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The Spatial Spillover Effect of Institutional Quality on the Path to Sustainable Socioeconomic Development in Africa

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ABSTRACT

Africa's sustainable socioeconomic development is increasingly challenged by institutional disparities, where weak governance undermines progress in human capital indicators such as life expectancy and educational attainment. Despite recognition of institutional quality's role in fostering transparency, accountability, and stability, existing research often overlooks its spatial spillover effects across interconnected African nations. This study aims to examine the direct and spillover impacts of institutional quality proxied by transparency (corruption perception), rule of law, and political stability on life expectancy and mean years of schooling in 42 African countries over the period 2012–2022. Employing spatial panel econometric models, including the Spatial Durbin Model (SDM), Spatial Autoregressive Model (SAR), and Spatial Error Model (SEM), the analysis controls for GDP per capita and population growth. The results reveal significant positive spatial autocorrelation in both outcomes (Moran's I: 0.536 for life expectancy; 0.469 for schooling). For life expectancy, institutional quality (particularly the rule of law) exhibits strong positive direct and spillover effects, amplified by regional GDP and population dynamics, indicating that governance improvements in one country enhance health outcomes in neighbors through policy diffusion and cross-border cooperation. In contrast, educational attainment shows no significant spillovers, driven primarily by domestic GDP, population, and rule of law, highlighting fragmented regional education systems. These findings underscore institutional quality as a regional public good, offering nuanced insights for harnessing spatial interdependence in Africa's development agenda.

1 | Introduction

The interplay of structural, political, and economic transformations in Africa increasingly relies on the robustness and coherence of its institutions, which underpin inclusive growth, development, and stability. The caliber of institutions, evaluated through transparency, accountability, rule of law, and political stability, has been acknowledged as a crucial factor for effective governance, poverty alleviation, policymaking, and resource allocation (Babatunde and Afolabi 2024). Life expectancy and years of schooling are two fundamental social outcomes that reflect human development and societal well-being (Fomba et al. 2022). These indicators are closely linked to institutional quality, which determines the effectiveness of public service delivery systems such as healthcare and education across African countries. Improvements in institutional quality increase transparency, reduce corruption, and enhance political stability, which in turn improve the accessibility and quality of healthcare

and educational services (Gebrihet et al. 2024). Therefore, institutional quality plays a key role in impacting these critical social outcomes in the continent's sustainable development journey.

Institutional quality possesses a global dimension, transcending national borders, and exhibits significant spatial spillovers, whereby reforms or failures in one country influence the developmental outcomes in adjacent countries. Externalities emerge through international trade, shared infrastructure, regional governance institutions, and transboundary migration. Thus, institutional quality is regarded as a regional public good with significant ramifications for Africa's economic development (Ahmad and Law 2024; Degbedji et al. 2024). This spatial aspect is particularly important when considering geographically interconnected social outcomes like life expectancy and years of schooling, which are influenced by policy diffusion and institutional learning across borders.

Institutional quality primarily pertains to the capacity of public and political institutions to formulate and implement laws, maintain order, mitigate corruption, and provide public services with transparency and accountability (Sun et al. 2021; Erin et al. 2024). Empirical research demonstrates a positive correlation between institutional quality and economic development, including growth, poverty alleviation, health improvements, and education outcomes (Hunjra et al. 2023; Kpegba et al. 2024). The considerable disparity in institutional performance across Africa results in uneven progress in social outcomes. Countries with superior institutions typically display better human capital development, fiscal stability, and ecological management (Humphrey 2017; Babatunde and Afolabi 2024). Conversely, weak institutions contribute to vulnerability, exclusion, and governance deficits.

Spatial spillover effects describe the degree to which the institutional quality of one nation affects that of neighboring nations. Ahmad and Law (2024), using spatial econometric techniques like the spatial Durbin model, show that stronger political and financial institutions in one African country significantly correlate with improved governance and economic growth in adjacent countries. Sun et al. (2021) similarly show that improvements in governance can generate spatial spillovers in energy efficiency across African economies, indicating that institutional reforms may transmit benefits beyond national borders. Such findings reveal that institutional reforms can cascade across borders via trade agreements, policy alignments, and collective institutional learning, thus amplifying social and economic benefits regionally. This implies that the improvement of life expectancy and educational attainment in one country may spillover and positively impact neighboring countries' social development. However, these studies predominantly focus on macroeconomic or energy-related outcomes, leaving open important questions regarding the spatial transmission of governance effects on core human capital indicators.

Despite these insights, extant research often examines institutional spillovers in isolation, focusing primarily on economic growth or sector-specific performance rather than systematically analyzing human capital indicators such as life expectancy and mean years of schooling within a unified spatial framework. While Ahmad and Law (2024) apply spatial econometric frameworks to analyze governance spillovers on economic growth across African countries, and Sun et al. (2021) investigate spatial governance effects on energy efficiency in the continent, no prior study has concurrently examined the direct and spatial spillover effects of disaggregated institutional quality measures—specifically public sector transparency, rule of law, and political stability—on both life expectancy and mean years of schooling using the Spatial Durbin Model (SDM), Spatial Autoregressive Model (SAR), and Spatial Error Model (SEM) across a panel of 42 African countries from 2012 to 2022. Furthermore, existing spatial-governance studies rarely employ sustainability-adjusted human development indicators. In contrast, this study derives life expectancy and years of schooling from the Sustainable Development Index (SDI), thereby embedding ecological constraints into the measurement of human development and explicitly situating governance-human linkages within a sustainability-oriented framework (SDI 2025). By integrating SDI-based proxies with a continent-wide spatial panel design, the analysis is able to uncover not only whether institutional quality matters, but also how it affects diffuse geographically across countries that share economic, political, and environmental interdependencies.

Building on this gap, this research employs spatial panel regression models to analyze how institutional quality, including public sector transparency, rule of law, and political stability, impacts life expectancy and years of schooling across 42 African countries, while explicitly decomposing direct and spatial spillover effects and controlling for GDP per capita and population growth. The study also documents and interprets the asymmetric nature of these spillovers, showing that institutional quality generates strong regional externalities for health outcomes, whereas educational attainment is driven mainly by domestic conditions and displays limited spatial diffusion. Accordingly, the study reframes its focus into the following research questions (RQ):

RQ1. *Does institutional quality have a spillover influence on life expectancy and years of schooling in African countries?*

RQ2. *What mechanisms drive spatial spillover effects of governance reforms on social outcomes?*

RQ3. *How can regional institutional collaboration enhance sustainable social development in Africa?*

This study contributes explicitly to academic and policy literature. First, it jointly quantifies the direct and spillover impact of disaggregated institutional quality on SDI-based life expectancy and educational attainment using advanced spatial econometric methods in the African context (SDI 2025; Ahmad and Law 2024). Second, the study provides empirical evidence on the asymmetric nature of these spillover effects on health and education outcomes, thereby offering nuanced insights into sector-specific transmission channels of governance reforms that are not captured in prior spatial studies focused mainly on economic or energy outcomes (Sun et al. 2021; Gebrihet et al. 2024). Third, this study employs a comprehensive set of spatial econometric specifications, including the Spatial Durbin Model (SDM), the Spatial Autoregressive model (SAR), and the Spatial Error Model (SEM), following the statistically significant results of Moran's I

test for spatial autocorrelation. This approach provides a robust assessment of how governance operates as a regional public good (Kassouri 2021; Kuşkaya et al. 2025). Finally, it offers actionable insights for policymakers to leverage spatial interdependence through regional frameworks like the African Union's Agenda 2063 to advance sustainable human development across the continent. Combining governance studies, development economics, and geographical analysis, this research melds comprehensive panel data with spatial econometric modeling to elucidate the institutional quality as both a national imperative and a regional public good (Degbedji et al. 2024).

The organization of subsequent sections is presented as follows: Section 2 reviews the literature on the subject. Section 3 highlights the theoretical framework of the study. Section 4 describes the estimation strategy and data. Section 5 yields empirical findings and discussion. The final section delineates the conclusion and policy recommendation.

2 | Literature Review

Institutional quality refers to the potential of the public sector to effectively make decisions, implement policies, and manage public resources in a manner that is transparent, participatory, and accountable. A strong public sector facilitates the equitable and efficient exploitation of educational resources, thereby enhancing the impact of educational investments. Moreover, transparent institutions can significantly reduce income inequalities, keep corruption in check, and enhance public healthcare services via rational spending. In this part, we comprehensively discuss relevant literature examining the relationship between institutional quality and various socioeconomic indicators.

2.1 | Institutional Reforms and Healthcare Service Quality

Empirically, Vian (2020) and Mackey et al. (2018) examined the critical role of transparency and accountability within health systems, emphasizing their influence on the overall quality of healthcare delivery. Their findings underscore that pervasive issues such as bribery, corruption, and unethical procurement practices contribute significantly to the misallocation of resources and deterioration in the standard of public health services. Similarly, Beblavý et al. (2022), Lindoso et al. (2021), and Waddington et al. (2019) underscored the significance of citizen engagement and mechanisms of social accountability as vital components in improving the quality and responsiveness of healthcare services. Additionally, Nazar et al. (2022) asserted that non-transparent trade practices undermine the strategic planning capabilities of health systems and pose a serious threat to the equitable realization of the right to healthcare access.

Furthermore, Hunter et al. (2020), Irtyshcheva et al. (2022), and Siddiqi et al. (2020) emphasized that transparency-oriented public administration plays a key role in mitigating corruption risks and enhancing the overall quality and efficiency of healthcare service delivery. Naher et al. (2020) conducted an in-depth analysis focused on South and Southeast Asia, concluding that challenges such as bribery, informal payments, and limited transparency significantly undermine the quality and effectiveness of healthcare service provision in the region. Lastly, Locke et al. (2025) conducted a comprehensive assessment of how transparency is integrated into sustainability initiatives within the U.S. healthcare system. Their findings revealed that practices associated with "greenwashing" compromise public perceptions of transparency in the public sector and negatively influence the quality and credibility of healthcare services in the United States.

2.2 | Institutional Reforms and Education Quality

Ríos et al. (2024) applied multiple linear regression analysis across 84 municipalities in Spain and found that the transparent and open implementation of education policies by municipalities facilitates public oversight, ensures more equitable service planning, and promotes equal educational opportunities. Similarly, Gabriel and Castillo (2020) measured the levels of accountability and transparency in the public sector, emphasizing their role in easing the integration of disadvantaged groups into the education system, reinforcing local-level equal opportunity, and contributing to the improvement of educational infrastructure. De Guimarães et al. (2020), through Structural Equation Modeling (SEM) in Brazil, demonstrated that access to education services, information availability, and digital participation are directly linked to quality of life, highlighting that individuals with higher education levels tend to have more pronounced expectations of public transparency.

Guha and Chakrabarti (2019) and Irtyshcheva et al. (2022) argued that transparent practices in the public sector ensure the effective utilization of educational resources and enhance the implementation of education policies. Erin et al. (2024), applying the Generalized Method of Moments (GMM) in African countries, identified the significant role of public transparency in improving access to education services, resource allocation, and service quality. Glass and Newig (2019) noted that transparency in public administration contributes indirectly to education performance by ensuring fair distribution of resources and improving service delivery quality. Guerrero-Gómez et al. (2021) and Meschede (2019) emphasized that transparency in municipal administration enhances educational performance and resource efficiency. Lastly, Waas et al. (2010) found that transparent governance in public educational institutions positively impacts academic outcomes and strategic planning.

