

The Role of Governance, Social Investment, and Human Development in Achieving Sustainable Development Goals: A Cross-Country Panel Analysis

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Abstract

This study evaluates the role of governance efficiency, social investment, and human development in achieving the Sustainable Development Goals (SDGs) for a group of fifteen countries totaling three development levels: Eagle (developed), Next (emerging), and Others (low and developed) for the period 2000-2023. The study employs descriptive trend analysis, two pooled ordinary least squares (OLS) regression specifications, Levin-Lin-Chu panel unit-root tests, a full diagnostic battery, Granger causality analysis, and Johansen cointegration tests to highlight that the Human Development Index (HDI) has a strong and positive impact on SDG outcomes in both regression specifications (Bloom, Canning, & Sevilla, 2004), while the coefficient for governance efficiency and social investment is negative in the full panel model, but is rather a reactive and crisis-driven response of public spending. Both causality tests validate the response that governance, social investment, ecological conditions and human development mutually Granger cause SDG performance and cointegration result indicates a state of long-run equilibrium between institutional, ecological and developmental indicators of about 40% of the countries sampled and of the remaining, none show a long-run equilibrium. Finally, regional descriptive trends indicate that, overall, there is lagged response by Next and Others behind Eagle countries in scores on the SDG index as well as scores on governance, social investment and HDI, whereas ecology, trade/FDI, and social investment exhibit sporadic instead of linear change over 2000-2023 consistent with the shock-and-recovery dynamics in 2008-2011, 2014-2016 and 2020. The findings indicate that sustainable development is far from any country being alike, with coherent institutions, consistent social expenditure, and a robust human capital base being more dependent on achieving durable progress than a country's income classification. Policy implications are discussed concerning cross-sectoral coordination for developing economies.

Keywords: Sustainable Development Goals; governance efficiency; social investment; human development; panel data; cointegration

Introduction

The seventeen goals outlined in the 2030 Agenda for Sustainable Development, adopted by the UN General Assembly in 2015, outline interlinked expectations that are expected to drive economic,

social and environmental strides in every nation, regardless of income level (United Nations, 2015). The Agenda draws on the Millennium Development Goals' core principles of the 1987 routine definition of sustainable development, which view them as development that meets the needs of today's world without damaging the capacity of future generations to meet their needs (World Commission on Environment and Development, 1987; Sachs, 2015). This thinking was transposed to the Rio Earth Summit of 1992 and Agenda 21, which explicitly linked environmental conservation to poverty eradication and social equity (Bárcena, 1992), but was then sharply criticized about its exclusive focus on the social elements of development and marginalization of environmental and governance elements, which the SDG framework was meant to address (United Nations, 2015).

10+ years on, countries' performance on SDGs has been very uneven. Although the institutions continue to be beneficial, it is not income that alone accounts for the performance, which remains superior in high-income countries with established institutions, through the eyes of emerging and low-income economies. As Sachs et al. (2020) note, several South Asian and Sub-Saharan African countries make insufficient positive moves in multiple areas despite making measurable positive strides in individual aspects of employment, education, and other areas, suggesting that an underlying reason for the lack or limited progress in multiple countries is the quality of governance, the consistency of social spending, and the strength of human capital. Institutional Theory suggests that the development path of a country is defined above all by its ability to enforce property rights, maintain the rule of law and consistently implement policy (North, 1990); this was operationalized as government effectiveness, regulatory quality and control of corruption in the Worldwide Governance Indicators repeatedly shown to correlate with the development trajectory in cross-country research (Rodrik, Subramanian, & Trebbi, 2004). When institutions are weak, public spending will also be reactive, spending in response to crises reverses the long-term positive contribution to be seen in governance indicators – despite these indicators being beneficial – in the short term, eroding the effectiveness of governance indicators will result in a negative statistical relationship between governance indicators and short-term results, yet despite that the long-term benefit is positive (Grindle, 2017, Transparency International, 2020).

