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Achieving sustainable development goals: do governance and foreign direct investment matter?

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This study extends previous sustainability literature by demonstrating how good governance and foreign direct investment (FDI) promote the achievement of sustainable development goals (SDGs)—overall and their economic, social, and environmental pillars. Good governance and FDI are considered key macroeconomic and institutional determinants that shape SDGs in Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA). Using a balanced panel of 56 SSA and MENA countries from 2000 to 2022, we address cross-sectional dependence, endogeneity, and heterogeneity by employing advanced econometric techniques. The findings reveal that governance and FDI positively contribute to achieving overall and economic SDGs, while oversight has a marginally significant positive effect on social sustainability. However, governance and FDI have a positive but insignificant effect on environmental sustainability. The region-specific analysis further reveals that governance and FDI contribute marginally significant influence on SDGs progress in the SSA and MENA regions, with observed differences across countries due to the differences in institutional frameworks. The study applied several robustness analyses, confirming the validity of our main results. This study highlights valuable insights to policymakers by providing guidance on developing strategies to enhance the progress toward the achievements of the SDGs through governance reforms and investment policies.

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Introduction

Sustainable development aims to improve quality of life and promote economic self-sufficiency while balanced economic growth and environmental protection (Kingsbury et al. 2004; Megwai et al. 2016). The 2030 Agenda for sustainable development offers an integrated farmwork to address environmental challenges and resource shortages caused by human activities (UNEP, 2019). The economic, social and environmental pillars provide a crucial role to address challenges and implementing green policies for the economy (Purvis et al. 2019).

Effective institutions, transparency and accountability provide a foundation for aligning governance with sustaianble development goals. The Worldwide Governance Indices (WGI) provides six dimensions of governance: control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability (Kaufmann et al. 1999). Previous studies has established relations between governance and progress in achieving the overall SDGs (Boța-Avram et al. 2018), economic sustainable (Safdar et al. 2022), social sustainable (Almaqtari et al. 2024) and environmental sustainability (Omri and Mabrouk, 2020).

Like other developing countries, Sub-Saharan African (SSA) and Middle East and North African (MENA) have global governance challenges and limit financial resources that affect the achievements of SDGs. In the both regions, corruption is a widespread phenomenon affecting government expenditure, governance quality and political conflicts (Ahmed and Anifowose, 2024; Farooque et al. 2022). In this case, foreign direct investment (FDI) considers as a significant resource of technological transfer in enhancing SDGs (Aust et al. 2020; Izadi and Madirimov, 2023) and supporting environmental quality (Bokpin, 2017; Haibo et al. 2019).

Empirical studies in the literature on the relationship between governance, FDI, and SDGs provide mixed findings. Most studies show that governance and FDI have a negative effect, while other studies argue that governance and FDI contribute significantly in achieving the SDGS. Moreover, most studies on the relationship between governance, FDI, and SDGs in the context of developed countries. However, there are only few studies in developing countries, especially in SSA and MENA countries.

To address this gap, this study examines segmented and pooled analysis to which governance quality and FDI influence overall SDG and the three pillars, economic, social and environmental sustainability. This study addresses the following research questions: (1) To what extent do governance and FDI contribute to achieving SDGs in SSA and MENA countries? (2) How do they influence the three dimensions of SDG in these contexts? Based on the conceptual frameworks of Costanza et al. (2016) and Barbier and Burgess (2017), this study examines the extent to which high-quality governance and FDI are significantly associated with progress in all three SDG pillars. While previous studies have explored the independent effects of governance and FDI on sustainable development, this research is among the first to analyse their interactive effects using region-specific insights.

This study contributes to the body of knowledge on sustainable development in several significant ways. First, most prior studies rely on partial proxies of sustainable development, such as CO_2 emissions, economic growth, or social indexes, such as education, health and employment in isolation, our study comprehensively investigates all three pillars of sustainable development (eg. economic, social and environmental sustainability), providing more details and integrated perspective on sustaianble development. Second, instead of relying on single concept governance measures, we construct a governance quality index that combines six institutional dimensions using principal components analysis (PCA), which more reflects governance quality measure. Third, this study focuses on SSA and MENA regions to address a clear geographical gap; only a limited number of studies have examined the relationship between governance, FDI and SDGs in SSA and MENA. However, both regions have governance and investment challenges. By understanding and providing stronger, region-specific insights results, this study significantly contributes insights for policymakers and regulators to address institutional and governance challenges. Fourth, unlike other research that analyses governance or FDI independently, this study offers a dual view by looking at their separate and combined effects on overall SDGs and its three pillars: economic, social and environmental. This all-encompassing approach helps scholars better grasp the interactions between institutional quality and foreign capital flows that influence development routes. Fifth, this study applied a segmented regional analysis that helps understand how institutional and governance quality enhance the progress toward the sustainable development goals in both regions. By examining heterogeneity among SSA and MENA regions, and revealing that while both governance and FDI are promoting the progress of the SDGs, the size and significant influence of these impacts differ by nation. These results underscore the need of prioritising region-specific insights, governance reforms and local policies to enhance governance systems and investment approaches in accordance with their institutional frameworks. Finally, this study provides region-specific recommendations and demonstrates how governance reforms and FDI can be aligned with differences local institutions to contribute significantly to the achievement of the SDGs in SSA and MENA countries. To address these contributions, this study offers new insight into how governance and FDI aligned with Sustainable development goals in developing countries.

We structure the remaining sections of this paper as follows: "Literature review and hypothesis development" reviews the relevant literature and develops the hypotheses. "Data and methodology" describes the methodology and data. "Empirical results and discussion" presents the empirical findings, including the robustness checks, and discusses their implications. "Conclusion and Policy Implications" concludes the study and offers recommendations.

Literature review and hypothesis development

According to transition theory, existing sociotechnical systems must undergo an essential multidimensional and long-term change in governance structure to shift successfully towards more sustainable initiatives (Markard et al. 2012). A reaction to the ongoing challenges encountered by contemporary cultures, a sustainability transition is an extensive move towards creating an environmentally and socially sustainable society (Grin et al. 2010). On the basis of transition theory, sustainable development is a slow, complex path towards more sustainable circumstances wherein institutions, technologies and economies are progressively changing. These revolutions require coordinated changes in social customs, economic policies and governance structures across countries (Loorbach, 2010). Good governance promotes learning systems, long-term strategic visioning and multi-actor involvement. Strong governance systems help match government policies with SDGs, encourage stakeholder involvement and enable sustainable investments (Abhayawansa et al. 2021). Meanwhile, FDI advances sustainable transitions through creative technologies. It can support sustainable infrastructure and renewable energy by learning and scaling sustainable ideas within a framework of strong governance (Wang et al. 2023). Understanding the dynamics of transitions in social systems requires adopting a comprehensive perspective that considers the

interaction between social factors and other elements—not only the dimensions related to human beings but also environmental, economic and technical factors.