2.3 | Institutional Quality and Income

Erin et al. (2024), using the Generalized Method of Moments to analyze the impact of public sector transparency on economic development in Sub-Saharan African countries, found that transparent governance supports economic growth by ensuring the effective and efficient utilization of public resources. Similarly, Abhayawansa et al. (2021), Donald and Way (2016), Glass and Newig (2019), Joseph et al. (2019), and Villa and Villa (2023) stated that increased transparency in the public sector simplifies tax revenue collection, ensures more efficient and equitable resource allocation, and enhances economic welfare by reducing income inequalities.

Govindan et al. (2020) highlighted that a lack of public sector transparency negatively affects economic growth and income generation processes.

García-Sánchez et al. (2020), through regression analyses examining the sustainability performance of state-owned enterprises, identified the lack of financial transparency as a fundamental obstacle to the economic productivity of public institutions. They revealed that increased transparency enhances companies' financial performance and expands economic activities that contribute to public revenues. Guha and Chakrabarti (2019) demonstrated that transparent and participatory practices at the local level facilitate the effective use of public revenues and improve economic participation. Vanegas Cantarero (2020) and Glass and Newig (2019) emphasized that institutional accountability balances budget processes, enhancing economic stability and revenue-generating capacity. Waddington et al. (2019) found that transparency reforms ease resource allocation processes, while Edwards and Romero (2014) concluded that reducing corruption and resource waste enables the utilization of public funds for developmental objectives.

3 | Theoretical Underpinnings

The theoretical foundation of this research is rooted in institutional economics and human capital theory, providing a framework to understand how governance structures influence sustainable socioeconomic development in Africa. Institutional economics, as advanced by North (1990) and Acemoglu and Robinson (2013), emphasizes that high-quality institutions, defined by transparency, accountability, rule of law, and political stability, reduce transaction costs, curb corruption, and enable efficient resource allocation, thereby fostering inclusive growth and poverty alleviation. In the African context, weak institutions exacerbate disparities in public service delivery, such as healthcare and education, which are critical for human development. Complementing this, human capital theory (Becker 1964; Schultz 1961) posits that investments in health (measured by life expectancy) and education (mean years of schooling) enhance productivity and societal well-being. Institutions play a mediating role by ensuring equitable access to these services, aligning with the SDGs 3 and 4 and the Sustainable Development Index (SDI), which integrates ecological constraints to promote resilient progress within planetary boundaries.

To integrate these perspectives more cohesively, it is essential to recognize the interplay between institutional economics, human capital theory, and spatial spillovers through mechanisms such as institutional complementarities and cross-border institutional diffusion. Institutional complementarities occur when governance structures at the national level, such as robust legal frameworks and anti-corruption measures, reinforce human capital investments by creating stable environments for education and health initiatives to thrive. At the same time, cross-border institutional diffusion allows best practices in governance to spread across neighboring countries via regional agreements, trade partnerships, or migration flows, aligning directly with spatial dependence where the institutional quality in one nation influences outcomes in adjacent ones. Governance thus operates simultaneously at national levels (e.g., country-specific policies on education funding) and regional levels (e.g., shared protocols under the African Continental Free Trade Area), amplifying human capital spillovers and addressing asymmetries in development. This multifaceted operation underscores the empirical motivation for examining not only direct institutional impacts but also indirect spatial effects, facilitating a seamless transition to spatial econometric approaches.

Building on these integrated foundations, the study incorporates spatial economics and spillover theory (Anselin 1988; LeSage and Pace 2009) to address the regional interdependence inherent in Africa's geography. Institutional quality is conceptualized as a regional public good, where governance reforms in one country generate externalities through trade, migration, policy diffusion, and shared infrastructure that impact neighboring nations' outcomes. This spatial perspective highlights asymmetries in development, where interconnectedness can amplify benefits from institutional improvements but also propagate failures, justifying the use of spatial econometric models like the Spatial Durbin Model to quantify direct and indirect effects. Such an integrated lens bridges gaps in prior literature, emphasizing regional cooperation under frameworks like the African Union's Agenda 2063 to harness spillovers for continent-wide sustainability.

4 | Estimation Strategy and Data

This research investigates the spatial spillover effects of institutional quality proxied by public sector transparency, rule of law, and political stability across 42 African countries (country list in the appendix, Table A1), while controlling for economic and population growth. To this end, the study employs several spatial panel regression models, including the Spatial Durbin Model, Spatial Autoregressive Model, and Spatial Error Model. This section outlines the process of implementing spatial econometric models by integrating QGIS (shapefile extraction), GeoDa (spatial weight matrix construction and spatial autocorrelation testing), and Stata software (spatial panel regression estimation). The rationale for applying spatial spillover models lies in the geographical interdependence of African countries in economic, social, and political dimensions. Such interdependencies increase these countries' vulnerability to external influences, particularly in areas of sustainable socioeconomic development such as health, education, and labor market infrastructure. Therefore, spatial modeling serves as a vital tool for capturing the patterns and magnitudes of spatial dependencies among African countries.

4.1 | Spatial Weight Matrix

Constructing a spatial weight matrix is an essential procedure in the estimation of spatial panel regression. This matrix is an exogenous parameter, used to quantify the degree of geographical interdependence between countries i and j within the study sample. To define spatial relationships and assign corresponding weights, this study utilizes the widely used

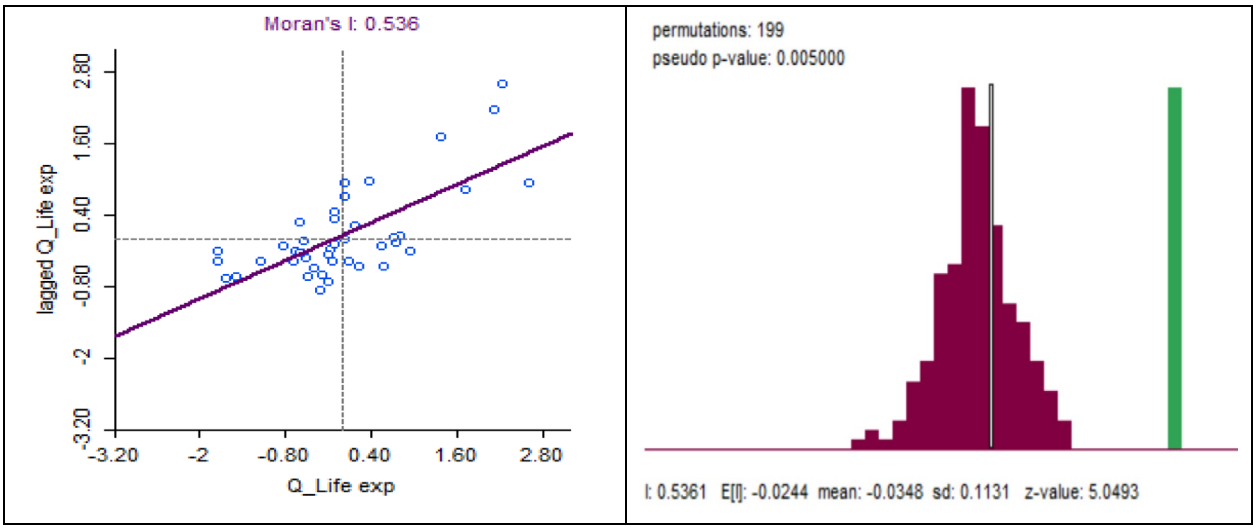

FIGURE 1 | Spatial autocorrelation test for life expectancy rate using Moran's Index. The results reveal a significant (pseudo *p*-value of 0.005) positive spatial dependence, with a Moran's I value of 0.536, indicating that countries with high (low) life expectancy tend to be geographically clustered with other countries exhibiting similarly high (low) values. Overall, the findings suggest the presence of significant regional clustering in life expectancy across African countries, justifying the use of spatial econometric approaches in further analysis.

Queen contiguity spatial weight matrix, constructed using a first-order Queen contiguity criterion, where two spatial units are considered neighbors if they share either a common boundary or a common vertex. In this framework, a weight of 1 is assigned to countries that are geographically contiguous, sharing either a common boundary or a single point, while a weight of 0 is assigned to non-contiguous countries. In the following equation, W is an adjacent order matrix with $n \times$ n spaces.

$$W_{ij} = \begin{cases} 1, \text{countries i and j are neighboring countries} \\ 0, \text{countries i and j are not neighboring countries} \end{cases} \quad (1)$$

This technique can identify a larger set of neighboring units, thereby capturing broader and more realistic spatial interactions. In this regard, Figures A1 and A2 in the Appendix clearly illustrate this feature by comparing the number of neighbors generated under the Queen contiguity criterion with those obtained using alternative spatial weight matrices, such as the Rook contiguity criterion. As mentioned by Anselin (1988), the Queen contiguity matrix is better suited to capturing spatial spillovers, as it reduces the likelihood of isolated regions and yields more robust spatial models, particularly when the underlying processes diffuse through both shared borders and points of contact. Consistent with this view, recent empirical studies in spatial analysis have largely employed the Queen contiguity matrix due to the aforesaid advantages (Guo et al. 2025; Hossain et al. 2025).

4.2 | Spatial Autocorrelation

Upon specifying the weight matrix, testing the spatial dependency (autocorrelation) is vital. This study uses Global Moran's Index to test the possible existence of correlation for the dependent variables (education and life expectancy). Moran's Index is widely utilized in the literature of spatial research to detect and evaluate the degree of spatial autocorrelation among the observational units in a given spatial dataset (Kassouri 2021). With reference to Moran (1948), the global Moran's Index is specified as follows:

$$Moran's\ I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}(u_i - \overline{u})(u_j - \overline{u})}{s^2 \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}} \quad (2)$$
$$\forall i = 1, \ldots, n \wedge \forall j = 1, \ldots, n$$

where;

$$\overline{u} = \frac{1}{N} \sum_{i=1}^{n} u_i, s^2 = \frac{1}{N} \sum_{i=1}^{n} (u_i - \overline{u})^2 \quad (3)$$

where u_i and u_j correspondingly indicate the dependent variables (socioeconomic outcomes) in the countries i and j. n indicates the number of spatial units in the study sample. W_{ij} represent the factors of spatial weights relating unit i and j such that $W_{ij} = 1$ when countries are neighbors, and $W_{ij} = 0$ when the spatial units (countries) share no common borders. Accordingly, the magnitude of spatial autocorrelation among the units is determined by the absolute value of Moran's I statistic, with higher values indicating stronger spatial dependence. Moran's Index is explained under the null hypothesis of no spatial autocorrelation. It is computed by the Z-score approach within the context of a standard normal distribution with $\mu = 0$ and $\sigma\ \sigma = 1$ (Kassouri 2021; Kuşkaya et al. 2025). Figure 1 presents the results of spatial autocorrelation for our models using Moran's Index. The Moran's Index for life expectancy is 0.536, indicating a significant positive spatial autocorrelation at the 1% level (*p*-value: 0.005). Similarly, Figure 2 reports a Moran's I value of 0.469 for mean years of education, also showing a positive and significant spatial autocorrelation among African countries. These findings suggest that achieving sustainable socioeconomic development in African

