, African countries have taken measures to protect the use of natural resources and manage pollution. Moreover, the average mean value of natural resource rent is 12.50%, with the maximum value reaching as high as 58.69%. This implies that dependence on natural resources for development can be beneficial for Africans when properly managed.

4.2 | Multicollinearity test

The correlation coefficients indicate the strength of a potential linear association between two or more variables. Multicollinearity arises when two or more independent variables are highly correlated, making it challenging to interpret the model accurately. An absolute correlation coefficient of 0.8 between two or more predictors signifies a strong correlation (Noumba et al., 2022). The results presented in Table 3 demonstrate that the linear correlation coefficients between the explanatory variables considered in each regression are all below 0.8. As a result, there is no significant multicollinearity, and the model's goodness of fit is satisfied.

4.3 | Cross-sectional dependence and panel unit root test

Results of the cross-sectional dependence are presented in Table 4. Using the Pesaran (2015) cross-sectional test, the findings indicate that the selected variables U_5M, TNR, PIES, HDI, FDI, TO, GDP, CPI, and URBAN exhibit cross-sectional dependence (CSD). This means that countries are interdependent and require that policymakers in all economies consider other economies when formulating policies. This cross-sectional dependence may lead to omitted variable bias or endogeneity, and it is essential to check whether the residuals of the error term from our main estimation are strongly correlated. To address this concern, we will use the Pesaran and Xie (2021) test for residuals to account for the biases.

Before conducting the Pesaran and Xie (2021) test, we present a unit root test that takes into account this cross-sectional dependence for further analysis. This unit root test will help ensure the reliability of our results by considering the potential impact of cross-sectional dependence on the variables under investigation.

4.4 | Panel unit root test

In this part of the analysis, cross-sectional dependence unit root tests of the panel were conducted using both first and second-generation tests, as shown in Table 5. The Im, Pesaran, and Shin (IPS) unit root test was utilized, but it does not account for CSD. Therefore, the appropriate unit root test that considers the cross-sectional dependence in the panel is the CIPS test. The results indicate that some of the variables were not stable at the level, as evidenced by both tests. However, all the variables became stationary when examined at their first differences at a 5% level of significance.

4.5 | D-K standard error estimation (baseline results)

The baseline estimates using the Discroll and Kraay standard error estimator are presented in Table 6. This table displays the results regarding the effects of natural resource dependence on child mortality and human development (models 1 and 3), as well as the interplay between natural resource dependence and PIES on welfare measures (models 2 and 4). From Model 1, it is evident that there is a positive

TABLE 2 Summary statistics.

Variable(s)	Obs.	Mean	Std.dev	Min	Max	Source of data
U_5M	510	89.75	33.35	13.5	195.5	WDI (2022)
TNR	510	12.50	10.30	0.73	58.69	WDI (2022)
PIES	510	3.17	0.52	2	4.5	WDI (2022)
HDI	510	0.48	0.07	0.30	0.68	UNDP (2022)
FDI	510	3.86	6.28	−26.64	39.81	WDI (2022)
TO	510	64.31	28.84	20.72	172.91	WDI (2022)
GDP	510	1.61	4.50	−36.56	18.07	WDI (2022)
CPI	510	7.31	28.89	−89.17	557.20	WDI (2022)
URBAN	510	3.90	1.18	−0.07	6.65	WDI (2022)

Note: U_5M, TNR, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, and urbanization respectively. where WDI denotes world development indicators and UNDP represents the United Nations Development Programme.

TABLE 3 Correlation matrix.

Pwcorr	U_5M	TNR	PIES	HDI	FDI	TO	GDP	CPI	URBAN
U_5M	1								
TNR	0.14	1							
PIES	−0.39	−0.32	1						
HDI	−0.74	−0.03	0.26	1					
FDI	−0.06	0.12	0.07	0.01	1				
TO	−0.06	0.43	−0.09	0.20	0.30	1			
GDP	0.06	0.01	0.16	−0.04	0.06	0.01	1		
CPI	−0.02	0.02	0.10	0.05	−0.02	0.03	−0.08	1	
URBAN	0.06	0.13	0.21	−0.23	0.03	−0.29	0.0 7	−0.05	1

Note: U_5M, TNR, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources, rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, and urbanization respectively.

TABLE 4 Cross-sectional dependence.

Variable(s)	Pesaran (2015)
U_5M	84.28***
TNR	24.09***
PIES	8.12***
HDI	79.98***
FDI	6.47***
TO	4.25***
GDP	17.48***
CPI	20.69***
URBAN	3.15**

Note: The null hypothesis of cross-sectional independence is tested against the alternative of cross-sectional dependence. U_5M, TNR, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources, rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, population growth, and urbanization respectively.

and statistically significant relationship between natural resource rent and under-five mortality. Specifically, a percentage point increase in natural resource rent, assuming everything else remains unchanged, leads to a 0.34% increase in under-five mortality in resource-dependent African countries. These results indicate that, on average, natural resource rents are associated with higher under-five mortality, corroborating with Tadadjeu et al., (2021). Similarly, Model 3 shows that the dependence on natural resources in Africa has a detrimental effect on human development, resulting in a rate of decrease of 0.047 in welfare. This suggests that African countries' reliance on natural resources may hinder human capital development, given its negative impact on welfare. This finding aligns with Noumba et al., (2022).