Key sustainability challenges in MENA and SSA. The MENA region faces significant challenges in promoting sustainable development via structural reforms aimed at fostering inclusive societies and facilitating economic diversification and growth (El-Anis, 2018). The Organization for Economic Co-operation and Development (OECD, 2016) asserts that achieving sustainable development in the MENA region necessitates a strong emphasis on implementing effective policies aimed at rural and urban development to foster sustainable and inclusive growth. MENA efforts should enhance urban-rural development relations. Several MENA countries have had political and economic crises in the 21st century, causing significant human and economic repercussions (Fardoust, 2016). Inadequate economic governance, coupled with the repercussions of the COVID-19 pandemic and conflicts necessitating substantial military expenditures, has intensified the pressure on many MENA nations to implement more effective social and economic policies to stimulate economic growth (Ismail et al. 2018). Despite a decline in poverty rate across MENA countries in recent decades, the overall number of individuals living in poverty has remained relatively stable, which is attributed to the region's high population growth rate (Ismail et al. 2018). Moreover, income inequality persists in MENA, marked by significant disparities in living standards among various population groups, high unemployment rates and the challenges faced by youth in coping with rising living costs (Halpern, 2015). Although MENA countries have ecosystems, infrastructure and financial resources to address these challenges (Jawad, 2015), the lack of government transparency, accountability and women's development limits their SDG achievement (World Bank, 2023). Environmental sustainability requires access to clean and efficient energy (Bishoge et al. 2020). Consequently, SSA countries are prone to the environmental effects of non-renewable energy. SSA countries have several energy resources, but social and political factors lead to human and financial restrictions. Unstable institutional and regulatory frameworks deter the implementation of such resources (Bishoge et al. 2020). Toh (2016) classifies the obstacles to achieving sustainable development outcomes in SSA as 'destiny' elements and 'policy' factors. Despite the challenges related to ethnic division and their vulnerability to the negative effects of climate change and energy issues, SSA countries such as Rwanda, Botswana and Uganda have achieved rapid economic growth.

Governance and sustainability. Haghighi and Takian (2024) argue that governance is highly correlated with economic sustainable development, suggesting that a better quality of governance structure enhances economic SDGs. Good governance encompasses organisational concerns, social equity and inclusivity. A collection of qualitative characteristics, pertaining to the procedures for creating rules and their organisational foundations, connects these factors. Sadiq et al. (2023) examine the environmental, social and governance factors in the efforts of ASEAN nations to achieve sustainable development targets from 1986 to 2020. Their findings indicate a significant correlation between environmental, social, governance and economic growth and the SDGs. Bowen et al. (2017) highlight accountability as a significant governance challenge and stress the importance of implementing monitoring mechanisms to track progress at the country level. It is not surprising, therefore, that governance challenges allow the formation of dysfunctional institutional structures. Governance challenges around the rule of law are broadly identified as determining factors for corruption, with Forson et al. (2016) going so far as to declare that only when the rule of law prevails can sustainable development be guaranteed. Accountability in this context is about the duty of the government to show effective governance towards the achievement of national goals, accommodating the demands of the public and accepting responsibility for enforcing punishments or sanctions (Forson et al. 2016). Ahlerup et al. (2016) argue that poor governance is a significant issue throughout Africa because of its highly fragmented ethnic profile. In turn, ethnic fragmentation has been linked to poor socioeconomic development outcomes in Africa by some commentators, who point to the link between economic growth and its likelihood of increasing average incomes. Such increases in income may also affect income distribution and, therefore, economic inequality among population groups. In countries with different ethnic groups but one main ethnic group, if smaller ethnic groups start to do better economically, the government might create policies that favour the main group, which could limit the ongoing economic growth. Ahlerup et al. (2016) analyse datasets for 20 SSA countries from 1999 to 2015 for any signs of correlation between defined periods of sustained growth and indicators of perceived impartiality in the governments' exercise of authority. They define sustained growth as a 2% or higher increase in gross domestic product (GDP) per capita for at least five consecutive years. The results of their study indicate that the selected SSA countries' governments, which were viewed as impartial by ethnic minorities, are more likely to show sustained economic growth.

Governance is further linked to the social dimension of sustainable development in terms of the way government institutions and policies enhance human development and the citizens' standard of living (Davis, 2017). Three aspects of good governance have long been associated with positive outcomes of sustainable social development: prevention of corruption, education of and communication with citizens, and implementation and enforcement of targeted social policies. Davis (2017) investigates the association between good governance and human development in SSA countries and finds a strong relationship between good governance and overall human development. Specifically, government policies and initiatives help improve government effectiveness and political stability.

Asongu and Odhiambo (2020) investigate how good governance affects the relationship between environmental damage and human development in 44 SSA countries from 2000 to 2012, focusing on environmental indicators. They find that the quality and enforcement of regulations and institutional governance in terms of the control of corruption and the rule of law have a modulating effect on CO_2 emissions, leading to a net negative effect on human development. Newell et al. (2019) examine the relationship between governance challenges and the implementation of climate-smart agriculture to achieve the UN SDGs in four SSA countries: Kenya, Tanzania, Ethiopia and Rwanda. Their findings indicate that all four countries demonstrates effective policy governance aimed at achieving sustainable development outcomes. Vyas-Doorgapersad (2021) discusses whether global governance is effective enough to uphold economic development and capable of combating poverty to achieve SDG 1 in BRICS countries. The results validate the notion that comprehensive governance cannot achieve full success without addressing issues of credibility and participation. Barbier and Burgess (2021) confirm that successful long-term sustainable development is related to sound governance and the efficacy of institutions.

Other studies have highlighted the influence of governance in different ways. Omri and Mabrouk (2020) discover a relationship between governance and both human development and GDP. Farooque et al. (2022) reveal that governance has a beneficial

effect on economic growth. Achim, Văidean, and Safta (2023) demonstrate a significant impact of governance on sustainable development. Knox and Orazgaliyev (2024) reveal that poor governance, which is often associated with authoritarian nations, has a detrimental influence on SDG achievement. Baloch and Wang (2019) reveal that effective governance results in a decrease in CO_2 emissions in BRICS nations. Ahmed and Anifowose (2024) examine the relationship between corruption, corporate governance and SDG achievement in Africa. Their findings reveal that governance has a positive impact on the achievement of SDGs. Asongu and Odhiambo (2021) investigate the effect of income-driven governance on the human development index as a sustainable development outcome in the SSA region from 2000 to 2012. The researchers find that governance driven by 'middle income' SSA nations has a greater effect on inclusive human development than governance driven by 'low income' SSA nations. To support environmental, social and governance sustainability with circular economy alignment, companies should invest in cleaner production technologies and include sustainability committees in their governance systems (Agyemang et al. 2025).

The relationship between governance and sustainable development in MENA countries is of particular interest given their general geographical positioning at the nexus points of Africa, Asia and Europe and the potential for strong growth across their tourism, business services and green energy sectors (Omri and Mabrouk, 2020). Indicators of governance quality, such as those established by the World Bank in 2016, show that MENA countries generally achieve poor results in terms of corruption control and the quality or efficiency of government institutions. Many MENA countries are actively pursuing institutional development, modernising their decision-making processes through structural adjustments and upgrading their governance systems. Omri and Mabrouk (2020) explore the effect of good economic, political and institutional governance on three aspects of sustainable development outcomes—economic, environmental and social—in 20 MENA economies from 1996 to 2014. Their results indicate that political and institutional governance positively influenced all three aspects of sustainable development. Awijen et al. (2022) examine the relationship between governance and renewable energy, finding that good governance positively affects renewable energy initiatives.

Simionescu et al. (2021) suggest that government efficiency has a mitigating impact on pollution in both the short and long term. Additionally, suppressing corruption and adhering to the rule of law contribute to the long-term preservation of the environment. Previous studies have typically focused on examining the impact of governance on SDGs using country-level data and specific governance indicators. The economic, social and environmental impacts of FDI vary across studies. Certain studies identify beneficial effects, such as economic expansion and information dissemination; others emphasise adverse outcomes, including environmental degradation and labour exploitation. The evidence is contradictory, showing that FDI is neither naturally advantageous nor detrimental; instead, its effects depend on other factors. A robust governance structure may affect the impact of FDI by ensuring that foreign investments align with sustainability goals. Strong governance, including regulatory quality, anti-corruption measures and institutional effectiveness, promotes responsible investment and discourages exploitative business behaviour. It guarantees rights and promotes environmental sustainability. By contrast, weak governance increases the probability of profit repatriation, corruption and environmental deterioration, resulting in less accountability. Hence, it complicates the use of FDI for sustainable development. The existing literature suggests that the link between governance and sustainable development is inconclusive. Based on the mixed findings in the literature, we formulate the following hypotheses:

H1a: Governance contributes significantly to the achievement of overall SDGs in SSA and MENA countries.