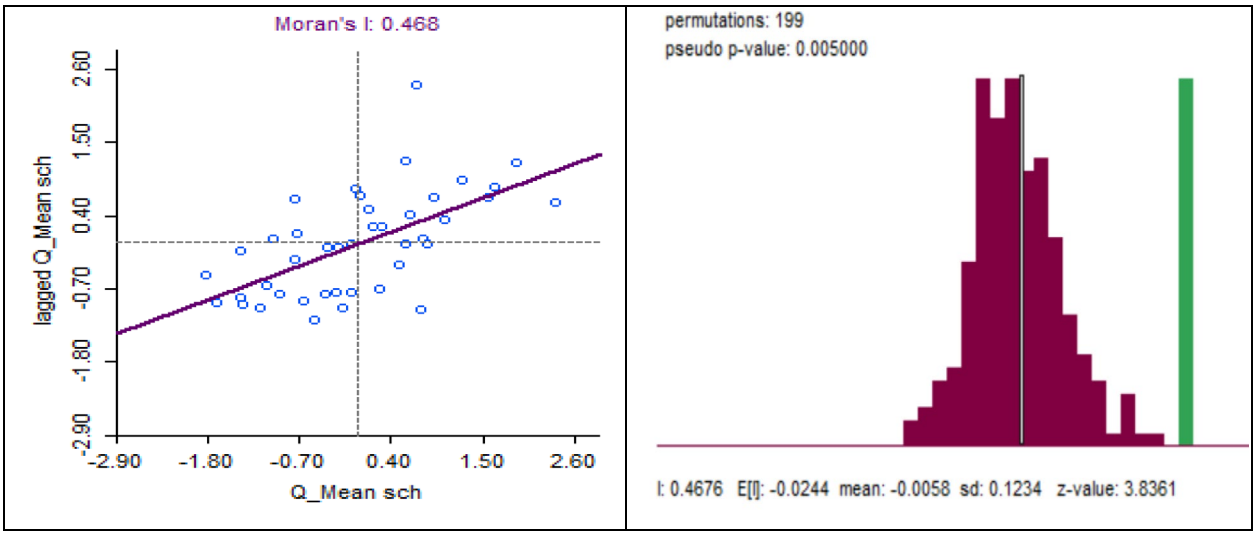

FIGURE 2 | Spatial autocorrelation test for years of schooling using Moran's Index. The results indicate a significant (pseudo *p*-value of 0.005) positive spatial dependence, with a Moran's I value of approximately 0.468, suggesting that countries with higher (lower) average years of schooling tend to be geographically clustered with countries exhibiting similar educational outcomes. The observed Moran's I is far from the expected value under spatial randomness (−0.024), yielding a statistically significant z-value, confirming the presence of significant regional clustering in educational attainment across African countries.

countries requires coordinated efforts, given their geographical interlinkages.

4.3 | Spatial Panel Models

To test for the spillover effects of institutional quality on sustainable socioeconomic development, we employed three spatial panel regressions, namely, the Spatial Autoregressive Model, Spatial Error Model, and Spatial Durbin Model (SDM) (Abban et al. 2023). It is worth mentioning that, in the spatial analysis, the endogenous variables (life expectancy rate and education) are influenced not only by changes in the explanatory variables within a given country captured by the direct effects but also by changes in those variables in neighboring countries, which are reflected through the indirect (spillover) effects. Specifically, while the direct impact measures the influence of domestic factors, the indirect impact captures how external factors in adjacent countries affect domestic sustainable socioeconomic development outcomes.

4.3.1 | Spatial Autoregressive Regression (SAR)

Following Kassouri (2021), the spatial autoregressive model takes the following form:

$$z_{it} = \alpha + \lambda \Sigma_{j=1} W z_{jt} + \Sigma_k x_{it}^{(k)} \delta_k + \mu_i + \vartheta_t + \varepsilon_{it} \quad (4)$$

where z_{it} is representing the dependent variables for country $i = 1, 2, \ldots N$. At time $t = 1, 2, \ldots . T$. x_{it} is a $k \times 1$ vector of independent variables. W *is a* row-normalized weight matrix, Wz_{jt} detects the interaction effects of the dependent variables in neighboring countries on the dependent variable z_{it}, and λ represents the strength and direction of spatial interaction between one country and its geographical proximity countries. μ_i and ϑ_t indicate the spatial specific effects and time-period effects.

4.3.2 | Spatial Error Model (SEM)

In SEM, the stochastic term of country i is hypothesized to rely on the error terms of neighboring countries j according to the spatial weight matrix (W) and an idiosyncratic component e_{it}. The specification of the spatial error model takes the following form:

$$\boldsymbol{z_{it}} = \boldsymbol{\alpha} + \lambda \Sigma_{j=1} W z_{jt} + \Sigma_k x_{it}^{(k)} \delta_k + \mu_i + \vartheta_t + e_{it} \quad (5)$$

where $e_{it} = \phi \Sigma j = 1 \text{Wejt} + \varepsilon_{it}$. In the above equation, the spatial interactions are incorporated in the error term. Wejt indicates the geographical interactions among the disturbances of the different units under examination.

4.3.3 | Spatial Durbin Model (SDM)

To reflect the spatial interactions in both dependent and independent variables, the spatial Durbin model was developed. The spatial Durbin model is specified as follows:

$$\boldsymbol{z_{it}} = \boldsymbol{\alpha} + \lambda \Sigma_{j=1} W z_{jt} + \Sigma_k x_{it}^{(k)} \delta_k + \Sigma_{j=1} W x_{jt}^{(k)} \theta_k + \mu_i + \vartheta_t + \eta_{it} \quad (6)$$

where θ is a $k \times 1$ vector of parameters to be estimated. η_{it} is the disturbance term. Given the inconsistency of fixed effects and random effects models since they include spatial interactions, this study utilizes maximum likelihood estimation. For geographic econometric models, the most widely used regression technique is the maximum likelihood methodology (Alnour

TABLE 1 | Data description.

Variable	Definition	Source
EXP	Life Expectancy Rate, disaggregated from Overall SDI	Sustainable Development Index Organization: https://www.sustainabledevelopmentindex.org/
SCHO	Years of Education, extracted from the Total Sustainable Development Index	Sustainable Development Index Organization: https://www.sustainabledevelopmentindex.org/
CPI	Corruption Perceptions Index. A global ranking measuring the perceived levels of public sector corruption in countries. A country's score is the perceived level of public sector corruption on a scale of 0–100, where 0 means highly corrupt and 100 means very clean.	Transparency International: The Global Coalition against Corruption: https://www.transparency.org/en/cpi/2024
GDPPC	Gross Domestic Product, per capita (constant 2015 US$).	World Development Indicators: https://www.worldbank.org/ext/en/home
POP	Population sizes, total	World Development Indicators: https://www.worldbank.org/ext/en/home
RLW	Rule of Law: Percentile Rank	World Development Indicators: https://www.worldbank.org/ext/en/home
POL	Political Stability and Absence of Violence/Terrorism: Percentile. It measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. Estimates give the country's score on the aggregate indicator, in units of a standard normal distribution.	World Development Indicators: https://www.worldbank.org/ext/en/home

and Kocak 2025; Kuşkaya et al. 2025). Given the huge connectedness of African countries, the socioeconomic outcomes and institutional framework are anticipated to show endogeneity. However, we claim that a substantial part of the endogeneity may be driven by institutional spatial dependence (spillover effects) and the differences in development infrastructure and capabilities. As some spatial regressions, such Spatial Durbin Model, have the potential to explicitly capture spatial interactions by incorporating both endogenous and exogenous spillovers, it constitutes an appropriate and robust framework for estimating average direct and indirect effects across countries. Evidently, the Spatial Durbin Model is widely recognized as a flexible specification that helps reduce bias arising from omitted spatially correlated variables. By including spatial lags of the explanatory variables, the model captures unobserved factors that are spatially correlated with the regressors, thereby mitigating unobserved spatial heterogeneity (Beer and Riedl 2012; Kopczewska et al. 2017). In addition, the robustness of the results is assessed using an alternative spatial weight matrix based on the Rook contiguity criterion, which consistently supports the choice of the Queen contiguity matrix-based estimations for the main results (see Appendix Tables A2 and A3).

To estimate the spatial spillover effect of institutional quality on sustainable socioeconomic development, this study utilizes annual data extending the period 2012–2022 for 42 African countries selected based on data availability. For the sake of a more effective policy response, this study disaggregated the sustainable development index (SDI) into the health index, proxied by life expectancy, and the education index, measured as the years of schooling. In addition, this study considers controlling for population sizes and per capita income. The following equations reflect the main study objectives:

$$\text{Model 1: } \text{EXP}_{jt} = \alpha_0 + \alpha_1 \text{CPI}_{jt} + \alpha_2 \text{GDPPC}_{jt} + \alpha_3 \text{POP}_{jt} + \alpha_4 \text{RLW}_{jt} + \alpha_5 \text{POL}_{jt} + \varepsilon_{jt} \quad (7)$$

$$\text{Model 2: } \text{SCHO}_{jt} = \alpha_0 + \alpha_1 \text{CPI}_{jt} + \alpha_2 \text{GDPPC}_{jt} + \alpha_3 \text{POP}_{jt} + \alpha_4 \text{RLW}_{jt} + \alpha_5 \text{POL}_{jt} + \varepsilon_{jt} \quad (8)$$

where the corresponding life expectancy and education are represented by LEXP_{jt}, and SCHO_{jt} in country j at time t. α_1, α_2 α_3 α_4 α_5 are the parameters to be estimated. ε_{jt} indicates the stochastic error term. A comprehensive overview of the variables, including their definitions, measurement units, and sources, is provided in Table 1. To explicitly situate governance–human development linkages within a sustainability-oriented framework, this study employs sustainability-adjusted human development indicators (life expectancy and years of schooling) drawn from the Sustainable Development Index (SDI), thereby embedding ecological constraints into the measurement of human development. This specification helps inform the design of more inclusive policies for regional cooperation, enabling the harnessing of spillover effects to promote continent-wide sustainability. The SDI evaluates the ecological efficiency of human development by incorporating environmental constraints, acknowledging that progress must occur within the limits of planetary boundaries. It serves as an ecologically informed alternative to the Human Development Index (HDI), adapted for the conditions of the Anthropocene. The SDI is calculated by dividing a country's human development score based on indicators such as life expectancy, educational attainment, and income by its ecological

overshoot, which reflects the extent to which consumption-based CO_2 emissions and material footprint surpass equitable planetary boundary thresholds. Nations that attain comparatively high levels of human development while maintaining ecological sustainability are ranked higher on the index (SDI 2025). To explicitly situate governance–human development linkages within a sustainability-oriented framework, this study employs sustainability-adjusted human development indicators (life expectancy and years of schooling) drawn from the Sustainable Development Index (SDI), thereby embedding ecological constraints into the measurement of human development. This specification helps inform the design of more inclusive policies for regional cooperation under frameworks such as the African Union's Agenda 2063, enabling the harnessing of spillover effects to promote continent-wide sustainability.

5 | Empirical Results

5.1 | Preliminary Results

Initially, we draw an overview of key descriptive statistics. Table 2 reveals central tendencies and variability of socioeconomic and institutional variables across African economies. Mean value of life expectancy shows moderate variation (4.124) across the region with low standard deviation (0.09), indicating relative homogeneity within African economies. This outcome demonstrates that African economies face common health challenges such as inadequate healthcare systems, disease burden, and poverty-related mortality, and so forth. Despite differences in income levels and infrastructure. While some African nations have achieved higher longevity, many others are still struggling with low life expectancy due to malaria, HIV prevalence, and weak health structures. Median value of 4.12 supports this outcome. On the other hand, education (years of schooling) reveals a mean value of 2.335 for Africa, depicting underinvestment in human capital. Median (2.393) infers that some African economies are clustered around the mean or above, although significant heterogeneity is observed in the region. This reflects the dual nature of education attainment in the region; for instance, South Africa, Ghana, and Botswana have made prominent development in education, while others are still facing low school enrollment, high dropout rates, and poor quality of education. This disparity accentuates the challenges faced by the region in aligning education with SDGs. It is important to mention that both socioeconomic indicators (life expectancy and education) were extracted from the overall sustainable development index (SDI), which employs normalization procedures, thus ensuring cross-country comparability and consistency with ecological constraints. As a result, the reported values do not indicate raw years of life or years of schooling; they reflect standardized indices, capturing relative human development performance. In this context, a 1-unit change in life expectancy and years of schooling should be explained as a proportional improvement in the underlying human development dimension rather than a one-year increase in life expectancy or schooling. This process enables significant comparison between countries and over time while avoiding scale distortions inherent in raw values.