After including PIES (Models 2 and 4), the results do not differ significantly. The coefficients of natural resource rents remain significant and continue to reduce human well-being. However, as anticipated, the effect of PIES on mortality is negative, indicating its potential to improve welfare among countries. Nonetheless, the impact of PIES on human development is positive but insignificant, which suggests that enforcing stringent rules and regulations for

TABLE 5 Panel unit root test.

Variable(s)	CIPS Level	CIPS First difference	IPS Level	IPS First difference
U_5M	−2.241**	−2.663***	−1.627	−1.952**
TNR	−1.924	−3.452***	−1.287	−2.664***
PIES	−2.384***	−4.157***	−1.476	−2.624***
HDI	−2.057	−3.011***	−1.285	−2.002**
FDI	−2.470***	−4.295***	−1.797**	−2.438***
TO	−1.823	−3.653***	−1.671	−2.455***
GDP	−3.216 ***	−4.760***	−1.827**	−2.897***
CPI	−2.726 ***	−4.619***	−1.466	−2.655***
URBAN	−2.359***	−2.585***	−2.519***	−5.840***

Note: *$p < .1$, **$p < .05$, ***$p < .01$ are the significance levels. U_5M, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources, rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, population growth, and urbanization respectively.

TABLE 6 Natural resource dependence, PIES, and African welfare.

	U_5M Model 1	Model 2	HDI Model 3	Model 4
TNR	0.339**	0.335**	−0.0474**	−0.0466**
	(0.128)	(0.142)	(0.0192)	(0.0204)
PIES		−0.00538		0.00756
		(0.0688)		(0.0101)
TNR*PIES		−0.284		0.0169
		(0.167)		(0.0294)
FDI	−0.00329	−0.00335	−0.000490	−0.000540
	(0.00464)	(0.00441)	(0.000731)	(0.000673)
lnTO	−0.104***	−0.103***	0.0425***	0.0423***
	(0.0346)	(0.0347)	(0.00805)	(0.00810)
lnGDP	−0.00609	−0.00764	0.00220	0.00213
	(0.0101)	(0.00994)	(0.00281)	(0.00289)
lnCP	−0.259**	−0.263**	0.0468**	0.0457***
	(0.110)	(0.102)	(0.0166)	(0.0153)
lnURBAN	0.0567*	0.0642*	−0.0134	−0.0139
	(0.0269)	(0.0304)	(0.00856)	(0.00873)
Constants	6.017***	6.021***	0.104	0.111
	(0.666)	(0.614)	(0.119)	(0.112)
N0. Obs.	510	510	510	510

Note: *$p < .1$, **$p < .05$, ***$p < .01$ are the significance levels. Standard errors in parentheses are panel robust. U_5M, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, population growth, and urbanization respectively. Models 1 and 2 represent the dependent variable such as under 5 mortality and models 3 and 4 denote the human development index variable.

environmental sustainability can lead to improved welfare. Furthermore, the interaction coefficient of natural resource rent and PIES indicates that policies and institutions for environmental sustainability can potentially moderate the negative impact of natural resource rents on under-five mortality and human development, although the results are not statistically significant (Model 2, 4). To gain a deeper understanding of the actual effects of resource dependence and PIES on welfare, the study reported a marginal effect based on the percentile of PIES. This approach helps determine the rate at which the association between natural resource rent and PIES influences welfare, as shown in Table 7.

The study observed that the percentile values for the 5th and 25th percentile are the same and significantly increased under-five mortality by 0.47% while reducing human development by 0.06%.

TABLE 7 Baseline marginal effects of natural resource dependence, PIES and welfare.

Percentiles	Percentile values	Model 2	Model 4
5%	−.4755	0.470** (0.187)	−0.055* (0.031)
25%	−.4755	0.470** (0.187)	−0.055* (0.031)
50%	.0245	0.328** (0.141)	−0.046** (0.020)
75%	.5245	0.186 (0.136)	−0.038** (0.017)
99%	.5245	0.186 (0.136)	−0.038** (0.017)

Note: Standard errors in parentheses are robust. $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$ are the significance levels. Columns 3 and 4 show the marginal values of models 2 and 4 presented in Table 6 (Model 2 and Model 4), respectively.

Similarly, at the 50th percentile, the impact on welfare decreases, but it still leads to a 0.33% increase in mortality and a reduction of 0.05% in human development. Progressively, these marginal effects show no signs of positive influence on welfare, even at the highest percentile levels (75th–99th). Model 2 reveals that under-five mortality continues to increase, while Model 4 indicates a persistent reduction in human development in Africa. This evidence supports the resource curse hypothesis, given the significant reduction in welfare among African countries that rely on natural resources for development (Noumba et al., 2022; Tadadjeu et al., 2021). However, it is important to note that this estimation is for comparison purposes with the main results presented in Table 8, which takes into account the presence of endogeneity.

4.6 | System-GMM estimation (Main results)

The limitation of the D-K standard error, particularly when potential endogeneity exists, may have contributed to the insignificance of most of the estimates presented in Tables 6 and 7. To address this issue, this study utilized the two-step dynamic generalized method of moments (System-GMM), which effectively controls for endogeneity problems. It is worth noting that all the models passed the AR (2) test, as evident from the *p*-values, indicating the absence of second-order serial correlation in the error terms. Additionally, the number of instruments used is less than the number of countries. Overall, the validity of the instruments used, which is essential for the System-GMM approach, is confirmed, as demonstrated by the p-values of the Hansen test.