Education and health are generally considered as a precondition for viable growth. This connection between positive economic and distributional outcomes of higher investments in health and education is emphasised in SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education), a concept supported by Becker's (2009) work on human capital. The Human Development Index is a combination measure of health, education and income indicators which serve as a proxy for this accumulated human capital and is used throughout the literature as an outcome and predictor of broader developmental progress (UNDP, 2020). A second dimension is added with the Trade and Development theory, which asserts that if the country has a complementary institutional capacity, trade liberalization will increase growth and improve the standard of living, while without strong governance, trade liberalization will exacerbate environmental and distributive pressures (Krueger, 1998; Grossman & Helpman, 1991). Environmental Governance Theory supports this in that the institutions that run natural resources, mediate the effectiveness of governance and social investment to sustainability outcomes (Lemos & Agrawal, 2006; Ostrom, 2009), and evidence suggests that climate-related disruption and environmental degradation can lead to increased poverty and sustainability-depressing activity levels in agro-based economies (Khan et al., 2016; and IPCC, 2021).

Collectively, the Institutional Theory, the Trade and Development Theory and the Environmental Governance Theory constitute the research framework that is to be leaned upon in this study; governance efficiency, social investment, international trade and globalization, and human development are taken as the basic driving force of SDG performance, and ecological disorder is taken as the needed moderating condition, which can render the acting of the basic driving force more

or less effective in performance (Lemos & Agrawal, 2006, and IPCC, 2021). In this context, governance efficiency is supposed to affect results in hand via the “vehicles” of institutional quality and tax collection capacity, as well as those vehicles of social investment, educational spending and population dynamics, and, via the vehicles of human development, educational and income facets, while ecological disorder is a “conditioner” of the capacity of these vehicles, but not an independent direct predictor of results in hand (North, 1990; Krueger, 1998; Ostrom, 2009). These objectives are directly connected to the six study objectives, which analyse the efficiency of governance, social investments, international trade and globalization, human development, financial inclusion and the moderating effect of ecological disorder on SDG achievement, separately.

While the above is a list of drivers studied in isolation, few studies have used governance efficiency, social outlay, human growth and ecological instability together in a single empirical model that has included countries with varying levels of both development and governability (Arif et al., 2022; UNDP, 2019). Sachs et al. (2019) also note that scholarship on sustainable development is skewed towards developed country contexts with less study in contexts where state capacity is weaker, resources are limited and environmental stress is greater. This study fills in that gap utilizing panel data for 2000–2023 from fifteen nations divided into three categories: Eagle (developed), Next (emerging), and Others (low-income/developing) based on their institutional and developmental characteristics (UNDP, 2020; World Bank, 2022) and the question is: what are the combined effects of governance efficiency and social investment on SDG performance and do the effects of ecological volatility change these relationships? The remainder of the paper discusses the data and estimation approach, presents the empirical findings and implications for development policy.

Methodology

The study is underpinned by an objectivist-statistical research philosophy that can identify statistical relationships between the possible causes (governance, social, and ecological) and the effects (SDG) without researcher-guided interpretation (Saunders, Lewis, & Thornhill, 2019) and combines that with an explanatory/longitudinal research design that tracks the 15 countries from 2000 to 2023 in order to observe how changes in governance, social and human development relate to changes in SDG performance over time. The country selection was purposeful; countries divided into three tiers by their institutional and developmental characteristics: Eagle nations (high-income countries with strong governance and advancements in social indicators); Next nations (emerging economies with high rate of growth and still having governance and social-inclusion challenges); and Other nations (low-income countries facing greater development challenges in both governance effectiveness and development indicators) (UNDP, 2020; World Bank, 2022). The empirical model has the following form:

$$\begin{aligned} \text{SDG}_{it} = & \alpha_{it} + \beta_1 \text{GE}_{it}(\beta_1 \text{IQ}_{it} + \beta_2 \text{TC}_{it}) + \beta_2 \text{SI}_{it}(\beta_1 \text{ES}_{it} + \beta_2 \text{PG}_{it}) \\ & + \beta_3 \text{ITG}_{it}(\beta_1 \text{TV}_{it} + \beta_2 \text{FDI}_{it} + \beta_3 \text{Ex}_{it}) + \beta_4 \text{HDI}_{it}(\beta_1 \text{EI}_{it} + \beta_2 \text{GNI}_{it}) \\ & + \beta_5 \text{ED}_{it} \times (\beta_1 \text{GE}_{it} + \beta_2 \text{SI}_{it} + \beta_3 \text{ITG}_{it} + \beta_4 \text{HDI}_{it}) + \varepsilon_{it} \end{aligned}$$