TABLE 2 | Summary of the selected variables.

Variables	Mean	Median	Std. Dev.
Life Expectancy	4.124	4.120	0.090
Education Level	2.335	2.393	0.223
GDP	23.065	23.411	4.022
Population	16.364	16.496	1.230
Corruption	3.426	3.449	0.374
Rule of Law	3.076	3.335	0.892
Political Stability	3.038	3.218	0.859

For institutional quality, three indicators are used: corruption perception index, rule of law, and political stability. Corruption (3.426) and political instability (3.038) depict moderate clustering around the mean, while the rule of law shows a weak institutional framework. Moreover, corruption shows low dispersion, showing the governance challenges prevalent across Africa, with only a marginal difference between nations. This finding is reinforced by close values of mean and median, which point out weak institutional enforcement and lack of transparency that dents development outcomes in the region. Hence, corruption shows regional governance traps. While political instability shows considerable dispersion (0.859), suggesting a governance crisis and frequent conflicts. Therefore, instability in political systems reduces health system resilience, impacts education attainment, and diverts public spending toward security instead of economic growth. Contrary to that, wider variability is observed from the rule of law, displaying heterogeneity in institutional quality, which translates into uneven institutional performance. Accordingly, GDP demonstrates wider variability, explaining why certain African economies are progressing more than others. While population shows a notable standard deviation, reflecting that rapid population growth creates both opportunities (demographic dividend, availability of a large labor force) and challenges (saturation of the job market, education pressure, health care issues) for economies.

As an important prerequisite, this study utilized the Panel unit root tests (Lim-Pesaran-Shin unit root and Levin-Lin-Chu unit root) with cross-sectional dependence (CSD) to test the stationarity of the proposed variables. Table 3 discloses a mixed output since political stability is stationary at the level, while others are stationary at the first difference. To divulge the long-run association among the variables under study, the Kao cointegration and Westerlund tests are used. Tables 4 and 5 display that there is a strong indication of cointegration among the underlying variables of interest in the long term.

Null hypothesis: "No cointegration; the number of bootstraps replications = 500".

Remarkable regional disparities can be observed regarding life expectancy in Africa in Figure A3. These regional discrepancies reflect the differences in access to health care systems, economic development, and governance frameworks. Algeria, Libya, and Egypt (Northern Africa), and some parts of East Africa have the highest life expectancy of 77.1 years on average. It is attributable to an improved maternal health care system, efficient child health care programs, and better infrastructure.

TABLE 3 | Panel unit root test (with CSD).

	Level		1st Difference	
Variables	**Statistic**	***P***	**Statistic**	***P***
Lim-Pesaran-Shin unit-root				
Life Expectancy	3.083	0.635	−10.982	0.000*
Education Level	2.091	0.832	−6.063	0.000*
GDP	3.011	0.627	−7.001	0.000*
Population	1.782	0.887	−9.432	0.000*
Corruption	2.992	0.762	−7.913	0.000*
Rule of Law	2.912	0.743	−8.091	0.000*
Political Stability	−3.562	0.041**	−5.832	0.000*
Levin-Lin-Chu unit-root				
Life Expectancy	1.909	0.952	−6.564	0.000*
Education Level	2.081	0.771	−6.934	0.000*
GDP	1.652	0.981	−4.032	0.000*
Population	1.728	0.974	−3.478	0.033**
Corruption	2.981	0.712	−5.086	0.000*
Rule of Law	1.591	0.988	−4.782	0.000*
Political Stability	−4.581	0.000*	−7.811	0.000*

Note: Under the null hypothesis of no stationarity, *, and ** indicate 1% and 5% levels of significance, respectively.

TABLE 4 | Cointegration test.

Kao cointegration test	**Statistic**	***P***
Model 1: Life expectancy model		
MDF	3.982	0.011*
DF	1.892	0.034**
ADF	2.673	0.005*
UMDF	0.781	0.238
UDF	0.613	0.313
Model 2: Year of schooling model		
MDF	2.842	0.043**
DF	0.683	0.253
ADF	2.042	0.051**
UMDF	1.002	0.214
UDF	3.589	0.000*

Note: * and ** indicate 1% and 5% levels of significance, respectively.

TABLE 5 | Panel cointegration (Westerlund 2007).

Stat	**Values**	***Z*-values**	**Probability**	**Robust *P***
Model 1				
Gt	−9.981	−9.110	0.000*	0.000*
Ga	−11.882	−11.109	0.000*	0.000*
Pt	−13.239	−14.210	0.000*	0.000*
Pa	−14.582	−14.656	0.000*	0.000*
Model 2				
Gt	−7.112	−7.119	0.000*	0.000*
Ga	−8.781	−8.702	0.000*	0.000*
Pt	−10.119	−10.137	0.000*	0.000*
Pa	−11.109	−11.180	0.000*	0.000*

Note: * denotes a 1% significance level.

In contrast, South Sudan, Zimbabwe, and Chad fall under the lowest life expectancy economies across the region, highlighting the fragile health care capacity and weak institutions. While middle-range economies have a life expectancy of 60–62 years approximately, showing gradual improvement but still lagging due to disease burden, inadequate public health investments, and governance weaknesses.

The years of schooling map (Figure A4) also shows regional discrepancies across the continent. The highest schooling years average between 12.3 and 15.5 in Namibia, South Africa, and Lesotho, having a relatively higher education system than other African countries. West Africa falls in the middle range of education, around 9–11 years, reporting mild progress yet still lagging behind global averages. Moreover, the lowest levels range between 0 and 2.8, showing educational barriers in the form of poverty, weak institutional reforms, and limited investment in the education sector.

Correspondingly, the corruption perception index in Figure A5 demonstrates regional clustering across the continent. Southern African economies are performing better in terms of CPI, reflecting less corruption, while Central and West African economies portray the opposite picture. While the North-West divide reflects a moderately better range. The clustering of CPI reflects systemic corruption, weak institutions, and governance challenges that are a barrier to development.

The political stability distribution map (Figure A6) also shows striking regional disparities. The highest politically stable African economies (Yellow and green colored) lie in Southern Africa and some parts of West and Central Africa, depicting strong institutional structures where relative peace adds to sustainable governance continuity. These areas dominate the legacy of robust post-independence institutions and peaceful transitions. By contrast, the lowest level of political stability (dark purple color) prevails in fragile and conflicted areas; for instance, Congo, Chad, Libya, and Central Africa, where ongoing civic wars, governance crises, and ethnic tension hit these economies badly.

Accordingly, Figure A7 shows clear disparities in the spatial distribution of population size across the continent. The largest population, up to 223 million (dark purple color), is concentrated in Algeria, Nigeria, Egypt, Rwanda, and so forth, dominating the region demographically. The population here is the hub of Africa's economic, social, and political dynamics. Conversely, smaller economies such as Lesotho, with populations under half a million, highlight their limited demographic influence. Surprisingly, some African countries with large land areas have sizeable populations, yet they remain less dense, such as Chad, Mali, and Niger, in contrast to small but high-density economies, for instance, Rwanda. Such uneven distribution of population, with a handful of populous economies, accounts for the majority of the continent's population.

Figure A8 represents the deep rule of law dividing across the African countries, revealing a striking disparity within the region, where stronger RLW is concentrated in Botswana, Kenya, Tanzania, and South Africa (darker green colors), while Chad, Congo, and Central Africa display very weak RLW due to conflicts and authoritarian disruptions. These act as a barrier to sustainable socioeconomic development as RLW is key to endorsing effective service delivery, protecting civic rights, and promoting investment in critical sectors.

5.2 | Main Results and Discussion

5.2.1 | Baseline Results

The study first reports Pooled OLS, fixed effects (FE), and random effects as the baseline model. Table 6 indicates that an increase in income (GDP) boosts life expectancy in Africa. Similarly, as the population grows, life expectancy increases. Moreover, results show that institutional quality, measured by the rule of law and political instability, reduces life expectancy of people across the continent. Hausman tests point to FE as suitable for both models. Overall, the baseline model displays GDP as a consistent and significant driver of increasing health outcomes and education, depicting the fundamental role of economic development in Africa. Population growth, on the other hand, is weakly significant on Pooled OLS and RE models for life expectancy, while FE shows a strongly positive and significant impact. Depicting that the increasing rate of urbanization and improved health services/public services are directly linked with higher life expectancy (Miranda-Lescano et al. 2023). Similar findings are for education level as well; results advocate that a large population demands more investment in education. For institutional quality, corruption does not show any impact in both models, while the rule of law and political instability lead to lower life expectancy. Insignificant outcome of corruption depicts the indirect and mediated nature of corruption and its impact on life expectancy and education. Corruption affects human development through public spending composition, resource leakage, and service delivery efficiency, all of which are intermediate fiscal and institutional channels. In African countries, corruption could be systematic and dynamic; for this reason, it exhibits limited variation within a country over time. Moreover, in low-income African nations with a weak institutional framework, marginal improvement in corruption may not be able to produce observable effects on health and educational outcomes due to structural constraints that dominate service delivery (Akinbode et al. 2020; Bolatito 2023).

Similarly, political instability is negative and insignificant in the FE model, reflecting within-country dynamics. For the periods of increased political instability, many African

TABLE 6 | Results of baseline model.

	OLS	FE	RE	OLS	FE	RE
Variables	**Life expectancy**	**Life expectancy**	**Life expectancy**	**Education**	**Education**	**Education**
GDP	3.278***	1.830***	3.278***	1.215***	0.595**	1.215***
	(0.564)	(0.636)	(0.564)	(0.204)	(0.242)	(0.204)
Population	1.414*	7.244***	1.414*	0.205	2.371***	0.205
	(0.780)	(0.996)	(0.780)	(0.278)	(0.379)	(0.278)
Corruption	−0.00870	−0.0142	−0.00870	−0.00376	−0.00312	−0.00376
	(0.0166)	(0.0152)	(0.0166)	(0.00617)	(0.00580)	(0.00617)
Rule of Law	−0.0355***	−0.0344***	−0.0355***	0.0147***	0.0177***	0.0147***
	(0.0138)	(0.0128)	(0.0138)	(0.00510)	(0.00488)	(0.00510)
Political Stability	−0.0200**	−0.0139	−0.0200**	0.00713*	0.00942***	0.00713*
	(0.00983)	(0.00906)	(0.00983)	(0.00365)	(0.00345)	(0.00365)
Constant	−36.87***	−98.27***	−36.87***	−21.99***	−43.00***	−21.99***
	(8.864)	(10.69)	(8.864)	(3.178)	(4.070)	(3.178)
Observations	450	450	450	450	450	450
R-squared		0.410			0.312	

TABLE 7 | Results of the spatial Durbin regression (SDM) analysis for life expectancy.