The estimates from models 1 and 3 in Table 8 show the direct effects of natural resource rent on under-five mortality and HDI in Africa respectively. In both models, the coefficients of natural resource rent are negative and statistically significant, as shown in the baseline results in Table 6. Specifically, a percentage point increase in resource rent leads to a 1.25% increase in under-five mortality and a 0.169% reduction in human development in Africa. These findings suggest that the heavy dependence on natural resources negatively affects the welfare of the people, which is not surprising considering the widespread environmental pollution, which can have detrimental effects on citizens' well-being. Moreover, African economies heavily reliant on natural resource rents are vulnerable to the Dutch disease, limiting their capacity to generate employment opportunities, finance social infrastructure to enhance human development and reduce under-five mortality rates (Tadadjeu et al., 2021). These findings support the resource curse hypothesis, which is consistent with the findings of previous studies (Erdogan et al., 2020; Lotfalipour & Salehnia, 2022; Noumba et al., 2022) that suggest natural resources is a curse to African development. This adverse impact of natural resource dependence on under-five mortality could be attributed to the fact that governments and policymakers do not allocate sufficient proceeds to improve health and education in Africa. The continent is known for its poor environmental conditions, including issues related to sanitation, water, and climate change, which have a detrimental effect on child survival. To achieve the sustainable development target of reducing under-five mortality to less than 25 per 1000 live births by 2030, it is crucial for African leaders to allocate a significant portion of resources to the healthcare sector for precautionary measures. This can only be achieved when measures are taken to address issues such as corruption, embezzlement of public funds, and mismanagement of resources. Without addressing these challenges, it may be difficult to reach the target. Therefore, it is essential to take appropriate measures to mitigate these effects; otherwise, they may have a long-lasting impact on education, health, and living standards of the people in Africa. Addressing these challenges is crucial for promoting the well-being and development of the population.

As a consequence, numerous studies (Andersen & Ross, 2014; Asiamah et al., 2022; Lessmann & Steinkraus, 2019; Papyrakis, 2017) have attempted to assess the effectiveness of political and economic institutions in reducing the undesirable impact of environmental issues. However, these studies have yielded mixed results, leading to inconclusive findings. To achieve this goal, we investigate the significance of policies and institutions for environmental sustainability and their role in mitigating the negative effects of natural resource dependence on African welfare. To understand the relevance of PIES, we estimated the indirect effect by including PIES and the interaction term of PIES and TNR as shown in models 2 and 4 for the respective welfare outcomes. Interestingly, the inclusion of PIES in Models 2 and 4 demonstrates that it has a positive impact on human development and reduces under-five mortality. As expected, the interaction coefficients of PIES and TNR show a negative impact on under-five mortality and a positive impact on human development, indicating an improvement in welfare in Africa. This highlights the importance of environmental policies geared toward sustainability, which can help African countries transform their natural resources into blessings, ultimately achieving sustainable growth and development (Oteng-Abayie et al., 2022). Therefore, countries heavily dependent on natural resources, without proper policies and institutions for environmental sustainability, are more likely to view their resources as a curse rather

TABLE 8 Natural resource dependence, PIES and African welfare.

	U_5M Model 1	Model 2	HDI Model 3	Model 4
$\ln U5\_M_{t-1}$	1.028***	1.020***		
	(0.00582)	(0.00578)		
HDI_{t-1}			1.000***	0.994***
			(0.0212)	(0.0218)
TNR	0.0125***	0.0172***	−0.00169**	−0.00593***
	(0.00199)	(0.00293)	(0.000803)	(0.00199)
PIES		0.00953***		0.00188
		(0.00332)		(0.00159)
TNR*PIES		−0.0759***		0.0358***
		(0.0154)		(0.0129)
FDI	0.000707***	0.000633***	0.000164	−0.000440*
	(0.0000910)	(0.000148)	(0.000193)	(0.000225)
LnTO	−0.0234***	−0.0308***	−0.00275	0.00772
	(0.00430)	(0.0102)	(0.00504)	(0.00694)
LnGDP	−0.00152	−0.00272**	0.00528***	0.00436***
	(0.000917)	(0.00110)	(0.000996)	(0.000915)
LnCPI	0.0294***	0.0153**	−0.00789**	−0.0106***
	(0.00548)	(0.00676)	(0.00373)	(0.00371)
LnURBAN	−0.110***	−0.0924**	0.00776	0.0231***
	(0.0251)	(0.0391)	(0.0103)	(0.00772)
Constants	−0.0645	0.0485	0.0402*	−0.00321
	(0.0442)	(0.0789)	(0.0225)	(0.0298)
Period fixed effects	Yes	Yes	Yes	Yes
No.observations	480	480	480	480
No.groups	30	30	30	30
No. Instruments	27	27	26	26
AR2[*P*-value]	−0.697[0.486]	−0.308[0.758]	−1.676[0.0937]	−1.325[0.185]
Hansen[*P*-value]	22.73[0.201]	18.38[0.302]	24.65[0.103]	19.22[0.204]