H1b: Governance has a significant effect on the achievement of economic SDGs in SSA and MENA countries.

H1c: Governance contributes significantly to the achievement of social SDGs in SSA and MENA countries.

H1d: Governance has a significant influence in advancing environmental SDGs in SSA and MENA countries.

Foreign direct investment and sustainability. Several studies examined the role of foreign direct investment in shaping sustainable development and the findings remain underexplored. In this context, Odugbesan et al. (2022) reveal that FDI have an indirection causal association with sustaianble development in 33 SSA countries. Similarly, Aust et al. (2020) confirm a positive relationship between FDI and the SDG. They find that FDI has the greatest positive impact on achieving SDGs in North Africa compared to East Africa. Izadi and Madirimov (2023) argue that FDI has a positive and statistically significant impact on SDG scores. However, other studies find an insignificant relationship between FDI and sustainable development as measured by renewable energy (Saygın and İskenderoğlu, 2022). Guoyan et al. (2022) analyse the factors affecting CO_2 emissions and threatening environmental sustainable development in MENA countries. In particular, they explore the nonlinear association between CO_2 emissions and FDI in these countries using annual data from 1995 to 2016. Applying the panel smooth transition regression model, the researchers find a nonlinear nexus point between the two variables. Additionally, their results indicate that at low economic regimes, FDI increases CO_2 emissions, but as the economy progresses to a high regime, a negative and significant relationship emerges between the two variables. The study also confirms that FDI can lead to a reduction in CO_2 emissions upon reaching a particular threshold point. According to Aust et al. (2020), foreign investors play a crucial role in the success of African countries, especially in North Africa. Political and civil rights play a crucial role in understanding SDG scores, as countries with more stability are better able to achieve economic, social and environmental sustainability.

Yi et al. (2023) argue that FDI has a significant role in reducing Co2 emission and enchaining environmental revaluations. Foreign investment may enhance environmental legislation and significantly reduce carbon emissions in resource-intensive industries. In China, FDI significantly influences the restructuring of the country's manufacturing sector by introducing new technology (Yi et al. 2023). Similarly, Tang et al. (2020) argue that countries with high levels of globalisation achieve excellent performance in achieving SDGs. Nevertheless, when technology is transferred via FDI, it has both positive and negative impacts on carbon emissions. FDI has resulted to fewer carbon emissions, which has made China's manufacturing sector more energy-efficient. Innovative industries and novel technologies that reduce carbon emissions are examples of a positive effect of FDI. On the other hand, FDI has adverse impacts since it makes it easier for enterprises that affect significantly to shift their operations from nations with strict environmental regulations to ones with fewer strict ones. This makes carbon emissions worse. Ridzuan et al. (2017) explore how FDI and trade openness contribute to achieve sustainable development. They concluded that FDI helped Malaysia grow quicker, share revenue more equitably, and cut down on pollution. Their results also show that although trade openness helps development and lowers economic inequality, it does not have much of an effect on the quality of the environment.

The pollution haven hypothesis posits that when high-income economies invest in nations with weak climate rules, such investment may have detrimental effects on the host countries because it leads to the transfer of polluting technology, commodities and services to such countries (Sarkodie and Strezov, 2019). The significance of FDI for sustainable development can be seen in the results of Kardos (2014), who highlight the significance and pertinence of FDI in companies that impact the environment. Jugurnath and Emrith (2018) examine how FDI contributed to environmental degradation in small island developing states from 2004 and 2014. They conclude that FDI did not contribute to environmental deterioration during the study period. Li et al. (2019) examine the correlation between FDI and environmental performance and find that FDI had an insignificant impact on environmental performance in the whole sample. On the other hand, Ayamba et al. (2020) discovered that FDI has an insignificant influence on environmental quality in China. In summary, the influence of FDI on the environmental performance of developing countries is insignificant. Previous studies concentrate on the environmental impacts of FDI or its economic advantages without focusing on all three pillars of sustainable development: economic, social and environmental sustainability. Therefore, to address this gap, this study examines the effects of FDI on economic, social and environmental sustainable development. Specifically, it assesses the trade-offs and synergies among the economic, social and environmental outcomes of FDI in SSA and MENA countries. The mixed findings of the literature inform the formulation of the following hypotheses:

H2a: FDI has a significant positive association with overall SDGs in SSA and MENA countries.

H2b: FDI has a positive association with economic SDGs in SSA and MENA countries.

H2c: FDI has a significant relationship with social SDGs in SSA and MENA countries.

H2d: FDI has a significant positive association with environmental SDGs in SSA and MENA countries.

Data and methodology

Data. This study aims to investigate the impact of governance and FDI on the achievement of overall SDGs, focusing on the three pillars of sustainable development: economic, social and environmental. It utilises balanced panel data from 2000 to 2022, covering 56 countries in SSA and MENA. These countries are selected because of their low governance quality and SDG challenges. Several countries in SSA and MENA face governance challenges that interfere with SDGs. Owing to missing data, we reduce the sample to 56 countries. SDG indicators are derived from the United Nations Development Programme (UNDP), whereas other variables are obtained from World Bank data.

Measurement of variables

Dependent variables. Sustainable Development Goals: Practices related to SDGs are categorised into economic, social and environmental SDGs. These SDGs serve as dependent variables for this study. The economic ECO_SDGs index measures a country's progress towards achieving the economic-related targets of SDGs. It includes 7 of the total 17 SDGs. The social SOC_SDGs index includes 5 of the total 17 SDGs. A high index score indicates that corporations are committed to generating a good social effect via their economic activity. The environmental ENV_SDGs index refers to the capacity of a corporation to maintain and safeguard the natural environment over a prolonged period by implementing suitable practices and regulations. It includes 5 of the total 17 SDGs (Barbier and Burgess, 2017).

Independent variables. Governance quality (GOV), this study employed the Worldwide Governance Indicators developed by World Bank to measure national governance quality. Kaufmann et al. (2011) identified six indicators of governance: voice and accountability, political stability, government effectiveness quality, regulatory quality, rule of law, and control of corruption. To avoid potential weighting biases and the higher intercorrelations among the six of governance dimensions, this study applied a principal components analysis (PCA) to create a composite measure for the overall GOV dimensions.

Foreign direct investment: FDI is crucial in promoting sustainable development and achieving SDGs. It is more significant in developing countries as it is the primary source of their external financing (Acquah and Ibrahim, 2020). Establishing strong collaboration across nations with different economic levels is crucial for successfully addressing sustainability concerns (Caiado et al. 2018).

Control variables. This study includes gross domestic product, population and globalisation index as control variables due to their significant influence on a country's economic growth and market. They reflect the overall macroeconomic indicators, which could influence a country's ability to involved in the global system, support governance, attract foreign direct investment and implement policy that enhances sustainable development goals. Including these variables ensures a more accurate estimation of the relationship between governance, FDI and SDGs by mitigating omitted variable bias and capturing the broader macroeconomic and structural context. Gross domestic product reflects a country's level of economic development and resource availability, which significantly affects nation's ability to contribute to achieving economic, social and environmental sustainability. It is measured as the natural logarithm of gross domestic product (Anas et al. 2024). Another critical element is population size, which is measured as the natural logarithm of the population total (Sharif et al. 2023). Globalisation may be enhancing the flow of technology and capital, which could improve governance and support to achieve sustainable development goals. It is measured as The KOF overall globalisation index (Zafar et al. 2019). Another significant control variable, the size of the government plays a significant role in progressing toward the SDGs, through government expenditures. Where the government size influences the quality of government services, including health, education, infrastructure, and environmental activities. These elements together contribute to achieve SDGs. Also, the size of the government may have an effect on governance and foreign direct investment. For example, countries with a higher score of government size are more likely to have robust institutions, higher level of environmental protection, implementations of regulations and rules that contribute to attract FDI. thus, leads to achieving SDGs. Table 1 presents the variables and data sources utilized in this study.