Life expectancy	Coef.	Std. Err.	z	$P>z$
Main				
GDP	−3.1E-05	0.000736	−0.04	0.966
Population	0.023272	0.009857	2.36	0.018*
Corruption	−0.00027	0.003143	−0.09	0.931
Rule of Law	0.004418	0.003118	1.42	0.157
Political Instability	−0.00265	0.00259	−1.02	0.306
_cons	0.936634	0.186391	5.03	0.000*
Wx				
GDP	0.006939	0.001638	4.24	0.000*
Population	0.060039	0.013842	4.34	0.000*
Corruption	0.003838	0.008989	0.43	0.669
Rule of Law	0.006731	0.00469	1.44	0.151
Political Instability	−0.00541	0.004249	−1.27	0.203
Spatial rho	0.402397	0.046098	8.73	0.000*
Variance lgt_theta	−3.00659	0.130682	−23.01	0.000*
sigma^2_e	0.000232	1.62E-05	14.32	0.000*
chi^2(5)	64.00			0.000*
Direct effect				
GDP	0.000801	0.000769	1.04	0.298
Population	0.032996	0.008957	3.68	0.000*
Corruption	0.000298	0.003582	0.08	0.934
Rule of Law	0.005449	0.003111	1.75	0.08***
Political Instability	−0.00344	0.002737	−1.26	0.209
Indirect effect				
GDP	0.010585	0.00254	4.17	0.000*
Population	0.106934	0.016905	6.33	0.000*
Corruption	0.005589	0.014692	0.38	0.704
Rule of Law	0.013338	0.007241	1.84	0.065**
Political Instability	−0.01026	0.006886	−1.49	0.136
Total effect				
GDP	0.011387	0.002945	3.87	0.000*
Population	0.13993	0.017427	8.03	0.000*
Corruption	0.005887	0.016621	0.35	0.723
Rule of Law	0.018786	0.008485	2.21	0.027**
Political Instability	−0.0137	0.008567	−1.6	0.11

Note: *, ** indicate 1% and 5% levels of significance, respectively.

nations often experience regime entrenchment, post-conflict consolidation, and centralized political control rather than inclusive governance systems (Folorunsho and Samuel 2025). Given that, stable political governance is achieved through repression, spending on security, and fiscal discipline, which crowds out health spending and social services (Fidelis and Baah 2025). Hence, political stability does not necessarily translate into immediate gains in life expectancy (Khan et al. 2024). Moreover, African health systems are heavily influenced by disease burden, poor sanitation, weak health systems, and, more prominently, limited access to food and clean water that evolves slowly (Okesanya et al. 2024). As FE removes cross-country differences and captures only short-term evolution in political stability, it is unlikely to generate rapid improvement in life expectancy. Furthermore, Khan et al. (2024) show that political stability alone is not a determining factor to improve human development unless accompanied by an effective institutional setup. Hence, stable but weakly accountable regimes in Africa often fail to translate political calm into improved health outcomes, explaining the negative and insignificant association observed in the findings. However, it improves the education level if political systems are stable enough, meaning that institutions matter more for education than for health.

5.2.2 | Spillover Impacts on Life Expectancy

Initially, we conducted chi-square (Chi^2) tests to examine whether the SDM can be simplified to the SAR or SEM models. When the reported Prob > Chi^2 equals 0.000, we strongly reject the null hypothesis, indicating that the imposed restrictions are invalid and that the SDM specification is preferred. The corresponding Chi^2 test statistics are reported in Tables 7 and 8. Overall, the model selection tests consistently support the SDM specification, as the Chi^2 *p*-values indicate rejection of the null hypothesis in favor of the SDM. Therefore, we report and interpret only the SDM results as the baseline model for the analysis, both the health and education models.

Moran's I Index of 0.536 for health (life expectancy) reveals a significant positive spatial autocorrelation among African countries (see Figure 1). Indicating that outcomes of life expectancy are not randomly distributed, but rather formed through regional clustering. This means that regions of high life expectancy in the continent are mostly located near other regions with the same high outcomes, and vice versa for areas of poor health outcomes. It indicates regional cooperation and cross-border health policies in addressing disparities. Table 7 reports the findings of SDM and reveals an interesting fact that life expectancy

TABLE 8 | Results of the spatial Durbin regression (SDM) analysis for education.

Education level	Coef.	Std. Err.	z	$P>z$
Main				
GDP	0.010352	0.000604	17.13	0.000*
Population	0.19211	0.086047	2.23	0.026**
Corruption	0.003146	0.006337	0.5	0.62
Rule of Law	0.035739	0.012428	2.88	0.004*
Political Stability	0.00539	0.009494	0.57	0.57
_cons	−1.28877	1.300328	−0.99	0.322
Spatial rho	0.044998	0.109901	0.41	0.682
Variance lgt_theta	−3.17515	0.322825	−9.84	0.000*
sigma^2_e	0.00163	0.000359	4.54	0.000*
chi^2(5)	12.91			0.0242*
Direct effect				
GDP	0.010376	0.00059	17.58	0.000*
Population	0.201779	0.083095	2.43	0.015*
Corruption	0.003393	0.00653	0.52	0.603
Rule of Law	0.035813	0.012276	2.92	0.004*
Political Stability	0.005485	0.00917	0.6	0.55
Indirect effect				
GDP	0.000485	0.001223	0.4	0.692
Population	0.004456	0.023249	0.19	0.848
Corruption	0.000333	0.000959	0.35	0.728
Rule of Law	0.001487	0.004299	0.35	0.729
Political Stability	0.000276	0.001268	0.22	0.828
Total effect				
GDP	0.010861	0.001441	7.54	0.000*
Population	0.206235	0.078097	2.64	0.008*
Corruption	0.003726	0.007	0.53	0.595
Rule of Law	0.037300	0.013155	2.84	0.005*
Political Stability	0.005760	0.009709	0.59	0.553

Note: *, and ** indicate 1% and 5% levels of significance, respectively.

is not only shaped by domestic factors but also by spatial factors through neighboring countries, demonstrating regional dynamics. Hence, this dual effect reflects the presence of spatial spillover effects that prevail in the regions where borders are porous, health risks are transboundary, and institutional structures vary substantially.

In Table 7, main effects results show that GDP is not statistically significant for the African countries in the case of health outcomes, suggesting that growth in GDP/income is not a guarantee of longer and healthier lives. The argument supports the "income-health paradox," whereby weak health care structures, income inequality, and inefficient governance are constraints that hinder the economic development from translating into improved health outcomes (Fanning and O'Neill 2019). Connecting to Grossman's model of human capital, individuals make investments in health care for production and consumption purposes, yet income inequality, poor governance, and weak health care structures are critical hurdles in achieving gains from the health care system (Sepehri 2015; Foreman-Peck and Zhou 2025).

Population growth is a significant driver of life expectancy in Africa, dictating the fact that a large population generates economies of scale in health care systems, which enhances easy access to medical facilities and other health care interventions. Institutional indicators such as corruption, rule of law, and political stability are insignificant. Moreover, the Spatial rho test (0.40) emphasizes the Moran's Index in Figure 1, revealing the significant spatial dependency among African countries. It means that life expectancy in one country is significantly influenced by improvements in health outcomes of its neighboring states. Put differently, regional health spillovers, cross-border health care programs, disease control programs, medical migration, and diffusion of health outcomes depict such interdependence, showing that health outcomes are not isolated in geographically connected regions due to their public good nature. Health is non-excludable and non-rival at the regional level as diseases spread through borders (Janik 2009; Açıkgöz 2022), so do the public health care programs, medical innovation, and institutional reforms.

Wx terms provide further insights into the role of regional externalities. Population and GDP in neighboring economies are significant and affect life expectancy positively. Higher GDP per capita/economic growth in neighboring states facilitate cross-border investments in healthcare systems, medical tourism, and knowledge spillover, while increasing population supports regional vaccination programs and training networks for healthcare personnel. Direct effects, on the other hand, confirm that GDP is positive yet insignificant, portraying that economic development in the absence of institutions is not sufficient, as efficient institutions effectively redistribute economic resources (Rodríguez-Pose 2013). However, spillover effects (indirect effects) and total effects are significant, stating that domestic economic growth alone does not determine life expectancy, but rather regional economic growth, such as GDP level in neighboring states of African countries, significantly affects life expectancy domestically, having spillover effects. Demonstrates that regional economic growth causes health benefits via medical and pharmaceutical trade, cross-border use of health facilities, shared knowledge, and technology transfer (Chanda 2017; Oso et al. 2025). Neoclassical theory states that the benefits of growth spread through international trade, migration, and regional integration (Kaczmarczyk 2023). The African economies are interconnected, so an improvement in income in one economy can fund cross-border health care programs, improve health

infrastructures, and augment regional access to medical technologies.

Population growth improves life expectancy with a significantly positive impact in both direct and indirect models. Byaro et al. (2022) argue that population growth is a significant factor contributing to life expectancy in Africa. However, spillover effects (indirect effects) are stronger in the sense that population growth in neighboring states of African countries is significantly affecting life expectancy domestically (Mberu and Ezeh 2017). Large population yields a demographic dividend accompanied by investment health, increasing demand for better health care services, and creating economies of scale in health care provision (Sahoo et al. 2023; Osareme et al. 2024). Additionally, Flessa and Huebner (2021) argue that population density fosters innovation in the delivery of health care. Moreover, population growth in neighboring states highlights the importance of demographic scale in drawing funding and fostering health care campaigns across borders. It establishes the role of regional economic integration in raising health outcomes.

Contrary to that, corruption is positive yet insignificant in all models. Literature suggests that corruption undermines service delivery and erodes trust in governance (Bolatito 2023). Moreover, the insignificance of corruption here accounts for two reasons: dominance of other indicators of institutional quality and corruption impacts health indirectly through resource allocation inefficiencies rather than through immediate effects on life expectancy. Another indicator of institutional quality, the rule of law, is positive and significant in direct, indirect, and total effects models. The outcome suggests that African economies are not only benefiting from strengthening their own legal frameworks but also from the improvement of their neighbors' institutional structure (Salifu et al. 2024). This resonates with institutional theory, showing that institutions provide platforms necessary for translating economic resources into social welfare enhancement (Tkach et al. 2019; Chen et al. 2022). It indicates that strong institutions improve access to health care vicinities, ensure accountability, enforce regulatory frameworks, reduce medical negligence, and deliver health care services to all by reducing inequality and ensuring better allocation of resources for health. The findings correspond with Vian (2020) and Mackey et al. (2018). Hadipour et al. (2023) view that the rule of law, transparency, and accountability within health care systems significantly impact the overall quality of healthcare delivery.

Moreover, spatial spillovers occur due to efficient institutions in neighboring states that encourage regional collaboration, improve cross-border health care frameworks, and ensure public trust (Cruz 2014; Oso et al. 2025). Spillovers of the rule of law imply that institutional quality diffuses through cross-border policy mechanism harmonization (Komissaryuk and Güngör 2025). Also accentuates that a better governance structure is not only a national asset but also a regional public good (Madjid 2024). Nations with powerful institutional structures contribute to regional stability, limit cross-border diffusion of diseases, and encourage regional health care policies (Bacanu 2024; Perna et al. 2022).

Lastly, political stability is negative and insignificant, showing unstable political structures. Unstable political systems divert resources away from public health, disrupt health services delivery, displace populations, and weaken institutional performance. Mackey et al. (2018) emphasize that poor governance, corruption, and immoral procurement acts play a critical role in resource misallocation and decline access to public health services. Locke et al. (2025) put stress on the role of transparency in the healthcare system and determined it to be critical for sustainability.

Summing it up, life expectancy is not just shaped by domestic policies but also by cross-border factors. Results confirm that regional economic development, population growth, and institutional quality are critical drivers of life expectancy in Africa. Economies with strong institutions are better at transforming their economic and population growth into health improvement. Side by side, the prosperity of neighboring states and good governance affect a nation's development trajectory. Adding, economic development in the absence of institutions is not sufficient, as efficient institutions effectively redistribute economic resources. Efficient legal frameworks and governance raise life expectancy within economies, along with a strong positive regional spillover impact. In contrast, corruption and political stability do not show any regional multiplier effect, indicating that their impacts are confined to national boundaries. Portraying that economic development in the absence of institutions is not sufficient, as efficient institutions effectively redistribute economic resources. Hence, SDM highlights that health outcomes are heavily shaped by regional clustering.