Note: $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$ are the significance levels. Standard errors in parentheses are panel robust. *P*-Values are in the brackets. U_5M, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources, rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, population growth, and urbanization respectively. Models 1 and 2 represent the dependent variable such as under 5 mortality and models 3 and 4 denote the human development index variable.

than a blessing. However, this study demonstrates that African countries that actively protect, promote, and manage the use of their natural resources and pollution experience sustainable improvement in welfare. The findings imply that African countries should prioritize the efficient use and management of natural resources by investing in sustainable water, sanitation, and the adoption of renewable energy to reduce the hazards associated with an unsustainable environment. Given that many health complications, such as diarrhea, malaria, pneumonia, and other infectious diseases, are linked to the changing environment, the survival of children becomes critical. Therefore, we suggest that African countries embrace the importance of PIES to mitigate the adverse impact of natural resources on under-five mortality and human development. Implementing PIES can help refute the notion of a 'resource curse' in resource-dependent nations and contribute to the overall welfare and well-being of their populations.

Turning to the control variables, as expected, FDI and inflation have an adverse effect on welfare. This is evident from the coefficients of FDI and CPI, which show an increase in under-five mortality and a reduction in human development, thus putting human well-being at risk. This outcome is not surprising, given that the influx of multinational companies, such as mining and oil production companies, can potentially harm communities and human life through poor sanitation and unsafe access to drinking water (Tadadjeu et al., 2020). Moreover, countries that heavily rely on natural resources often base their economies on the export of primary products, making them vulnerable to price volatility in the international market. Consequently,

TABLE 9 Marginal effects of natural resource dependence, PIES and African welfare (GMM).

Percentiles	Percentile values	Model 2	Model 4
5%	−.4755	0.053*** (0.007)	−0.023** (0.008)
25%	−.4755	0.053*** (0.007)	−0.023** (0.008)
50%	.0245	0.015*** (0.003)	−0.005** (0.002)
75%	.5245	−0.023** (0.009)	0.013** (0.006)
99%	.5245	−0.023** (0.009)	0.013** (0.006)

Note: Standard errors in parentheses are robust. *$p < .1$, **$p < .05$, ***$p < .01$ are the significance levels. Columns 3 and 4 show the marginal values of models 2 and 4 presented in Table 8 (Model 2 and Model 4), respectively.

TABLE 10 Residual test using Pesaran and Xie (2021).

Equation	Pesaran and Xie (2021) CSD test
U_5m (GMM ESTIMATION)	
Predicted Residual	−0.45 (0.653)
HDI(GMM ESTIMATION)	
Predicted Residual	−0.45 (0.653)

Note: This table displays the predicted residuals for the System-GMM estimation for the respective outcome variables to test whether the residuals exhibit strong cross-sectional dependence. Where U_5M and HDI represent under five mortality rate and human development index respectively. *P*-values are shown in the parentheses, indicating that we do not reject the null hypothesis of weak cross-section dependence against the alternative of strong cross-dependence.

the purchasing power of the poor decreases, negatively impacting their standard of living. Again, trade openness, GDP per capita, and urbanization have all demonstrated a positive influence on human well-being. The coefficients of these variables indicate a reduction in under-five mortality and an increase in human development. These findings contradict the results reported by Redmond and Nasir (2020) and Erdogan et al. (2020). In addition to Table 8, the study presents the marginal effects of Models 2 and 4, as shown in Table 9. The inclusion of these marginal effects aims to provide a clearer understanding of the rate at which the welfare of Africans increased with the implementation of PIES.

The results in Table 9 reveal that the dependence on natural resources and policies and institutions for environmental sustainability has a complementary effect on increasing child mortality from the 5th to the 50th percentile by 0.053% to 0.015% and reducing human development by 0.023% to 0.005%. This indicates that for African countries to enhance their welfare, they need to significantly enhance their commitment to strengthening environmental sustainability rules and regulations aimed at protecting natural resources and reducing pollution, reaching at least the 75th percentile value. Furthermore, the analysis demonstrates that between the 75th and 99th percentile range, the complementary effect of PIES on natural resources significantly reduces under-five mortality by 0.023% and increases human development by 0.013%. Therefore, environmental sustainability must not be subject to political motivation, where corruption, rent-seeking, and poor management can be identified. Instead, it should be effectively managed to yield positive effects on child mortality rates and human development thus contributing to the overall well-being of the population.

4.6.1 | Placebo test for cross sectional dependence (GMM results)

Importantly, System-GMM is known for its ability to control for endogeneity resulting from possible simultaneity, omission of relevant variables, or measurement errors. However, it does not directly capture cross-section dependence in panel models. Nevertheless, to authenticate our findings, a residual test of the error term is required to see whether there exists cross-sectional dependence among economies (Pesaran & Xie, 2021). Given that there is a presence of cross-sectional dependence in (Table 4), it is reasonable to predict the residual from our GMM estimation models to test whether to reject the null hypothesis of weak cross-section dependence against the alternative of a strong cross-section dependence. While various tests are available to correct CSD such as Pesaran (2015) cross-section test (CD), Juodis and Reese (2022) weighted CD test, Fan et al. (2015) power enhancement CD test and the CDSTAR (CD*) test for Pesaran and Xie (2021), it is essential to choose an appropriate one. In light of this, we use the Pesaran and Xie (2021) test in Table 10 which corrects for biases that lead to endogeneity.