Estimation technique. The study employs a panel data method to address heterogeneity and CD issues. Following Pesaran and Yamagata (2008), we employ a slope homogeneity test to assess the variability of slope coefficients across countries, recognising that differences in economic, social and environmental factors may result in heterogeneous effects. It is also probable that a panel will exhibit CD as a result of the growing trends of globalisation and economic integration (Hasan, 2019; Zaidi et al. 2019). Thus, CD must be examined before the panel is estimated. The study employs a CD test developed by Pesaran (2021). Next, we conduct stationarity tests using second-generation unit root tests, such as the CADF and CIPS test statistics, originally

Table 1 Measurement variables and data sources.

Variable Name	Definition	Symbols	Source
Dependent Variables			
Overall Sustainable Development Score	The SDG Index score is presented on a scale of 0 to 100 and can be interpreted as a percentage towards optimal performance on the SDGs.	SDGs	United Nations Development Programme (UNDP)
Economic SDGs	Average of seven SDGs developed by UNDP: SDG1 (No Poverty), SDG2 (Zero Hunger), SDG3 (Good Health and Well Being), SDG6 (Clean Water and Sanitation), SDG7 (Affordable and Clean Energy), SDG8 (Good Jobs and Economic Growth) and SDG9 (Industry, Innovation and Infrastructure). The average value lies between (0) and (100).	ECO_SDGs	United Nations Development Programme (UNDP)
Social SDGs	Average of five SDGs developed by UNDP: SDG4 (Quality Education), SDG5 (Gender Equality), SDG10 (Reduced Inequalities), SDG16 (Peace, Justice and Strong Institutions), SDG17 (Partnerships for the Goals). The average value lies between (0) and (100).	SOC_SDGs	United Nations Development Programme (UNDP)
Environmental SDGs	Average of five SDGs developed by UNDP: SDG11 (Sustainable Cities and Communities), SDG12 (Responsible Consumption and Production), SDG13 (Climate Action), SDG14 (Life Below Water), SDG15 (Life on Land). The average value lies between (0) and (100).	ENV_SDGs	United Nations Development Programme (UNDP)
Independent Variables			
Governance quality	It is calculated as a composite measure for the overall six dimensions of governance: voice and accountability quality, political stability quality, government effectiveness, regulatory quality, rule of law, and control of corruption.	GOV	World Bank
Foreign Direct Investment	Foreign direct investment, net inflows of capital expressed as a percentage of GDP.	FDI	World Bank
Control Variables			
Gross domestic product	Natural log of GDP per capita (current US$)	GDP	World Bank
Population	Natural log of total population	POP	World Bank
Globalisation Index	A composite index that measures globalisation (economic, social and political borders).	GI	KOF Swiss Economic Institute
Size of Government	It is measured expenditures, taxes and enterprises.	SG	Gwartney et al. (2021)

Source: Created by the authors

developed by Pesaran (2021) as well. We then use the second-generation cointegration technique developed by Westerlund and Edgerton (2007). Subsequently, we employ the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) approach because it effectively captures long-term dynamics in panel data while addressing critical econometric challenges common in macro panels. By applying CS-ARDL, we obtain reliable estimates of the long-term relationship among GO, DFI and SDG achievement while controlling for heterogeneity across countries and policy implications. Additionally, to address the issue of endogeneity that might arise from causal inference and missing data. We use the generalised method of moments (GMM) technique to account endogeneity issue. Lastly, we used the Augmented Mean Group (AMG) and the fixed effects-difference in differences (FE-DK) estimators to enhance the reliability and accuracy of the main results.

Model specification. The study constructs the models below to evaluate the impact of governance and FDI on SDGs in SSA and MENA countries. It uses a dynamic panel approach.

$$SDGs_{it} = \beta_0 + \beta_1 \mathrm{GOV}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \ln \mathrm{GDP}_{it} + \beta_4 \ln \mathrm{PoP}_{it} + \beta_4 GI_{it} + \beta_5 GS + \mu_{it} \quad (1)$$

$$ECO\_SDG_{it} = \beta_0 + \beta_1 \mathrm{GOV}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \ln \mathrm{GDP}_{it} + \beta_4 \ln \mathrm{PoP}_{it} + \beta_4 \mathrm{GI}_{it} + \beta_5 \mathrm{GS} + \mu_{it} \quad (2)$$

$$SOC\_SDG_{it} = \beta_0 + \beta_1 \mathrm{GOV}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \ln GDP_{it} + \beta_4 \ln PoP_{it} + \beta_4 GI_{it} + \beta_5 GS + \mu_{it} \quad (3)$$

$$ENV\_SDG_{it} = \beta_0 + \beta_1 \mathrm{GOV}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \ln GDP_{it} + \beta_4 \ln PoP_{it} + \beta_4 GI_{it} + \beta_5 GS + \mu_{it} \quad (4)$$

where *it* denotes the country and time period, and the overall sustainable development index (SDGs), economic sustainability (ECO_SDGs), social sustainability (SOC_SDGs) and environmental sustainability (*ENV_SDGs*) scores are the dependent variables. Governance quality (GOV) and FDI are the main independent variables. The logarithm of GDP, the logarithm of Population (POP), Globalisation Index (GI) and government size (GS) variables are the control variables, with each β representing the slope coefficient of independent variables, while μ_{it} is the error term.

Empirical results and discussion

Descriptive analysis. Table 2 presents the summary descriptive statistics for the whole sample and the two regional subsamples: MENA and SSA nations. The average SDGs scores for the whole sample, MENA nations and SSA nations are 54.76, 59.74 and 52.58, suggesting that MENA countries perform comparatively better in achieving SDGs. The average ECO_SDGs score across the sample is 46.34, suggesting that both regions continue to face significant challenges in achieving economic-related SDGs. Similarly, the average SOC_SDGs score is 49.99, indicating that both regions show relatively weak progress in this area. However, the average ENV_SDGs score is 66.15, implying that

Table 2 Summary descriptive statistics of variables.