where SDG_{it} denotes achieving sustainable development goals for country i in year t ; GE is governance efficiency, decomposed into institutional quality (IQ) and tax collection (TC); SI is social investment, decomposed into educational spending (ES) and population growth (PG); ITG is international trade and globalization, decomposed into trade volume (TV), foreign direct investment (FDI), and exports (Ex); HDI is the Human Development Index, decomposed into the Education Index (EI) and gross national income per capita (GNI); ED is the ecological disorder index, entered as a multiplicative term that moderates the combined contribution of governance, social investment, trade and globalization, and human development; and ε_{it} is the error term (Kaufmann, Kraay, & Mastruzzi, 2010; Demirgüç-Kunt et al., 2017).

All of the constructs in the model were taken from a particular named secondary source rather than

collected. The efficiency of governance was calculated with the Worldwide Governance Indicators (WGI) from the World Bank, which are voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, control of corruption, and tax-revenue data from the International Monetary Fund and World Bank (Kaufmann, Kraay, & Mastruzzi, 2010). Social investment was captured by the public expenditure on education obtained from the Institute for Statistics carried out by UNESCO, and by population statistics made available by World Bank's World Development Indicators, WDI and the United Nations Department of Economic and Social Affairs on the premise that the expenditure on education and health are ways in which social investment helps to build the rigid social pillars that SDG 3 and SDG 4 rely upon (Becker, 2009; Bloom, Canning, and Sevilla (2004). International trade and globalization were represented by trade-openness ratios and exports from WDI and International Trade Centre (ITC) as well as foreign direct investment inflows and outflows from the World Bank (World Bank, 2022) and the United Nations Conference on Trade and Development (UNCTAD). The Human Development Index was disaggregated in its typical components, an Education Index (both mean and expected years of schooling taken from UNDP Human Development Reports) and gross national income per capita at purchasing power parity (WDI and UNDP Human Development Reports) so that income, education and welfare aspects of development could be analyzed together (UNDP, 2020). Deposit-account and loan-account penetration, credit-card ownership, and the density of ATMs were the proxies for financial inclusion, consistent with the literature, which mostly relates these indicators to inclusive growth and poverty reduction (Demirgüç-Kunt et al., 2017). Assessment SDG attainment itself (the dependent variable) was taken from the annual Sustainable Development Report (SDR) generated by the United Nations Sustainable Development Solutions Network that calculates country-level scores on the three dimensions of the SDG framework: poverty, health, and education (Sachs et al., 2020). Lastly, evidence has emerged connecting environmental pollution with reduced economic growth and increased poverty in the specific context of agriculture-dependent communities (Khan et al., 2016; IPCC, 2021), and hence, the environmental order was proxied using CO₂ emissions per capita, deforestation rate and severity of climate-related natural hazards, all gathered from the World Bank, United Nations Environment Programme and the Global Climate Risk Index, respectively.

This 240 country-year panel was estimated using five estimation methods, while a smaller panel of 24 observations over time years were used for a second regression specification. The SDG index and the four index components that constitute it, namely governance effectiveness, social investment, HDI-GNI and ecological disorder, as well as the two components of trade/FDI, were first analyzed by trend year by year 2000-2023 and by regional group, using descriptive trend analysis. The Levin-Lin-Chu (LLC) panel unit-root test was then used to determine if each series were stationary, which is a requirement for unbiased regressions estimation (Levin, Lin, & Chu, 2002). The results suggest that the direction and significance of the core relationships do not change with the level of temporal aggregation, as a pooled ordinary least squares (OLS) regression was estimated with all 240 country-year observations and another, more parsimonious specification, was estimated on the 24-observation annual series. Follow-up robustness tests were performed using the Hausman (1978) test for correlation between regressors and the error term, as well as the Durbin-Watson, Breusch-Godfrey, ARCH-LM, White's test, Breusch-Pagan/Cook-Weisberg, Jarque-Bera, variance inflation factors, and Akaike's and the Bayesian information criteria for testing serial correlation, heteroskedasticity, non-normality, multicollinearity, and relative model fit, respectively. Finally, following the common approach in panel studies of development outcomes (Bai & Ng, 2022 and Narayan & Popp, 2021), Granger causality and Johansen cointegration (VECRANK) tests analyzed the short-run predictive direction of a pair of variables, and the presence of long-run equilibrium relationships, respectively, at the country level.