The test results from Table 10 show that there is no cross-sectional dependence when all possible biases are corrected. Therefore, we do not reject the null hypothesis of weak cross-sectional dependence, making our results consistent, and valid. This ensures that the estimated relationships between natural resource dependence, PIES, and welfare are reliable and robust.

4.7 | Heterogeneity analysis

Although the main estimations demonstrated a significant and welfare-improving effect when complemented with PIES and TNR (Tables 8 and 9), the analysis did not explicitly show the path of impact. As a consequence, this study attempts to disaggregate countries into low- and high-level policies and institutions for environmental sustainability. Specifically, countries below the mean value of PIES (3.17) are regarded as having low environmental sustainability, while those above the mean (3.17) are considered to have high environmental sustainability. This analysis is essential as it provides workable recommendations to governments and the United Nations, aiming to achieve the 2030 SDG on human health and well-being.

TABLE 11 Natural resource dependence, PIES and African welfare.

	High U_5M Model 1	HD1 Model 2	Low U_5M Model 3	HDI Model 4
lnU_5M_{t-1}	1.007***		1.009***	
	(0.00540)		(0.00745)	
HDI_{t-1}		0.986***		0.983***
		(0.00280)		(0.0137)
TNR	−0.00542	0.00116	0.00611	−0.00161
	(0.00417)	(0.00131)	(0.00711)	(0.00215)
PIES	0.00870***	0.00223	0.00570	0.00107
	(0.00243)	(0.00177)	(0.00398)	(0.00283)
TNR*PIES	−0.0142	0.00401**	−0.0168	0.00317
	(0.00874)	(0.00178)	(0.00997)	(0.00536)
FDI	−0.000732***	−0.000113	0.000622	−0.0000133
	(0.000139)	(0.000192)	(0.000527)	(0.0000351)
LnTO	0.0211**	−0.000512	−0.00667	0.00111
	(0.00840)	(0.00215)	(0.00835)	(0.00199)
lnGDP	−0.00177*	0.00106	−0.0000665	0.00162***
	(0.000927)	(0.000636)	(0.00145)	(0.000305)
lnCPI	0.0160***	−0.00420**	0.00798***	−0.00747***
	(0.00174)	(0.00157)	(0.00239)	(0.00197)
lnURBAN	0.0102	0.000989	−0.00938*	−0.000566
	(0.0102)	(0.00381)	(0.00532)	(0.00158)
Constants	−0.243***	0.0331**	−0.0789***	0.0440***
	(0.0346)	(0.0127)	(0.0263)	(0.00982)
No. obs	240	240	240	240

Note: *$p < .1$, **$p < .05$, ***$p < .01$ are the significance levels. Standard errors in parentheses are panel robust. U_5M, PIES, HDI, FDI, TO, GDP, CPI, and URBAN represent under-five mortality, total natural resources, rents, policy and institutions for environmental sustainability, human development index, foreign direct investment, trade openness, GDP per capita, consumer price index, population growth, and urbanization respectively. Models 1 and 2 represent the dependent variable, such as under 5 mortality and model 3 and 4 denote the human development index variable.

TABLE 12 Marginal effects results on the heterogeneous estimates.

Percentiles	Values	U_5M High Model 1A	Low Model 1B	HDI High Model 2A	Low Model 2B
5%	−.4755	0.001 (0.006)	0.014 (0.010)	−0.0007 (0.001)	−0.003 (0.004)
25%	−.4755	0.001 (0.006)	0.014 (0.010)	−0.0007 (0.001)	−0.003 (0.004)
50%	.0245	−0.006 (0.004)	−0.006 (0.007)	0.001 (0.001)	−0.002 (0.002)
75%	.5245	−0.013** (0.006)	−0.003 (0.007)	0.003* (0.001)	0.00005 (0.002)
99%	.5245	−0.013** (0.006)	−0.003 (0.007)	0.003* (0.001)	0.00005 (0.002)

Note: Standard errors in parentheses are panel robust, *$p < .1$, **$p < .05$, ***$p < .01$ denote the level of significance. U_5M denotes under-five mortality with two columns labeled High (Model1A) and Low (Model1B) representing countries with high and low policies and institutions for environmental sustainability, respectively. Similarly, HDI represents human development index mortality with two columns labeled High (Model 2A) and Low (Model 2B) representing countries with high and low policies and institutions for environmental sustainability, respectively.

Given this, the results in Table 11 confirmed that countries with high environmental sustainability experienced higher welfare than those with lower sustainability of natural resources, after controlling for other variables. However, this analysis becomes more intuitive with the estimation of the marginal effect in Table 12, as it helps determine the rate at which these differences exist.

Based on the marginal estimates, it is observed that under-five mortality starts to decrease at the 50th percentile level for both countries with high and low policies and institutions for environmental sustainability, though this change is not statistically significant. However, in contrast to countries with low PIES, those with high PIES experienced a significant improvement in welfare, as evidenced by a reduction in under-five mortality by 0.013% from the 75th to the 99th percentile. Likewise, when considering human development, countries with high PIES scores above the mean of 3.17 showed a notable increase in human capital development compared to those below the average point. This demonstrates that environmental sustainability can yield benefits by reducing under-five mortality and enhancing human development. As a result, African countries should prioritize restructuring their development policies to protect and promote the sustainable use of natural resources and effective pollution management. These findings strongly suggest that with robust institutions and policies in place, environmental sustainability can play a significant role in improving welfare across African nations.