Whole Sample (All countries)

Variables	Obs.	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis
SDGs	1288	54.76	7.98	37.4	72.9	0.16	2.22
ECO_SDGs	1288	46.34	13.66	23.7	75.7	0.38	1.86
SOC_SDGs	1288	49.99	10.48	24.6	77.2	0.10	2.46
ENV_SDGs	1288	66.15	8.82	38.28	82.19	−0.28	2.10
GOV	1288	33.36	19.56	1.51	77.15	0.36	2.10
FDI	1288	4.04	8.37	−17.29	103.34	6.24	57.02
GI	1288	50.80	10.64	24.62	77.51	0.363	2.55
GS	1288	6.53	1.14	2.39	10	−0.147	3.25
GDP	1288	7.58	1.47	4.73	11.49	0.54	2.40
Pop	1288	16.25	1.30	13.02	19.19	−0.39	2.62
Middle East and North African Countries							
Variables	Obs.	Mean	Std.Dev.	Minimum	Maximum	Skewness	Kurtosis
SDGs	391	59.74	7.83	43.6	72.9	−0.44	2.09
ECO_SDGs	391	55.78	13.01	28.9	75.7	−0.60	1.95
SOC_SDGs	391	56.95	9.87	37.2	77.2	−0.24	2.10
ENV_SDGs	391	65.68	9.22	43.78	80.63	−0.36	2.07
GOV	391	35.58	20.66	1.51	71.95	−0.04	1.74
FDI	391	2.41	2.74	−4.54	15.75	1.63	7.77
GI	391	58.33	10.86	34.40	77.51	−0.28	1.87
GS	391	6.22	1.20	2.39	9.10	0.214	3.00
GDP	391	7.91	1.47	5.45	11.49	0.55	2.41
Pop	391	16.44	1.34	13.46	19.19	0.02	2.19
Sub-Saharan African Countries							
Variables	Obs.	Mean	Std.Dev.	Minimum	Maximum	Skewness	Kurtosis
SDGs	897	52.58	7.01	37.4	70.9	0.26	2.68
ECO_SDGs	897	42.22	11.77	23.7	73.9	0.81	0.289
SOC_SDGs	897	46.96	9.21	24.6	71.4	0.06	2.68
ENV_SDGs	897	66.36	8.63	38.28	82.19	−0.23	2.08
GOV	897	32.39	18.98	1.75	77.15	0.56	2.40
FDI	897	4.70	9.75	−17.29	103.34	5.4	42.28
GI	897	47.52	8.71	24.62	71.22	0.33	3.37
GS	897	6.67	1.09	2.53	10.00	−0.284	3.65
GDP	897	7.44	1.45	4.73	10.92	0.55	2.35
Pop	897	16.17	1.27	13.02	18.61	−0.64	2.66

Source: Created by authors.

environmental sustainability is relatively well addressed in both regions, though significant efforts are still required to meet overall SDGs. The governance quality appears to have challenges in improving the level of SDGs among SSA region, suggests relatively weak institutional frameworks and could reflect limited transparency and a lack of accountability in both regions. The average proportion of FDI inflow to GDP is 4.04%, indicating that the SSA and MENA regions are integrating into the global economy via FDI. Regarding the Globalisation Index, the average GI is 50.80, suggesting an acceptable level of integration into the global economic and social system. Government size, the average is (6.53), suggesting that both countries have moderately sized government, while the average GDP is 7.58, and the average POP is 16.25.

Correlation analysis. Table 3 presents the correlation coefficients between independent and dependent variables. In particular, governance (GOV) is strongly linked to ECO_SDGs and SOC_SDGs, meaning that better institutional quality is connected to high scores in sustainable development but does show a low correlation with ENV_SDGs. FDI demonstrates an no significant correlation with all SDGs. The GI demonstrates a strong positive correlation with all SDGs, indicating that integration into the global system contributes to achieving them. GDP also has a significant positive association with the SDGs, while government size and population have a significant negative relationship with SDGs.

Comparative analysis between SSA and MENA countries. Table 4 provides a comparative analysis of governance, FDI and SDGs between the SSA and MENA countries. The analysis focuses on understanding the factors that shape the governance practice in both regions, including the influence of the three pillars of SDGs. SSA and MENA are two diverse economic and political systems that have differing degrees of development, regulations, and cultural components. When you consider governance, FDI, and SDGs in SSA and MENA nations, you observe that their overall, economic, and social SDG ratings are quite different. MENA countries demonstrate a significantly higher average SDGs score (59.74) compared to SSA countries (52.58), with a difference at $p < 0.01$. MENA countries are also showing a higher average ECO_SDG score (55.78) compared to SSA countries (42.22). Moreover, the average SOC_SDGs score is significantly higher in MENA (56.95) than in SSA (46.22). Nonetheless, the average ENV_SDG scores of both regions are comparable. The governance quality (GOV) is slightly higher in MENA than in SSA countries, indicating that these regions are facing challenges related to poor governance indices, including lack of transparency, insufficient regulatory quality and low accountability. These obstacles impede development on the SDGs. SSA countries attract more FDI compared to

Table 3 Correlation analysis.

Variables	Name	1	2	3	4	5	6	7	8	9	10
1	SDGs	1.000									
2	SDG_ECO	0.93***	1.000								
3	SDG_SOC	0.91***	0.82***	1.000							
4	SDG_ENV	0.27***	0.07***	0.07***	1.000						
5	GOV	0.58***	0.63***	0.55***	0.006*	1.000					
6	FDI	0.021	−0.005	0.036	0.002	0.092***	1.000				
7	GI	0.72***	0.74***	0.64***	0.15***	0.60***	0.05*	1.000			
8	GS	−0.09**	−0.07**	−0.16**	0.017	−0.04*	0.025	0.051*	1.000		
9	GDP	0.08***	0.15***	0.18***	0.13***	0.05*	0.04*	0.11***	−0.04	1.000	
10	POP	−0.05**	−0.12***	−0.14***	−0.023***	−0.19**	−0.04*	0.001	0.02	0.12*	1.000

***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Table 4 Comparison of the mean differences between SSA and MENA for all variables.

Variables	All sample		SSA countries		MENA countries		*t*-value
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	
Panel A: Dependent variables, Sustainable development goals							
Overall SDGs	54.76	7.98	52.58	7.01	59.74	7.83	15.55***
ECO_SDGs	46.34	13.66	42.22	11.77	55.78	13.01	17.68***
SOC_SDGs	49.99	10.48	46.22	9.21	56.95	9.87	17.04***
ENV_SDGs	66.15	8.82	66.36	8.63	65.95	9.22	−1.24
Panel B: Independent variables							
GOV	−1.58	1.00	−0.18	0.91	0.41	1.06	9.66***
FDI	4.04	8.37	4.70	9.75	2.41	2.74	−6.47***
GI	50.80	10.64	47.52	8.71	58.33	10.86	17.40***
GS	6.53	1.14	6.22	1.20	6.67	1.09	−8.93***
GDP	7.58	1.47	7.44	1.45	7.91	1.47	.5.37***
POP	16.25	1.30	16.17	1.27	16.44	1.34	3.34***
No of observations	1288		897		391		

*** is a significant level at <0.01.

Table 5 Cross-sectional dependence and unit root tests.

Variable	CD test	CIPS 1(0)	CPIS 1(1)	CADF 1(0)	CAFD 1(1)
SDGs	145.1***	−1.86	−4.32***	−1.60	−2.04***
SDG_ECO	152.57***	−2.26***	−4.60***	−1.80	−2.83***
SDG_SOC	104.42***	−1.93	−4.28***	−1.73	−2.32***
SDG_ENV	41.11***	−2.66***	−5.05***	−1.87	−2.43***
GOV	4.20***	−2.33	−4.78***	−1.78	−2.56***
FDI	13.31***	−2.83***	−5.08***	−2.28	−2.58***
GI	154.27***	−2.65***	−4.80***	−2.23	−2.52***
GS	3.40***	−2.20***	−4.60***	−2.25	−2.65***
GDP	146.27***	−2.63	−4.08***	−1.68	−2.56***
POP	181.33***	−1.93***	−2.41***	−1.79	−2.25***

CD is cross-sectional dependence, CIPS is the Pesaran unit root test, and CADF is the augmented Dickey-Fuller test in the presence of CD. *** represent statistical significance at 0.01 level, H0: Cross-sectional Independence.

MENA countries, but the average GI is significantly higher in MENA countries than in SSA countries.