Analysis

Before moving on to formal estimation, it is helpful to look at the path of each core series through the sample, as some of the results of the regressions and the causation results reported below can be interpreted more easily once their respective series are seen through time. The SDG performance over the last two and a half decades points to three distinct trends: (1) ‘Eagle’ countries have consistently delivered high scores, potentially reflecting good institutional growth, continuous public investment and consistent regulations (Kaufmann, Kraay & Mastruzzi, 2010); (2) a moderate improvement trajectory for the ‘Next’ group, whose members tend to improve their scores as they carry on with the process of regulatory reform, economic diversification, etc.; and (3) a gradual improvement trajectory for the ‘Others’ group, which begins with low levels of performance and improves their results over time, plausibly tied to development assistance and the growth of a new framework for human development (Sachs et al., 2020). This trend is reflected when comparing average scores on governance efficiency, social investment, and HDI across the three groups: Eagle countries outperform on each index, Next countries have an especially policy-intensive focus on social investment, and the Others group underperforms on all three, suggesting an absence of fiscal space and institutional capacity to be drivers of this weaker performance.

The direction of the movement is not unidirectional over the period, however, with two steep increases, two deep declines (down to around 0.28 in 2008), a stabilization phase (around 0.75 to 0.80 from 2011 to 2014), another steep rise (landing above 1.1 in 2015), another decline (to below 0.8 in 2016 and 2017, and below 0.7 in 2019), a partial rebound (between 0.75 and 0.80 from 2021 to 2022) and easing again (to around 0.63 by 2023); a tangle of shocks and mean reversion behaviour rather than a sustained trend (IPCC 2021). By contrast, governance effectiveness grows, albeit somewhat unevenly, in a path generally upward and then slowly leveling off within a high, tight band (between 92 and 98) and followed, if anything, by a sharp one-time slide to close to 92 (2014-2016), only to recover to the mid-90s (2019) before a slight dip that has not yet been matched by a corresponding increase this year, consistent with the sort of discrete institutional shock that Grindle (2017) correlates with governance reform episodes, rather than with a structural downfall. The total evolution of HDI-GNI shows a strong secular increase, crossing the lower twenty-thousand level at the beginning of the series to top the fifty-four-thousand level in 2013, and shrinking subsequently to the mid-forty-thousand level during 2014–2017, slightly recovering in 2018–2019, contracting again around 2020, and then rebounding sharply in 2021 to arrive at a new peak near fifty-five thousand in 2023, which is consistent with a secular evolution of human-capital accumulation punctuated by shock- and recovery-dynamics described by Bloom, Canning and Sevilla (2004). The social investment level has actually varied in a relatively small range throughout this time, moving from around 5.4 in 2000; 4.6 - 4.8 (with some fluctuations and more of a mean reversion around a mid level policy level between 2004 and 2019); 4.1 (significant downtrend at the end of 2022) and 4.7 - 4.8 (beginning 2023 - and more of a mean reversion around a mid level policy rate). The trade and FDI flows are the most volatile series in the panel and are near zero around 2004-2005, before experiencing a strong spike and a correction in 2007-2008, only to start a cycle of lower amplitude with growth from about thirty billion to ninety billion by 2014-2015, falling back in the subsequent 2016-2017 year and oscillating between forty and eighty billion, lifted at some point around 2020, and settled to lower levels in 2023; a strongly right-skewed distribution that is consistent with episodic surges rather than steady growth (Krueger, 1998).

The complete range of scores on governance effectiveness across the panel, starting around 7.6 and ending at 97.6, shows that they are not all grouped around a particular score for governance and confirms that the institutional environments that they come from are truly weak and truly strong, as is the cross-country variation identified by Kaufmann, Kraay, and Mastruzzi (2010) as critical to isolate governance effects. In the case of social investment, the intensity of the cross-country variation

in public spending was only moderate, as the mean value on the measurement scale was 4.0 and the range was relatively small. Most of the regions featured in the analysis appear to have HDI-GNI in the range of 1,600 to 106,000, with an average of around 20,060, a range that is deliberately comprised of low-, middle-, and high-income economies consistent with existing literature that advocates for comparing development outcomes across heterogeneous nation-states (e.g., Sachs et al., 2019; UNDP, 2019). For its part, SDG index itself showed a mean of 636.8 with a very wide range (52.2-6090.5) indicating that its underlying measure was not in a conventional range from 0-100 and that aggregation should be kept in mind when interpreting the center of the distribution.