5 | CONCLUSION

The primary objective of this study is to examine the impact of natural resource dependence, policies and institutions for environmental sustainability on African welfare. Utilizing panel data from 30 African countries spanning the period from 2005 to 2021 and employing the two-step dynamic generalized method of moments, our findings demonstrate that African countries heavily dependent on natural resources experience negative effects on welfare, specifically in terms of under-five mortality and human development. Moreover, we identify that the interaction between PIES and natural resource rents plays a significant role in reducing under-five mortality and promoting human capital development in Africa.

The empirical findings of this study have important policy implications. The implementation of PIES has proven effective in mitigating the negative impact of natural resource rents on welfare. It is evident that poor environmental management can lead to adverse health effects, increased poverty, and hinder the development of children. PIES acts as a mediator, leading to improved welfare in resource-dependent African countries. African nations should prioritize the efficient and sustainable use of natural resources by investing in water and sanitation infrastructure and embracing renewable energy. This will help reduce the hazards associated with an unsustainable environment. The connection between environmental changes and various health issues like diarrhea, malaria, pneumonia, and other infectious diseases underscores the criticality of protecting children's lives.

Therefore, it is recommended that African countries recognize the importance of implementing PIES to alleviate the adverse impact of natural resources on under-five mortality and human development. This is because to reach the sustainable development goal of decreasing under-five mortality to below 25 per 1000 live births by 2030, it is imperative for African leaders to allocate a substantial portion of resources to the healthcare sector for preventive measures. Not only that it is crucial to direct revenues toward initiatives that foster human growth and potential through human capital investment. By doing so, we can combat ignorance and promote sustainable progress and advancement, benefiting both the present and future generations. Investing in education, training, and skill development will empower individuals to actively participate in the pursuit of sustainability and contribute to Africa's long-term prosperity. Again, countries with strong PIES should continue strengthening their institutions responsible for natural resource management and pollution control, aiming for the general well-being of their citizens. Given the relevance of high PIES, countries with weaker PIES should stringent their environmental sustainability regulations to safeguard their natural resources and promote sustainable development for the people.

This study is not without limitations. First, it is important to acknowledge that the study assumed linear relationships among the variables of interest. However, considering that many of these variables may have nonlinear associations, it is essential to incorporate nonlinear analysis in future research. Second, the study did not extensively explore the long-term impact of natural resource rents and PIES on welfare in Africa. To address these gaps, we recommend that future studies focus on conducting in-depth analyses of these variables' long-run effects in Africa and beyond.

ORCID

Desmond Mbe-Nyire Mpuure https://orcid.org/0000-0003-1425-1604
Jennifer Dokbila Mengba https://orcid.org/0000-0003-3537-2501

REFERENCES

Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. *Handbook of Economic Growth*, *1*, 385–472. https://doi.org/10.1016/S1574-0684(05)01006-3

Andersen, J. J., & Ross, M. L. (2014). The big oil change: A closer look at the Haber–Menaldo analysis. *Comparative Political Studies*, *47*(7), 993–1021. https://doi.org/10.1177/0010414013488

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277–297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Asiamah, O., Agyei, S. K., Bossman, A., Agyei, E. A., Asucam, J., & Arku-Asare, M. (2022). Natural resource dependence and institutional quality: Evidence from sub-Saharan Africa. *Resources Policy*, *79*, 102967. https://doi.org/10.1016/j.resourpol.2022.102967

Ayesu, E. K., Sakyi, D., Arthur, E., & Osei-Fosu, A. K. (2022). The impact of trade on African welfare: Does seaport efficiency channel matter? *Research in Globalization*, *5*, 100098. https://doi.org/10.1016/j.resglo.2022.100098

Barbier, E. B. (2021). The evolution of economic views on natural resource scarcity. *Review of Environmental Economics and Policy*, *15*(1), 24–44. https://www.journals.uchicago.edu/doi/abs/10.1086/712926

Bejaković, P. (2018). Working together: Integration, institutions and the sustainable development goals, world public sector report 2018. *Public Sector Economics*, *42*(4), 487–494.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143.

Byaro, M., Nkonoki, J., & Mafwolo, G. (2023). Exploring the nexus between natural resource depletion, renewable energy use, and environmental degradation in sub-Saharan Africa. *Environmental Science and Pollution Research*, *30*(8), 19931–19945. https://link.springer.com/article/10.1007/s11356-022-23104-7

Daniele, V. (2011). Natural resources and the 'quality of economic development. *The Journal of Development Studies*, *47*(4), 545–573. https://doi.org/10.1080/00220388.2010.506915

Dietz, S., Neumayer, E., & De Soysa, I. (2007). Corruption, the resource curse and genuine saving. *Environment and Development Economics*, *12*(1), 33–53.