Cross-sectional dependence and panel unit root tests. CD in panel data occurs when the residuals of different cross-sectional units (e.g. countries) are connected with each other. Its significance resides in its potential to result in skewed and ineffective statistical estimations, inaccurate standard deviations and, eventually, untrustworthy conclusions if not adequately resolved. Given that this study involves an in-depth analysis of the presence of CD in panel data, it conducts a CD test to detect this issue in our models. The CD test statistics were initially developed by Bailey et al. (2016); Chudik and Pesaran (2015); and Pesaran (2021). We then test the existence of CD issues in the study models. The results reported in Table 5 indicate the existence of a CD issue in all variables. Once this issue is addressed, the next stage involves establishing the order of integration for this study. We perform second-generation unit root tests, the CIPS and CADF panel unit root tests.

Table 5 shows that, according to CADF and CIPS statistics, almost all variables in the model demonstrate stationarity in the first difference at a significance level of at least 1%. At this significance level, the null hypothesis of non-stationarity is rejected, confirming that these series follow an I(1) process. We can also verify that none of our variables are integrated in the second order.

Slope homogeneity tests. Table 6 presents the results of the slope homogeneity tests for our models. The statistical results indicate that the slope coefficients across the panel are heterogeneous, which means the relationship among governance, FDI and SDG achievement differs significantly across countries, which justifies the use of the CS-ARDL estimator that allows for slope heterogeneity.

Test for panel cointegration. We apply Westerlund (2007) analysis to the cointegration order between our variables. Table 7 presents the cointegration test findings, indicating the existence of cointegration between the variables. The results demonstrate

cointegration in both the group mean (Gτ and Ga) and panel mean (Pτ and Pa), thus rejecting the null hypothesis of no cointegration.

CS-ARDL results and discussion. Following the assessment of cross-sectional dependence among the variables, we estimate the long- and short-term relationships among governance, FDI and SDGs using the CS-ARDL technique. This estimation is due to the increased likelihood of CD and slope heterogeneity in panel data analysis when many nations are being examined. The panel data analysis strategy developed by Chudik and Pesaran (2015) utilises the dynamic common correlated impact approach to control potential problems of CD and heterogeneity in panel data. Table 8 reveals the results of CS-ARDL estimations as below:

The findings from CS-ARDL estimations shown in Table 8, which evaluate the long- and short-run relationships among governance, FDI and SDGs, are split across overall, economic, social and environmental dimensions in SSA and MENA countries. The ECTs in all models are significantly negative at $p < 0.01$, which reflects the stability of the study models. In Model 1, the results reveal that governance is positively significant association with the achievement of overall SDGs (coefficient = 0.397, $p < 0.05$), which is one unit increase in governance is related with a 0.40-point improvement in overall SDG, therefore supporting H1a. in this case, effective governance serves as a valuable critical for countries that enhances progress towards SDG achievement. A possible explanation for this result could sound governance significantly contribute SDG progress. It is in line with the perspective in transition theory that countries with robust governance systems tend to achieve SDGs. In addition, it is consistent with the findings of Ahmed and Anifowose (2024) and Sadiq et al. (2023), who confirm that governance improves the progress towards achieving SDGs for a nation by enhancing accountability, transparency and supportive institution efficiency. Hence, good governance guarantees SDG achievement. Consistent with the literature supporting the argument that good governance improves progress towards economic SDGs (ECO_SDGs), in this study, governance has a significant positive relationship with economic SDGs (coefficient = 0.476, $p < 0.05$) in the long run in Model 2. Indicating that a one unit increased in the governance score leads to increase 0.48-point in progress toward the achievement of economic sustaianble development. In the short run, governance is positive and statistically significant, and this result again exhibits the same trend in the long run. A possible explanation for this finding may be that sound governance is considered a vital factor of macroeconomic and institutional determinants that could affect economic sustainability in SSA and MENA regions, therefore supporting H1b. This result is consistent with those of

Table 6 Slop homogeneity test.

Test	Model 1	Model 2	Model 3	Model 4
Delta	11.30***	10.03***	5.26***	5.50***
Delta adj.	14.70***	13.06***	6.84***	7.15***

***, **, * represents statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Table 7 Results of Cointegration Tests.

Statistic	Model 1		Model 2		Model 3		Model 4	
	Value	*P*-value	Value	*P*-value	Value	*P*-value	Value	*P*-value
Gτ	−2.63	0.005***	−2.95	0.000***	−2.52	0.064*	−3.17	0.000***
Ga	−24.02	0.000***	−25.57	0.000***	−15.12	0.000***	−16.48	0.000***
Pτ	−14.68	0.006***	−16.99	0.083*	−15.01	0.024**	−22.52	0.000***
Pa	−14.87	0.000***	−18.66	0.000***	−10.97	0.006***	−15.75	0.000***

***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Table 8 Results of CS-ARDL Estimations.

Independent variables	Dependent Variables			
	Overall SDs	ECO_SDGs	SOC-SDGs	ENV_SDGs
	Model 1	Model 2	Model 3	Model 4
Long run				
GOV	0.397** (0.175)	0.476** (0.173)	0.723* (0.367)	0.673 (0.392)
FDI	0.042** (0.019)	0.058* (0.031)	0.006 (0.078)	0.009 (0.080)
GI	0.036** (0.018)	0.033 (0.021)	0.016 (0.059)	−0.051 (0.049)
GS	−0.154** (0.05)	−0.029 (0.05)	−0.136 (0.136)	−0.184 (0.124)
GDP	0.195*** (0.075)	0.189** (0.091)	0.678** (0.310)	0.987** (0.423)
POP	−0.374 (2.779)	−3.462 (2.749)	−1.956 (3.88)	−0.169 (3.13)
Short run				
ECT	−0.778*** (0.074)	−0.834*** (0.047)	−0.546*** (0.037)	−0.986*** (0.052)
Δ GOV	0.260** (0.101)	0.273** (0.104)	0.460 (0.252)	−0.348 (0.203)
Δ FDI	0.012 (0.014)	0.042 (0.034)	0.019 (0.051)	−0.001 (0.040)
Δ GI	0.025* (0.015)	0.022 (0.013)	0.007 (0.038)	−0.029 (0.027)
Δ GS	−0.090* (0.03)	0.024 (0.034)	−0.067 (0.08)	−0.103 (0.06)
Δ GDP	0.103 (0.15)	−0.189 (0.16)	−0.12 (0.37)	0.527 (0.33)
Δ POP	−0.057 (1.75)	−1.88 (1.60)	−2.06 (2.55)	−0.65 (1.84)

Standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Barbier and Burgess (2021) and Haghighi and Takian (2024). Turning to social sustainability as a dependent variable in Model 3, the results indicate that governance have marginally significant positive influence on social sustainability (coefficient = 0.723, $p < 0.10$), indicting that good governance, such as enhancing transparency and accountability might support social sustaianble development goals (eg. reduce poverty, education, healthcare and equality) in long run, but insignificant effect in the short run. This finding means that a strengthening governance reform is associated with the computable progress in the social sustainability, thus marginally supporting H1c. A possible explanation for this finding could be that governance contributes to the attainment of social SDGs. In SSA and MENA countries, the governance index not only complements the promotion of economic development but also has great potential to marginally positive impact social sustainable development. Hence, the result in both regions highlights the need for governance reforms to stimulate the countries to improve their governance quality, especially focus for poverty, healthcare and education and reduce corruption, and achieve social sustainability. This is consistent with the findings of Omri and Mabrouk (2020) and Davis (2017), who analyse the relationship between governance and SDGs and reveal that political and institutional governance positively contribute to social SDGs. However, in Model 4, governance is positively but statistically insignificant associated with environmental sustaianble development goals in the long and short run in both nations. Therefore, H1d is rejected. This means that the governance systems in these countries, which focus on economic and social sustainable outcomes, have faced several challenges regarding effective environmental sustainable development. A possible explanation for this finding could be that environmental governance is still insufficiently prioritised. Issues such as global CO_2 emissions, energy poverty, climate change and environmental pollution persist in SSA and MENA countries. Governments in both regions need for targeted environmental pillar with sound governance and complementary investment policies.