5.2.3 | Spillover Impacts on the Year of Schooling

Moran's I statistics (0.468) for education (years of schooling) reveal moderately strong positive spatial autocorrelation across African economies (see Figure 2). This indicates that educational attainment is not randomly distributed but clustered. Countries with high average schooling levels are located close to other high-performing neighbors, whereas low-performing countries are geographically located near low educational attainment ones (Goux and Maurin 2007).

Table 8 reports the outcome for the level of education (measured in terms of years of schooling) in Africa affected by institutional quality and other factors such as GDP and population. Results show that with a 1% increase in GDP, the level of education improves by 0.01 units, depicting that economic development directly impacts higher education attainment (Pink-Harper 2015). Aligning with human capital theory that claims higher levels of income attract households to allocate resources toward education as a long-term investment with returns (Bagama 2024; Li et al. 2024). Population growth and the rule of law are significantly enhancing educational attainment in Africa. Moreover, *spatial rho* is statistically insignificant, which measures whether the education level in one country is associated with that of its neighbors. Spatial dependency is insignificant, indicating that educational attainment across the African region does not exhibit spatial clustering. Putting it differently, improvement in the education system of one African nation does not translate into the neighboring country's education outcomes. Hence, the African education system is fragmented due to differences in the curriculum of

each nation, resource mobilization, and governance structure of each nation (Gbesoevi et al. 2025). So, the education system in Africa is bound by national borders. This result is reinforced by the uniform insignificance of indirect effects for all explanatory variables, despite their strong and statistically significant direct effects. The contrast between direct and indirect effects shows asymmetry, suggesting that educational outcomes respond primarily to country-specific fiscal capacity and institutional quality rather than to regional diffusion mechanisms (Onatunji 2025). Reflecting that the institutional structure of the African education system is largely governed by local government in terms of financing, curriculum design, policy implementation, and teacher recruitment, with limited regional harmonization (Gbesoevi et al. 2025). Such characteristics are country border specific; even neighboring nations are experiencing good governance mechanisms. As a result, governance improvement in one country while strongly affecting its own education capacity does not transmit to neighboring nations. A pattern reflects the sharp contrast between significant direct effects. The absence of education spillover, therefore, highlights the sector-specific nature of spatial dependence rather than a general lack of regional connectivity.

Direct and total effects for GDP are consistently positive and significant, hence translating economic growth into improvement in the education system. In other words, economic development directly impacts and improves education (human capital formation). Governments of rich economies allocate resources for education similarly, and wealthy households invest more in education (Acuna et al. 2024). Hence, they jointly put efforts into inclusive growth in achieving education-related SDGs. Findings show that population exerts a positive and significant impact on educational attainment. This demonstrates a demographic dividend for African economies, but along with risks of not having adequate and planned investment (Eastwood and Lipton 2011). Moreover, high population growth can strain resources and lessen education quality. From an institutional quality perspective, only the rule of law shows a significant impact on education level. This implies that strong legal support enforces education rights. The findings correspond with Hadipour et al. (2023). On the other hand, corruption and political stability show no significant impact on education level, showing that their influence is uneven across the African region. No spillover effect is noted in the results, and that is consistent with the *spatial rho* showing spatial dependency. This means that progress in the education system in one economy does not affect neighboring countries' educational outcomes. It shows the absence of regional learning mechanisms and weak or no regional interconnectedness of educational policies in Africa. Therefore, these findings show that the education system in each African nation is shaped domestically rather than by regional spillovers. Contrarily, Nieuwenhuis and Hooimeijer (2016) and Laliberté (2021) find contrasting evidence.

The overall findings highlight that educational system heterogeneity weakens spatial transmission. African nations are remarkably different in their schooling structures, education spending efficiency, and language of instruction. Hence, educational attainment across the African region is primarily dependent upon domestic circumstances such as GDP, population dynamics, and institutional quality, instead of spatial spillover. GDP growth and population expansion generate opportunities; hence, the rule of law ensures that opportunities are translated into sustainable and equitable educational outcomes. Then, the absence of spatial dependence and spillover effects accentuates the fragmented nature of the educational setup throughout the region, highlighting that educational progress remains domestically concentrated. For education to be a true engine of sustainable development, poverty reduction, social stability, and inclusive growth are required to be maintained through domestic governance and economic policies. Moreover, African economies need to pursue regional cooperation and policy harmonization to transform isolated gains into collective progress and attain the sustainable development agenda of the continent.

6 | Conclusion and Policy Recommendation

6.1 | Conclusion

This study has illuminated the pivotal role of institutional quality in shaping sustainable socioeconomic development in Africa, with a particular emphasis on its spatial dimensions. By integrating spatial econometric models with panel data from 42 African countries spanning 2012–2022, the research demonstrates that institutional factors such as transparency, rule of law, and political stability not only exert direct influences on key human development indicators but also generate significant spillover effects, albeit asymmetrically across outcomes. For life expectancy, the findings reveal robust spatial interdependencies, where enhancements in rule of law and economic factors like GDP and population in one country positively cascade to neighboring nations, fostering regional health resilience through mechanisms like cross-border policy alignment. Conversely, educational attainment appears more insular, influenced predominantly by domestic conditions without notable spillovers, underscoring the fragmented nature of education policies in the region. These results affirm institutional quality as a regional public good, bridging gaps in prior literature that often isolated national effects and overlooked geographic interconnections.

Overall, the study contributes to development economics and governance scholarship by quantifying spatial spillovers in an African context, highlighting how institutional reforms can amplify sustainable outcomes beyond borders. It reinforces the need for coordinated regional strategies to address disparities in health and education, aligning with broader SDGs for inclusive growth and human well-being.

6.2 | Policy Recommendations

Drawing from the empirical evidence of institutional spillovers and their role in sustainable socioeconomic development, this section outlines targeted, actionable policy recommendations. These focus on enhancing regional coordination through specific mechanisms, timelines, and implementation strategies under frameworks like the African Union (AU) and regional economic communities (RECs).

1. **Strengthen Regional Institutional Collaboration via Harmonized Governance Platforms**: To harness

positive spillovers in life expectancy from rule of law and economic factors, AU member states should establish a dedicated Regional Governance Coordination Unit within the AfCFTA Secretariat by 2027. This unit would develop binding protocols for cross-border institutional monitoring, including annual joint audits of anti-corruption measures and the creation of a shared digital platform for real-time health policy data exchange. For instance, task forces comprising representatives from at least three neighboring countries could pilot programs in regions prone to transboundary issues, such as the Sahel, for disease outbreak response, with funding sourced from AU development funds and international partners like the World Bank. Success metrics could include a 20% reduction in cross-border corruption incidents within 5 years, tracked through standardized reporting.

2. **Implement Domestic and Regional Rule of Law Reforms with Incentive-Based Adoption**: Policymakers at the national level should enact reforms by introducing enforceable legal frameworks, such as mandatory e-governance systems for healthcare budgeting, starting with pilot implementations in high-corruption countries like Nigeria and the Democratic Republic of Congo by 2026. To foster regional coordination, the AU could launch a "Rule of Law Incentive Program" offering technical assistance and matching grants (e.g., up to $5 million per REC) to neighboring states that adopt compatible systems, ensuring interoperability for data sharing on public expenditures. This would involve biannual workshops facilitated by RECs like ECOWAS, where countries share implementation challenges and best practices, ultimately amplifying spillover benefits by reducing resource misallocation and enhancing transparency across borders.
3. **Advance Economic Integration through Targeted Health Infrastructure Projects**: Capitalizing on GDP and population spillovers for life expectancy, governments should prioritize funding for cross-border health initiatives within RECs, such as constructing shared regional medical hubs in border areas (e.g., an East African Community facility along the Kenya-Uganda border) with completion targeted for 2028. Coordination could be achieved via joint investment committees under the AU's Agenda 2063, where member states contribute proportionally to GDP and receive technical support from organizations like the African Development Bank. To address population pressures, these projects should include scalable vaccination and telemedicine networks, with protocols for equitable resource distribution based on demographic data, aiming to increase regional life expectancy by 2–3 years in high-density zones through annual performance reviews.
4. **Tackle Education Fragmentation with National Reforms and Regional Standardization Initiatives**: Given the absence of education spillovers, national governments should allocate at least 20% of GDP growth dividends to domestic human capital investments, such as subsidized enrollment programs and infrastructure upgrades in low-attainment countries like Chad and South Sudan, with rollout beginning in 2026. For regional coordination, the AU should convene an Education Harmonization Forum annually, starting in 2025, to develop a phased curriculum standardization roadmap (e.g., aligning STEM subjects across RECs by 2030) and establish teacher exchange programs involving at least 500 educators per year. Rule of law elements, such as anti-discrimination policies enforced through regional oversight bodies, would ensure equitable access, with progress monitored via shared databases to build future spillovers and reduce continental dropout rates by 15% over a decade.
5. **Establish Robust Monitoring and Evaluation Systems for Spatial Dependencies**: To provide ongoing guidance for regional policies, the AU should create interconnected National and Regional Data Hubs by 2027, utilizing spatial tools like Moran's I indices to map institutional spillovers in real-time. This would involve mandatory contributions from member states, with RECs responsible for quarterly data uploads on governance metrics (e.g., rule of law indices from the World Governance Indicators). Actionable steps include commissioning annual AU reports that identify underperforming clusters and recommend targeted interventions, such as reallocating 10% of regional budgets to spillover hotspots. Independent evaluations by external auditors every 2 years would ensure accountability, enable adaptive policy adjustments, and foster sustained coordination across the continent.

6.3 | Limitations and Future Research Directions

Despite its contributions, this study has limitations. First, the analysis relies on aggregate institutional proxies (e.g., corruption perception index), which may not capture micro-level nuances like informal governance practices prevalent in Africa. Second, the sample of 42 countries, while comprehensive, excludes some due to data availability, potentially biasing results toward data-rich nations. Third, the time frame (2012–2022) predates recent global shocks like COVID-19's full long-term impacts, limiting generalizability. Fourth, the models assume linear spillovers via geographic contiguity, overlooking non-spatial channels like digital connectivity or diaspora networks.

Future research could address these by incorporating disaggregated institutional data (e.g., sub-national levels) and extending the analysis to include post-2022 data for pandemic effects. Exploring non-linear thresholds or asymmetric spillovers using advanced techniques like Bayesian spatial models would provide deeper insights. Additionally, comparative studies across continents or sector-specific analyses (e.g., gender-disaggregated outcomes) could test the generalizability of findings, while qualitative case studies on successful regional collaborations might enrich policy prescriptions.

Author Contributions

Mohammed Alnour: conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft. **Suat Kara:** investigation, Software, Visualization, Writing – review and editing. **Yücel Oğurlu:**

resources, Validation, Writing – review and editing. **Md. Emran Hossain:** data curation, Formal analysis, Visualization, Supervision, Writing – original draft. **Shamsa Kanwal:** methodology, Project administration, Writing – original draft. **Sana Fatima:** writing – original draft, Resources, Writing – review and editing.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data can be made available from the corresponding author upon a reasonable request.