Dietz, T., & Rosa, E. A. (1994). Rethinking the environmental impacts of population, affluence and technology. *Human Ecology Review*, *1*(2), 277–300. https://www.jstor.org/stable/24706840

Dramani, J. B., Abdul Rahman, Y., Sulemana, M., & Owusu-Takyi, P. (2022). Natural resource dependence and economic growth in SSA: Are there threshold effects? *Development Studies Research*, *9*(1), 230–245. https://doi.org/10.1080/21665095.2022.2112728

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, *80*(4), 549–560. https://doi.org/10.1162/003465398557825

Duodu, E., & Mpuure, D. M. N. (2023). International trade and environmental pollution in sub-Saharan Africa: Do exports and imports matter? *Environmental Science and Pollution Research*, *30*(18), 53204–53220. https://link.springer.com/article/10.1007/s11356-023-26086-2

Duodu, E., Oteng-Abayie, E. F., Frimpong, P. B., & Takyi, P. O. (2022). The impact of the compact with Africa initiative on foreign direct investments and environmental pollution. *Management of Environmental Quality*, *33*(6), 1457–1475. https://doi.org/10.1108/MEQ-01-2022-0011

Ebeke, C., Omgba, L. D., & Laajaj, R. (2015). Oil, governance and the (mis) allocation of talent in developing countries. *Journal of Development Economics*, *114*, 126–141. https://doi.org/10.1016/j.jdeveco.2014.12.004

Erdogan, S., Yıldırım, D. Ç., & Gedikli, A. (2020). Natural resource abundance, financial development and economic growth: An investigation on Next-11 countries. *Resources Policy*, *65*, 101559. https://doi.org/10.1016/j.resourpol.2019.101559

Fan, J., Liao, Y., & Yao, J. (2015). Power enhancement in high-dimensional cross-sectional tests. *Econometrica*, *83*, 1497–1541.

Fosu, A., & Gafa, D. (2019). Natural resources, institutions and economic development in Africa. *African Review of Economics and Finance*, *11*(1), 29–52.

Gelb, A. H. (1988). *Oil windfalls: Blessing or curse?* Oxford university press.

Guilló, M. D., & Perez-Sebastian, F. (2015). Neoclassical growth and the natural resource curse puzzle. *Journal of International Economics*, *97*(2), 423–435. https://doi.org/10.1016/j.jinteco.2015.06.002

Gylfason, T. (2001). Natural resources, education, and economic development. *European Economic Review*, *45*(4–6), 847–859. https://doi.org/10.1016/S0014-2921(01)00127-1

Holtz-Eakin, D., Newey, W., & Rosen, H. S. (1988). Estimating vector autoregressions with panel data. *Econometrica: Journal of the Econometric Society*, *56*, 1371–1395. https://www.jstor.org/stable/1913103

Iheonu, C. O., Anyanwu, O. C., Odo, O. K., & Nathaniel, S. P. (2021). Does economic growth, international trade, and urbanization uphold environmental sustainability in sub-Saharan Africa? Insights from quantile and causality procedures. *Environmental Science and Pollution Research*, *28*, 28222–28233. https://link.springer.com/article/10.1007/s11356-021-12539-z

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

James, A., & Aadland, D. (2011). The curse of natural resources: An empirical investigation of US counties. *Resource and Energy Economics*, *33*(2), 440–453. https://doi.org/10.1016/j.reseneeco.2010.05.006

Juodis, A., & Reese, S. (2022). The incidental parameters problem in testing for remaining cross-section correlation. *Journal of Business Economics and Statistics*, *40*(3), 1191–1203.

Khasnis, A. A., & Nettleman, M. D. (2005). Global warming and infectious disease. *Archives of Medical Research*, *36*(6), 689–696. https://doi.org/10.1016/j.arcmed.2005.03.041

Kim, D. H., & Lin, S. C. (2017). Natural resources and economic development: New panel evidence. *Environmental and Resource Economics*, *66*(2), 363–391. https://link.springer.com/article/10.1007/s10640-015-9954-5

Kirikkaleli, D., & Adebayo, T. S. (2021). Do renewable energy consumption and financial development matter for environmental sustainability? New global evidence. *Sustainable Development*, *29*(4), 583–594. https://doi.org/10.1002/sd.2159

Lessmann, C., & Steinkraus, A. (2019). The geography of natural resources, ethnic inequality and civil conflicts. *European Journal of Political Economy*, *59*, 33–51. https://doi.org/10.1016/j.ejpoleco.2019.01.005

Lotfalipour, M. R., & Salehnia, N. (2022). Natural resources: A curse on welfare? *Resources Policy*, *79*, 103056. https://doi.org/10.1016/j.resourpol.2022.103056

Nchofoung, T. N., & Ojong, N. (2023). Natural resources, renewable energy, and governance: A path towards sustainable development. *Sustainable Development*, *31*(3), 1553–1569. https://doi.org/10.1002/sd.2466

Noumba, I., Noula, A. G., & Nguea, S. M. (2022). Do globalization and resource rents matter for human well-being? Evidence from African countries. *International Economics*, *170*, 49–65. https://doi.org/10.1016/j.inteco.2022.02.004

Ntajal, J., Höllermann, B., Falkenberg, T., Kistemann, T., & Evers, M. (2022). Water and health nexus—Land use dynamics, flooding, and water-borne diseases in the Odaw River basin Ghana. *Water*, *14*(3), 461 https://www.mdpi.com/2073-4441/14/3/461

Oduyemi, G. O., Owoeye, T., & Adekoya, O. B. (2021). Health outcomes and the resource curse paradox: The experience of African oil-rich countries. *Resources Policy*, *73*, 102201. https://doi.org/10.1016/j.resourpol.2021.102201