Regarding the relationship between FDI and overall SDGs, the results reveal that FDI has a positive significant influence on overall SDGs (coefficient = 0.042, $p < 0.05$), in the long run in Model 1. Therefore, H2a is supported. The positive relationship indicates that FDI might contribute to progress toward the achievement of SDGs. In Model 2, the result shows a positive significant correlation between FDI and ECO_SDGS (coefficient = 0.058, $p < 0.10$), therefore, H2b is partially supported. These results indicate that foreign investors play a crucial role in facilitating the attainment of overall and economic SDGs in SSA and MENA. They are also in line with the findings of Aust et al. (2020) and Izadi and Madirimov (2023), who conclude that FDI can positively impact SDGs. In Models 3 and 4, the results reveal that FDI seems to have a positive but insignificant relationship with social and environmental sustainability in the short and long run in SSA and MENA countries. This outcome is contrary to our expectations. A possible explanation for these findings could be that that political instability in SSA and MENA nations restrict the contribution of FDI towards achieving social and environmental SDGs. Thus, H2c and H2d are not supported. These results are consistent with those of Saygın and İskenderoğlu (2022), Li et al. (2019) and Ayamba et al. (2020), who discover an insignificant effect of FDI on sustainable development. These results indicates that FDI support both overall and economic sustaianble development goals, but not provide significant support into social and environmental sustaianble development outcomes, thus FDI and governance are not supporting complementary role in these regions.

With respect to control variables, the results report that GDP is significantly and positively associated with overall and the three pillars of SDGs in the long run, indicating that countries with high levels of GDP tend to make substantial progress towards achieving SDGs. These results align with literature (Aust et al. 2020). The GI also has a significant positive effect on overall SDGs, suggesting that countries with high levels of integration into the global economy perform better in achieving overall SDGs. These results are in line with those obtained by Tang et al. (2020). By contrast, governance size has a negative significant relationship with overall SDGs indicates that higher government expenditure with inefficiently spending leads to low progress toward the integration the SDGs.

Robustness checks

Endogeneity checks. To address the endogeneity problem between variables in our analysis, we perform the generalized method of moment (GMM) to account endogeneity concerns and omitted variable bias in dynamic panel data models, as demonstrated in a prior study (Omri and Mabrouk, 2020). By applying the GMM approach, we can assess the consistency of our results under a different estimation farmwork. The findings from the GMM approach align with those obtained from our primary estimations as shown in Table 9. Table 9 shows that the Hansen Tests of over-identification of all models (52.86–54.58) are not rejected with a *P*-values of (0.946–0.993). As such, this study cannot reject the hypothesis that the instruments used are valid.

Segmented regional analysis. To provide adequate empirical evidence of region-specific insights, and to ensure the reliability of main results across different regions, we conducted a segmented analysis by grouping the sample into two groups SSA and MENA countries. The results in Table 10 reveals that both governance and FDI remain a positive and significant influence on overall SDGs, although the coefficients are slightly different. For instance, governance has a strong significant influence in the SSA region (coefficient = 0.998, $p < 0.05$) than the MENA region (coefficient = 0.870, $p < 0.10$), indicating that there are institutional differences in governance system. A possible explanation for these results, both governance and FDI contribute significantly in achieving SDGs across differ regions. However, effective of governance and FDI based on local environmental regulations and local rules. These findings also demonstrate that governance and foreign direct investment permanently contribute to the achievement of the sustainable development goals, but the effectiveness of these two factors is contingent on the laws and institutions that govern each sector, as well as the methodology that governs that sector. One possible explanation for these disparities is that the benefits of governance and foreign direct investment are contingent on the degree to which environmental regulations and local governments are able to effectively support programs that aim to promote sustainable development. Therefore, these results demonstrate how essential it is to ensure that governance reforms and investment policies are appropriate for the types of institutions and development objectives that are specific to each region.

Alternative estimation techniques. To check the robustness of the CS-ARDL main results, we employed additional techniques, such as the Augmented Mean Group (AMG) estimator and the fixed effects-difference in differences (FE-DK) estimator. AMG further accounts for unobserved common factors and limits omitted variable bias, while FD_DK is another robust estimator, which is dealing with unobserved heterogeneity, time-invariant and more reliable inference with cross-sectional dependence. The findings from two tests, as shown in Tables 11 and 12, confirm our main results, indicating that governance and FDI contribute

Table 9 Results of the GMM approach.

Independent Variables	Dependent Variables			
	SDGs Model 1	ECO_SDGs Model 2	SOC_SDGs Model 3	ENV_SDGs Model 4
GOV	0.313*** (0.103)	0.441*** (0.099)	0.700* (0.376)	0.063 (0.358)
FDI	0.052*** (0.019)	0.045** (0.021)	0.23 (0.017)	0.015 (0.017)
GI	0.007 (0.039)	−0.008 (0.010)	0.137 (0.031)	0.009 (0.020)
GS	−0.003 (0.039)	−0.020 (0.036)	−0.051 (0.145)	−0.041 (0.119)
GDP	0.107*** (0.028)	0.143** (0.064)	0.139 (0.171)	0.104*** (0.026)
POP	0.052 (0.041)	0.531 (0.755)	0.572 (0.400)	−0.006 (0.248)
l.sdg	0.975*** (0.008)			
l.eco		0.982*** (0.010)		
l.soc			0.898*** (0.033)	
l.env				0.914*** (0.040)
Year dummies	Include	Include	Include	Include
Intercept	0.925 (1.06)	0.531 (0.755)	−5.463 (5.736)	6.125 (4.418)
No. of observations	1232	1232	1232	1232
Hansen test	52.92	54.58	53.26	52.86
Hansen test (*P*-value)	0.989	0.987	0.946	0.993
Arellano-Bond test for AR (1)	−5.93***	−5.93***	−5.29***	−3.21***
Arellano-Bond test for AR (2)	2.17	0.73	0.65	1.76

***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 levels, respectively. All variables are as previously defined. The Hansen test of over-identification is under the null hypothesis that all instruments are valid. AR (1) and AR (2) are tests for first- and second-order serial correlations in the first-differenced residuals, under the null hypothesis of no serial correlation.

Table 10 Results of CS-ARDL Estimations for all sample and sub-samples.

Independent variables	Dependent Variable: overall SDGs		
	All Sample	SSA sample	MENA sample
Long run			
GOV	0.397** (0.175)	0.998** (0.415)	0.870* (0.471)
FDI	0.042** (0.019)	0.035* (0.019)	0.038** (0.014)
GI	0.036** (0.018)	0.019* (0.072)	0.100 (0.090)
GS	−0.154** (0.05)	−0.021 (0.162)	−1.768* (1.027)
GDP	0.495*** (0.075)	0.458*** (0.081)	0.432*** (0.065)
POP	−0.374 (2.779)	−4.689 (6.931)	−5.889 (5.838)
Short run			
ECT	−0.778*** (0.074)	−0.627*** (0.053)	−0.755*** (0.0897)
Δ GOV	0.260** (0.101)	0.359* (0.178)	0.250 (0.220)
Δ FDI	0.012 (0.014)	0.046 (0.031)	−0.063 (0.041)
Δ GI	0.025* (0.015)	0.007 (0.035)	0.036 (0.043)
Δ GS	−0.090* (0.03)	−0.067 (0.057)	−0.737 (0.574)
Δ GDP	0.103 (0.15)	−0.061 (0.194)	0.494 (0.535)
Δ POP	−0.057 (1.75)	−1.552 (2.72)	−6.588 (4.66)

Notes: Standard error is in parentheses. *** represent statistical significance at 0.01 level.