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Appendix A

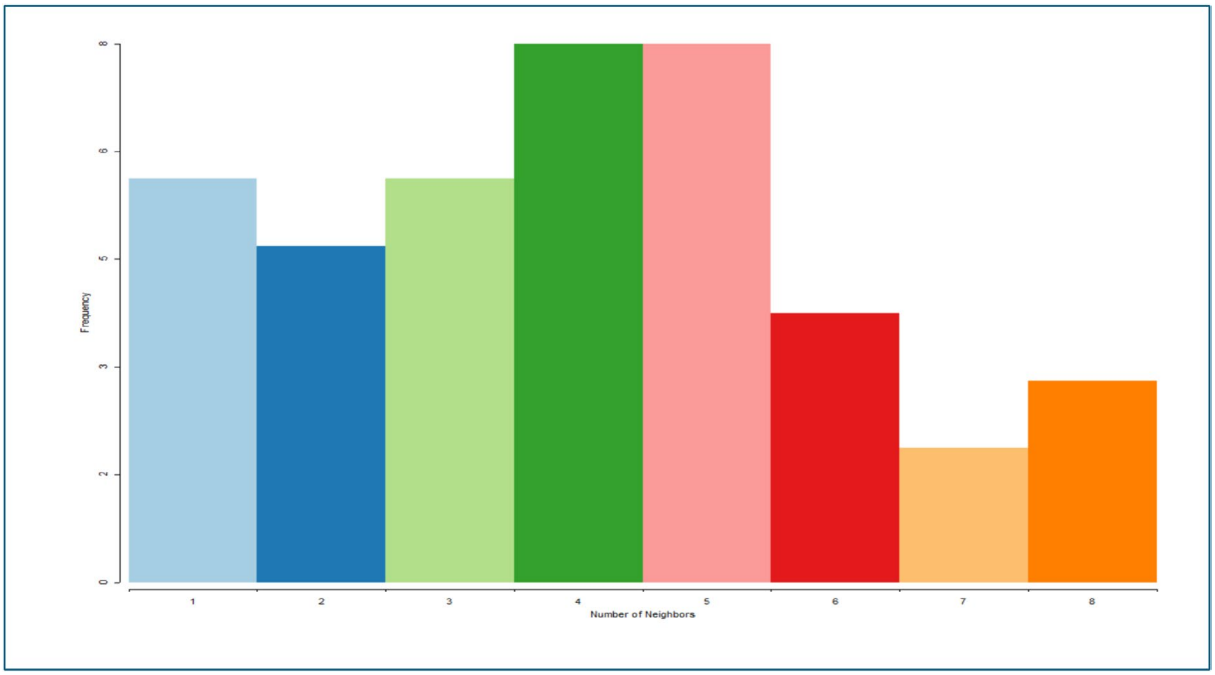

FIGURE A1 | Number of neighbors based on Queen contiguity criteria.

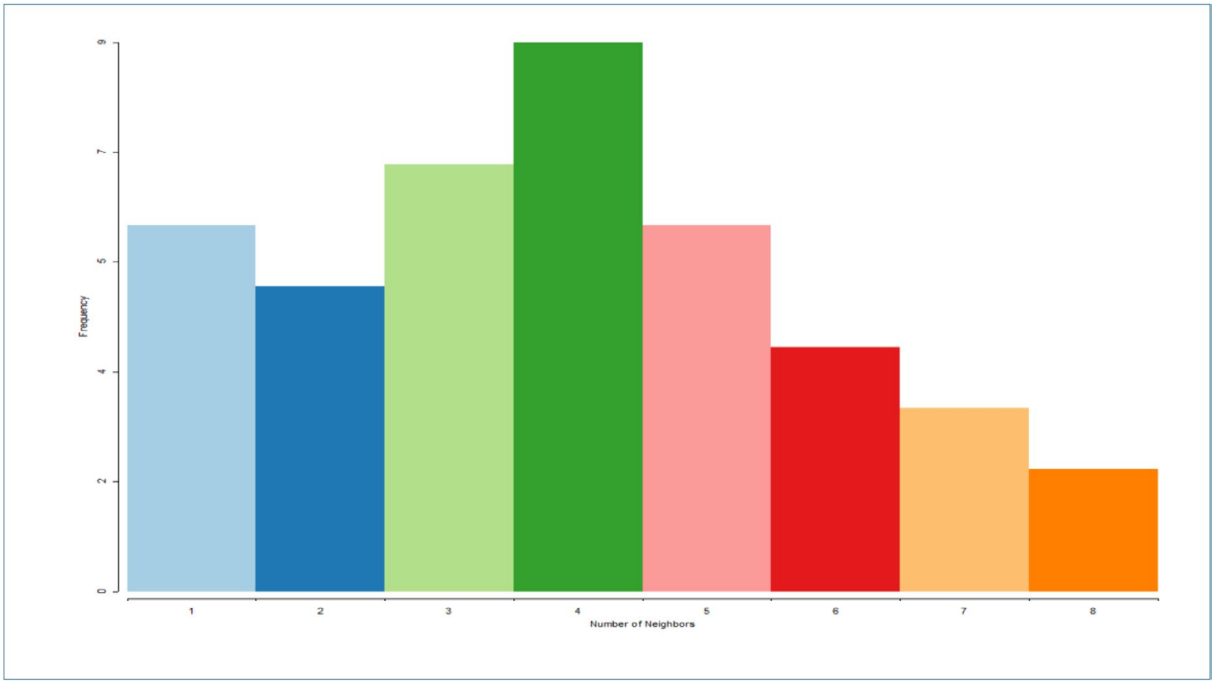

FIGURE A2 | Number of neighbors based on Rook contiguity criteria.

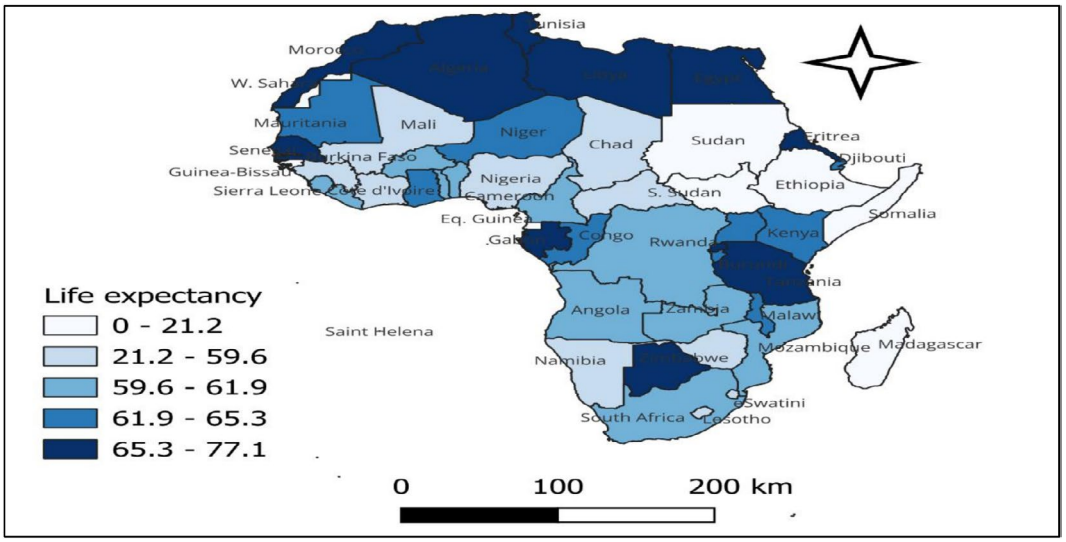

FIGURE A3 | Spatial distribution of life expectancy rate (years).

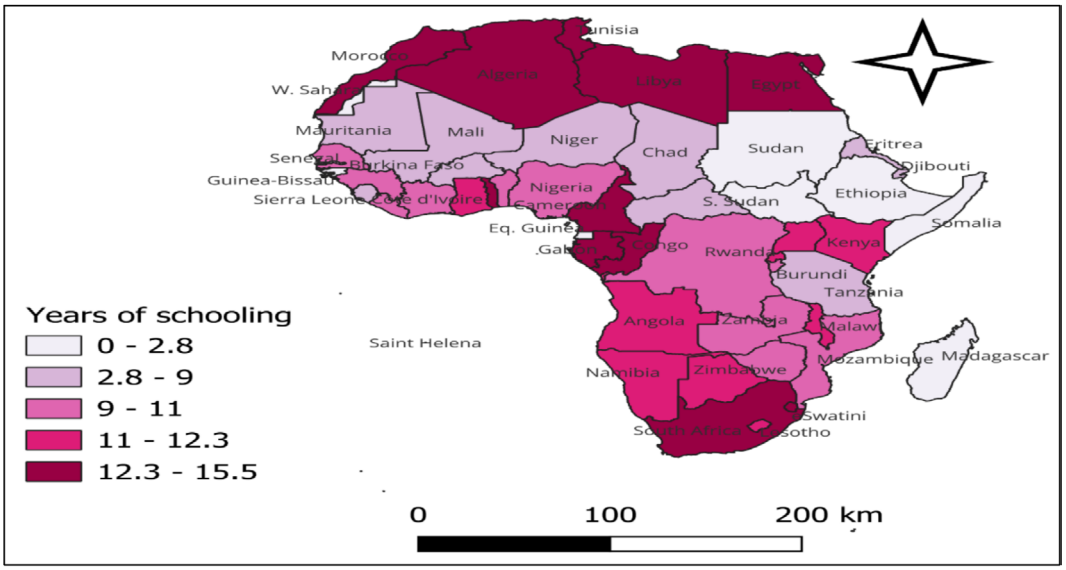

FIGURE A4 | Spatial distribution of years of schooling.

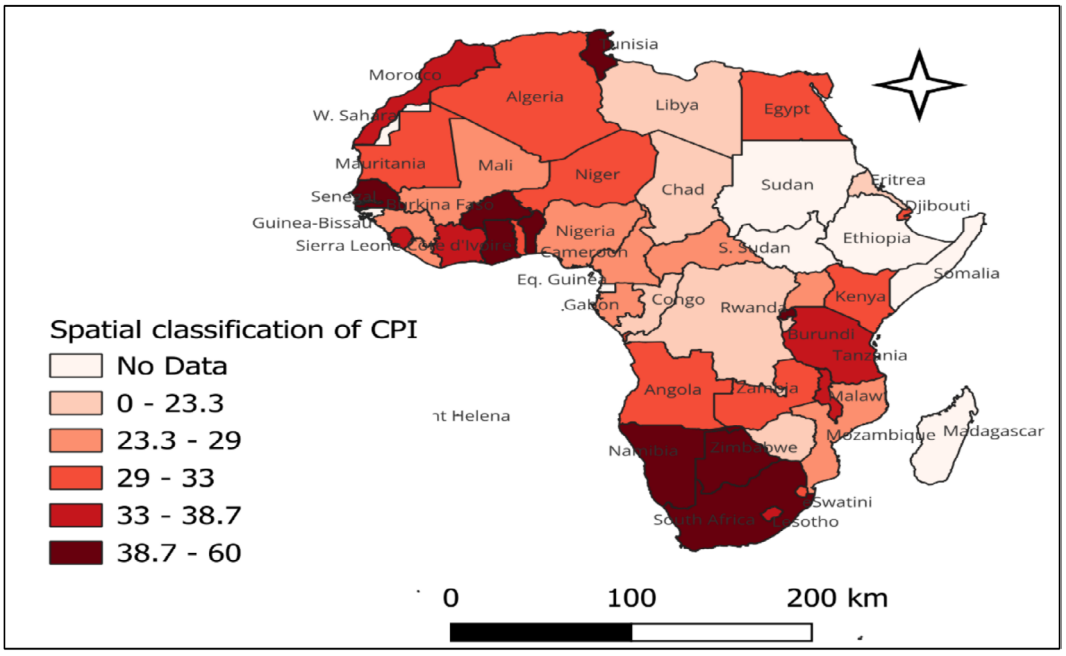

FIGURE A5 | Spatial distribution of corruption perception Index (CPI).