Oteng-Abayie, E. F., Duodu, E., Mensah, G., & Frimpong, P. B. (2022). Natural resource abundance, environmental sustainability, and policies and institutions for environmental sustainability in sub-Saharan Africa. *Resources Policy*, *79*, 103097. https://doi.org/10.1016/j.resourpol.2022.103097

Papyrakis, E. (2017). The resource curse-what have we learned from two decades of intensive research: Introduction to the special issue. *The Journal of Development Studies*, *53*(2), 175–185. https://doi.org/10.1080/00220388.2016.1160070

Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, *34*(6–10), 1089–1117. https://doi.org/10.1080/07474938.2014.956623

Pesaran, M. H., & Xie, Y. (2021). A bias-corrected cd test for error cross-sectional dependence in panel data models with latent factors. CESifo: Economics of Digitization (Topic). CESifo Working Paper No. 9234. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3904536

Redmond, T., & Nasir, M. A. (2020). Role of natural resource abundance, international trade and financial development in the economic development of selected countries. *Resources Policy*, *66*, 101591. https://doi.org/10.1016/j.resourpol.2020.101591

Rjoub, H., Ifediora, C. U., Odugbesan, J. A., Iloka, B. C., Xavier Rita, J., Dantas, R. M., … Martins, J. M. (2021). Implications of governance, natural resources, and security threats on economic development:

Evidence from sub-Saharan Africa. *International Journal of Environmental Research and Public Health*, *18*(12), 6236. https://doi.org/10.3390/ijerph18126236

Sachs, J. D., & Warner, A. (1995). *Natural resource abundance and economic growth*. NBER Working Paper Series. https://www.nber.org/papers/w5398

Sebri, M., & Dachraoui, H. (2021). Natural resources and income inequality: A meta-analytic review. *Resources Policy*, *74*, 102315. https://doi.org/10.1016/j.resourpol.2021.102315

Sharma, C., & Paramati, S. R. (2022). Resource curse versus resource blessing: New evidence from resource capital data. *Energy Economics*, *115*, 106350. https://doi.org/10.1016/j.eneco.2022.106350

Sinha, A., & Sengupta, T. (2019). Impact of natural resource rents on human development: What is the role of globalization in Asia Pacific countries? *Resources Policy*, *63*, 101413. https://doi.org/10.1016/j.resourpol.2019.101413

Smith, A. (1975). *The theory of international trade* (p. 472). Essays on Adam Smith. Clarendon Press.

Tadadjeu, S., Njangang, H., Asongu, S., & Kamguia, B. (2021). Natural resources, child mortality and governance quality in African countries. *Resources Policy*, *83*, 103702. https://mpra.ub.uni-muenchen.de/id/eprint/110597

Tadadjeu, S., Njangang, H., Ningaye, P., & Nourou, M. (2020). Linking natural resource dependence and access to water and sanitation in African countries. *Resources Policy*, *69*, 101880. https://doi.org/10.1016/j.resourpol.2020.101880

Tarrass, F., & Benjelloun, M. (2012). The effects of water shortages on health and human development. *Perspectives in Public Health*, *132*(5), 240–244. https://doi.org/10.1177/1757913910391040

United Nations. (2018). Working together: Integration, institutions and the sustainable development goals, world public sector report 2018, division for public administration and development management, Department of Economic and Social Affairs, (DPADM), New York. publicadministration.un.org

United Nations Development Programme (UNDP) (2022). *Human development report 2021/2022: Uncertain times, unsettled lives: Shaping our future in a transforming world*. Access All Data - UNDP Data Futures Platform. http://hdr.undp.org/en/data

Van Der Ploeg, F., & Poelhekke, S. (2017). The impact of natural resources: Survey of recent quantitative evidence. *The Journal of Development Studies*, *53*(2), 205–216. https://doi.org/10.1080/00220388.2016.1160069

World Development Indicators (WDI). (2022). Washington DC, world bank. https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators

World Health Organization. (2019). *Progress on household drinking water, sanitation and hygiene 2000–2017: Special focus on inequalities*. World Health Organization.

World Health Organization(2020), Child mortality (under 5 years) https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

Zakari, A., Li, G., Khan, I., Jindal, A., Tawiah, V., & Alvarado, R. (2022). Are abundant energy resources and Chinese business a solution to environmental prosperity in Africa? *Energy Policy*, *163*, 112829. https://doi.org/10.1016/j.energy.2022.123619

AUTHOR BIOGRAPHIES

Desmond Mbe-Nyire Mpuure is a PhD student at the University of Alicante, Spain. He holds an MPhil and MSc (Quantitative Economics) in Economics from the Kwame Nkrumah University of Science and Technology (KNUST, Ghana), and the former university. His primary research disciplines are Environmental Economics, Applied Microeconomics and Development, and International Trade and Finance.

Jennifer Dokbila Mengba is a PhD student at Uppsala University, Sweden. She holds an MPhil in Planning from the Kwame Nkrumah University of Science and Technology (KNUST), Ghana. Her research covers gender, mining, water resource management and local governance.

How to cite this article: Mpuure, D. M.-N., & Mengba, J. D. (2024). Natural resource dependence, policy and institutions for environmental sustainability and African welfare. *Sustainable Development*, *32*(3), 2176–2193. https://doi.org/10.1002/sd.2752