Table 11 AGM Robustness analysis results.

Independent variables	Dependent Variables			
	Overall SDs Model 1	ECO_SDGs Model 2	SOC-SDGs Model 3	ENV_SDGs Model 4
GOV	0.510*** (0.175)	0.590*** (0.203)	0.025** (0.010)	0.005 (0.004)
FDI	0.039*** (0.015)	0.047** (0.020)	0.002 (0.002)	0.002 (0.001)
GI	0.023** (0.010)	0.064*** (0.024)	0.001 (0.002)	0.001 (0.002)
GS	−0.077 (0.075)	−0.080 (0.053)	−0.006** (0.003)	−0.005** (0.002)
GDP	0.043** (0.018)	0.191** (0.077)	0.009 (0.012)	0.006 (0.011)
POP	6.367** (2.99)	1.422 (0.1.796)	0.576 (0.847)	0.098 (0.148)

Note: Standard error is given in the parentheses and ***, **, represents statistical significance at 0.01 and 0.05 levels,

Table 12 FE_DK Robustness analysis results.

Independent variables	Dependent Variables			
	Overall SDs Model 1	ECO_SDGs Model 2	SOC-SDGs Model 3	ENV_SDGs Model 4
GOV	0.193*** (0.042)	0.152*** (0.054)	0.262*** (0.093)	0.211 (0.125)
FDI	0.011** (0.004)	0.014** (0.006)	0.008 (0.006)	0.005 (0.003)
GI	0.016** (0.006)	0.025*** (0.008)	0.019* (0.010)	0.006 (0.010)
GS	−0.002 (0.015)	−0.035*** (0.010)	−0.008 (0.036)	0.001 (0.026)
GDP	0.057** (0.024)	0.160*** (0.031)	0.144** (0.062)	0.034* (0.018)
POP	−0.055 (0.101)	−0.153 (0.235)	−0.469 (0.353)	−0.210 (227)

Note: Standard error is given in the parentheses and ***, **, * represents statistical significance at 0.01, 0.05 and 0.10 levels,

significantly to the achievement of overall and economic SDGs in SSA and MENA countries. Although governance and FDI are still face challenges in progress integration with the SDGs. These findings show that institutional quality and foreign investment are still very significant for long-term development. The fact that they have a smaller influence on environmental SDGs shows that we need to concentrate our environmental governance policies. Also, the slightly negative effect of government size shows that making the public sector more efficient is vital for promoting sustainable development.

Conclusion and policy implications

This study investigated the relationship among governance, FDI and the achievement of overall SDGs, along with their three core pillars—economic, social and environmental—in SSA and MENA countries. Panel data models encountered some issues, including CD and slope heterogeneity, both of which were confirmed in this study. Therefore, to address these issues and provide more robust, reliable results, the study employed a CS-ARDL approach. The findings revealed that governance and FDI have a significant positive effect on overall and economic sustainable development goals. Governance has a marginally significant positive effect on social SDGs, while governance and FDI have an insignificant effect on environmental SDGs. Additionally, the region-specific analysis reveals that governance contributes significantly and positively to achieving SDGs in the SSA region, while governance's contribution is marginally significant in the achievements of SDGs, indicating governance remines challenged in the MENA region. FDI has a significant and positive influence on SDGs, suggesting that FDI continues to support SDGs in MENA countries, while the effect is relatively significant in the SSA region. Furthermore, GDP and globalisation were found to have a significant relationship with the SDGs. The findings are consistently reliable across many robustness tests, hence affirming their validity and policy implications. This study offers new perspective on the relationship between governance quality, FDI with regard to the achievements of overall SDGs and their three pillars, such as economic, social and environmental sustainable development in SSA and MENA regions, unlike previous studies that most focus on developed economies or investigates governance and FDI in isolation. The study considers interacting effects of governance and FDI on the three pillars of SDGs, such as economic, social and environmental sustainability and constructed governance index using principal components analysis (PCA). This study also employs a segmented regional analysis, revealing significantly variability in influence of governance and FDI on overall index of the SDGs across regions with differing institutional frameworks and governance challenges. These findings beyond single measure of SDGs analysis, highlighting that both governance and FDI play complementary role, with local institutional structure, in enhancing the SDGs. Thus, this study fills an important gap in the literature by provides novel, region-specific evidence and practical insights for policymakers. It emphasises the need for sound governance reforms and responsible FDI as vital drivers for enhancing the achievements of the SDGs in both regions.

A number of key policy implications for policymakers and regulators in SSA and MENA countries arise from these findings. Firstly, the study demonstrates that governance plays a fundamental role in achieving SDGs in developing nations, and in particular in the SSA region. Therefore, policymakers in SSA nations should enhance anti-corruption, governance capacity and accountability to support governance reforms, which are crucial for achieving the SDGs. To moderate positive but marginally significant impact of governance on the SDGs, policymakers in the MENA countries should improve the quality of governance and then link it to the sustainable development goals. SDG achievement needs more than economic sustainability; it also requires a planned alignment of governance with social and environmental sustainable development goals. Secondly, environmental sustainable development goals remain under-addressed in SSA and MENA regions, which are still focused on economic goals. As a result, policymakers in SSA and MENA regions should prioritise environmental governance efforts. It is critical to adopt effective policies aimed at reducing environmental risks, such as land degradation and low energy access in SSA nations and carbon emissions and water scarcity in the MENA nations. The establishment of environmental institutions and improvement of governance quality can eventually stimulate higher FDI, resulting in faster and increased environmental sustainability. Since FDI has a significant and positive association with SDGs, policymakers in the MENA region should design policies that attract investment aligned with sustainable development goals, such as encouraging investments in fostering technological innovation and socially inclusive investments. FDI has a positive, even marginally significant, influence on the SDGs in the SSA region therefore, policymakers should enhance the connection between FDI and the three pillars of SDGs, including economic, social and environmental, through improving institutional quality, skills development initiatives and technology transfer opportunities.

This study has two limitations that may need further research. First, this study only employed a few explanatory variables, like governance, FDI, GDP, globalisation, government size and population variables, which are most commonly used in the literature. Future research should be extended by including additional interactions that have a significant impact, such as the relationship between governance, FDI, and SDGs, which could be moderated by financial development, human capital, and gender inequality. Second, the current study focused on developing countries, but comparing them to developed countries could provide a better understanding of the situation in the SSA and MENA regions. It is also possible that some SSA and MENA nations have incomplete data in their SDG indicators, which

could lead to less accurate estimates. This analysis demonstrates that we need better datasets that include more types of interactions among governance, FDI and SDGs. Future research should include other measures of governance quality, FDI, and sustainable development to enhance our understanding of effective governance and investment policies, as well as to accelerate progress towards integrating sustainable development goals. Including interaction terms with dimensions of governance would also be helpful to determine how governance and FDI significantly contribute to attaining the SDGs, as well as to compare the findings from both developed and developing countries.

Data availability

For access to the datasets generated or analysed in the current study, please feel free to contact the corresponding author.

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Author contributions

Conceptualization, AH and RAl; methodology, AH and RAl; software, AH; validation, RAl; formal analysis, AH; investigation, RAl; resources, AH and RAl; data curation, AH; writing—original draft preparation, RAl; writing—review and editing, AH. All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not include any studies with human participants performed by any of the authors.

Informed consent

This article does not contain any studies involving human participants conducted by any of the authors.

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