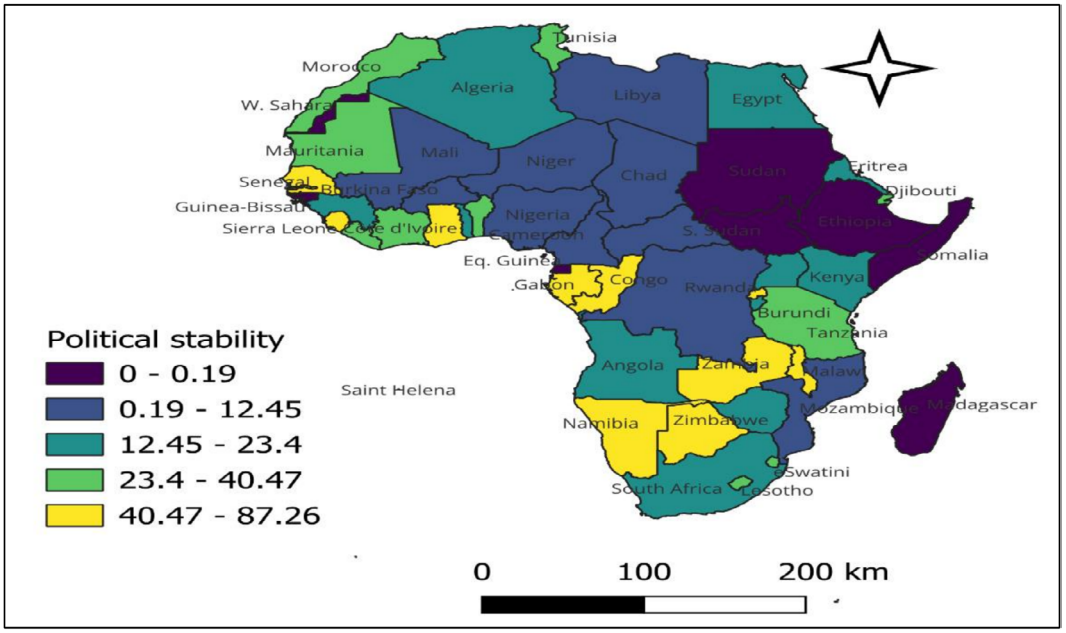

FIGURE A6 | Spatial distribution of political stability and absence of violence/terrorism.

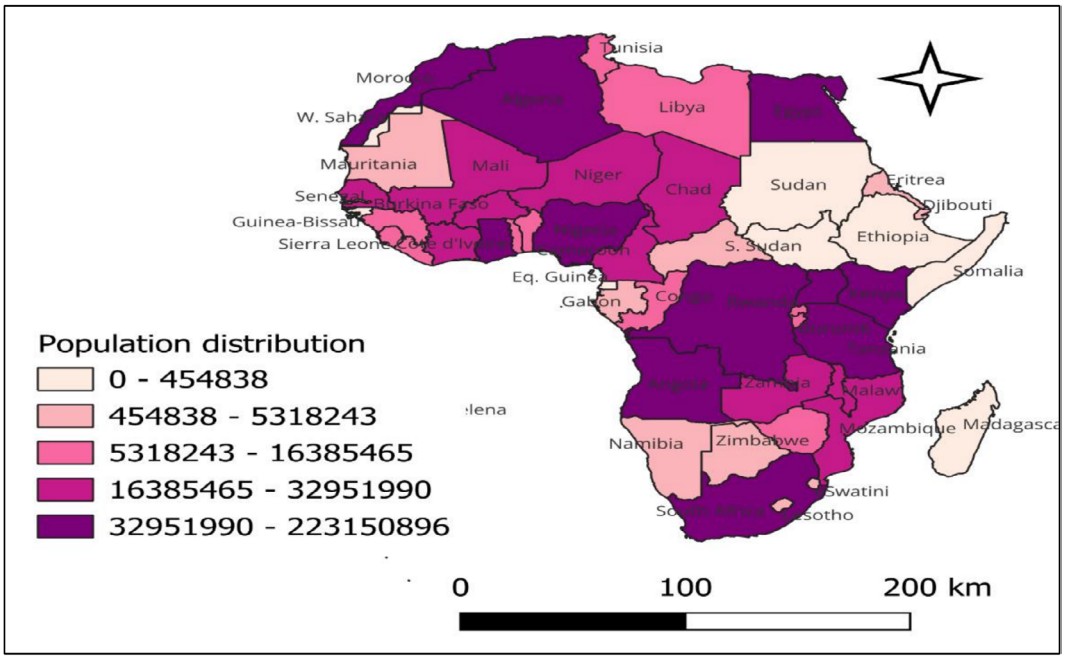

FIGURE A7 | Spatial distribution of population sizes, total.

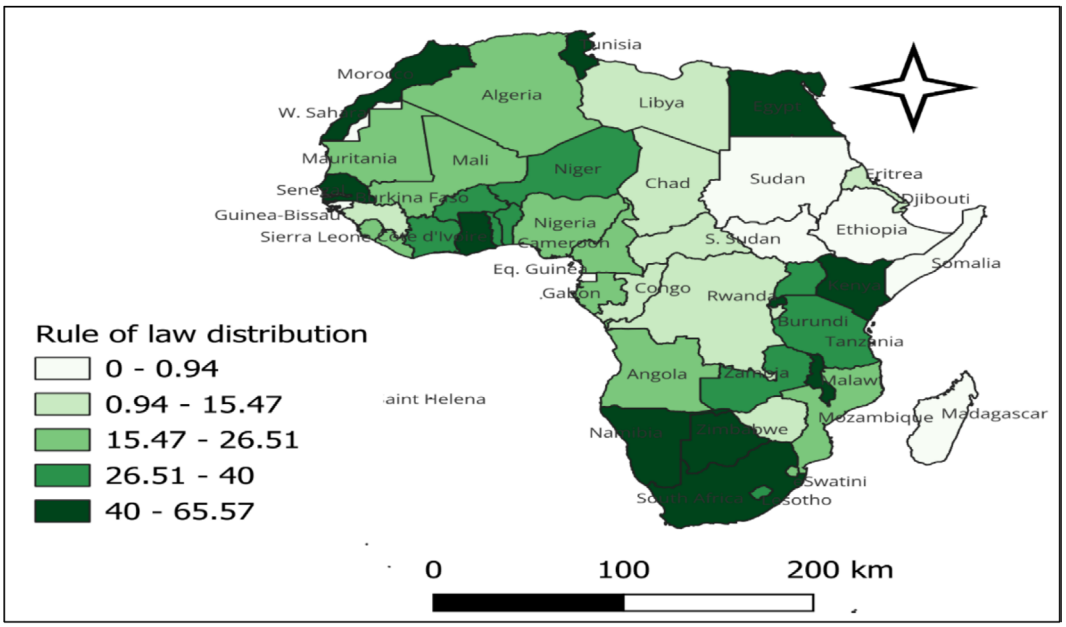

FIGURE A8 | Spatial distribution of the rule of law.

TABLE A1 | List of sample countries.

1	Botswana
2	Egypt
3	Dem. Rep. Congo
4	Chad
5	Sierra Leone
6	Guinea
7	Central African Rep.
8	Djibouti
9	Zambia
10	Nigeria
11	Benin
12	Rwanda
13	Uganda
14	Tanzania
15	Burundi
16	Gabon
17	Ghana
18	Côte d'Ivoire
19	Algeria
20	Mauritania
21	Senegal
22	Kenya
23	Cameroon
24	Namibia
25	Gambia
26	Togo
27	Burkina Faso
28	Malawi
29	Mozambique
30	Congo
31	Eritrea
32	Libya
33	South Africa
34	Liberia
35	Morocco
36	Tunisia
37	Angola
38	Mali
39	Zimbabwe
40	eSwatini
41	Lesotho
42	Niger

TABLE A2 | Results of the SDM analysis for life expectancy (Rook Contiguity criteria).

Life expectancy	Coef.	Std. Err.	*z*	*P*>z
Main effect				
GDP	7.98E-13	5.77E-12	0.14	0.89
Population	3.14E-08	1.73E-08	1.81	0.071
Corruption	0.002829	0.013215	0.21	0.83
Rule of Law	0.02962	0.01154	2.57	0.01*
Political Instability	−0.01855	0.007739	−2.4	0.017*
_cons	27.23932	2.839816	9.59	0.000*
Wx				
GDP	2.11E-11	1.02E-11	2.07	0.038**
Population	1.18E-07	2.64E-08	4.45	0.000*
Corruption	0.047065	0.028556	1.65	0.099
Rule of Law	0.019489	0.021044	0.93	0.354
Political Instability	−0.03914	0.012821	−3.05	0.002*
Spatial rho	0.528899	0.040307	13.12	0.000*
Variance lgt_theta	−3.01606	0.129579	−23.28	0.000*
$sigma^2$_e	0.794541	0.056098	14.16	0.000*
Direct effect				
GDP	4.84E-12	7.11E-12	0.68	0.496
Population	5.67E-08	1.96E-08	2.9	0.004*
Corruption	0.01433	0.014897	0.96	0.336
Rule of Law	0.02912	0.012509	2.33	0.02**
Political Instability	−0.0284	0.008628	−3.29	0.001*
Indirect effect				
GDP	4.13E-11	2.24E-11	1.85	0.065
Population	2.57E-07	5.32E-08	4.82	0.000*
Corruption	0.098604	0.05557	1.77	0.076
Rule of Law	0.007977	0.040399	0.2	0.843
Political Instability	−0.09606	0.025903	−3.71	0.000*
Total effect				
GDP	4.62E-11	2.75E-11	1.68	0.093
Population	3.13E-07	6.57E-08	4.77	0.000*
Corruption	0.112934	0.065052	1.74	0.083
Rule of Law	0.02114	0.047547	0.44	0.657
Political Instability	−0.12446	0.031704	−3.93	0.000*

Note: *, ** indicate 1% and 5% levels of significance, respectively.

TABLE A3 | Results of the SDM analysis for education level (Rook Contiguity criteria).

Education level	Coef.	Std. Err.	*z*	*P*>z
Main				
GDP	7.21E-12	2.52E-12	2.86	0.004*
Population	2.32E-08	7.87E-09	2.95	0.003*
Corruption	0.000618	0.005794	0.11	0.915
Rule of Law	0.009973	0.005051	1.97	0.048**
Political Instability	0.002764	0.003376	0.82	0.413
_cons	7.947351	0.808849	9.83	0.000*
Wx				
GDP	8.85E-12	4.47E-12	1.98	0.048**
Population	4.67E-08	1.18E-08	3.96	0.000*
Corruption	1.42E-05	0.012604	0	0.999
Rule of Law	0.00626	0.009328	0.67	0.502
Political Instability	0.01134	0.005529	2.05	0.04**
Spatial rho	0.106992	0.058182	1.84	0.066
Variance lgt_theta	−3.05478	0.133468	−22.89	0.000*
sigma^2_e	0.152935	0.010639	14.37	0.000*
Direct effect				
GDP	−7.06E-12	2.61E-12	−2.71	0.007*
Population	2.42E-08	7.79E-09	3.11	0.002*
Corruption	0.001268	0.005573	0.23	0.82
Rule of Law	0.009648	0.004892	1.97	0.049**
Political Instability	−0.002416	0.003271	0.74	0.46
Indirect effect				
GDP	8.75E-12	5.14E-12	1.7	0.089
Population	5.32E-08	1.21E-08	4.39	0.000
Corruption	0.000862	0.013458	0.06	0.949
Rule of Law	0.00557	0.010114	0.55	0.582
Political Instability	0.0125	0.006084	2.05	0.04**
Total effect				
GDP	1.68E-12	6.26E-12	−0.27	0.788
Population	7.75E-08	1.51E-08	5.14	0.000*
Corruption	0.002131	0.014955	0.14	0.887
Rule of Law	0.004078	0.011127	0.37	0.714
Political Instability	0.01008	0.007337	−1.37	0.169

Note: *, ** indicate 1% and 5% levels of significance, respectively.