Table 1. Descriptive Statistics of Key Variables (2000–2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
Governance effectiveness	240	54.629	26.359	7.638	97.600
Social investment	240	3.9995	1.2533	0.8639	6.7387
Trade / FDI	240	6.92×10^{10}	1.04×10^{11}	-8.94×10^{10}	5.11×10^{11}
HDI–GNI	240	20,060.21	21,131.02	440.0	80,450.0
Ecology index	240	0.9296	0.4588	–0.050	2.9150
SDG index	240	636.838	1707.629	52.187	6090.494

Note. Panel comprises 10 countries observed over 24 years (240 country-year observations). Individually, the series of governance efficiency, social investment and human development (HDI-GNI) and the ecological disorder index were stationary at the one percent level, with the adjusted t-statistic ranging between –2.86 and –3.54 indicating mean reversion, and hence the series could be used without differencing in the regression (Levin, Lin, & Chu, 2002). However, the SDG index itself did not reject the null of a unit root, which in turn suggests that the SDG index follows a non-stationary (trending) process over the panel (adjusted $t = 0.60$, $p = 0.73$). The distinction is important for interpretation: co-efficients on the stationary determinants are true equilibrium relations, and the dependent variable's non-stationarity suggests the need for using fixed-effects, first-differencing or cointegration methods of regression, which is further confirmed by the cointegration results below (Bai & Ng, 2022).

The panel-wide adjusted R^2 for the pooled OLS regressions of SDG outcomes with governance efficiency, social investment, HDI, and group classification was 0.62 which is on the broad range of the goodness of fit cross-country governance-development regressions reported elsewhere in the literature (Rodrik, Subramanian, & Trebbi, 2004).

Table 2. Pooled OLS Regression Results for Predictors of SDG Performance

Predictor	Coef. (β)	Std. Error	t-stat	p-value	Significance
Governance efficiency	–25.0861	9.0107	–2.78	0.0056	Sig. (1%)
Social investment	–655.3489	184.2841	–3.56	0.0004	Sig. (1%)
Human Development	+0.0163	0.0064	2.54	0.0112	Sig. (5%)

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Group (Next)	+1.2987	2.2673	0.57	0.5687	n.s.
Group (Others)	+2.2044	2.2793	0.97	0.3335	n.s.
Year dummies	Included	—	—	—	Control

Note. Adjusted $R^2 = 0.62$. Reference category for group dummies is “Eagle.” n.s. = not significant. Human development had a positive coefficient (better sustainability performance associated with higher health, education, and income gains) that was statistically significant at the 99% level, consistent with a theoretical expectation that increasing health, education, and income levels will directly enhance sustainability performance (Bloom, Canning, & Sevilla, 2004; Becker, 2009). Governance efficiency had a significant negative coefficient of $\beta = -25.09$ ($p = 0.000$) and social investment had a significant negative coefficient of $\beta = -655.35$ ($p = 0.000$). On its own, this would seem inconsistent with the results from North (1990) and Kaufmann, Kraay, and Mastruzzi (2010), but given the causality results below, perhaps a more sensible interpretation of this finding is that they have simply documented how the system changed after the Perturbation. Governments intervene in the SDG field more often when the performance level is already poor, such as during a fiscal or humanitarian crisis, and this makes them achieve low performance in SDGs in the short run despite the positive causal effect of these interventions in the longer run which is consistent with the reactive-policy dynamic described by Grindle (2017) in the case of governance reform in resource poor states. The Next group dummy was not statistically different from the Eagle baseline ($p = 0.569$), nor was the others group dummy ($p = 0.334$), indicating that by itself a country's developmental tier is not good enough to predict SDG performance as cautioned by Arif et al (2022). This is significant in and of itself because this indicates that it is not income classification per se that differentiates SDG trajectories, but actually structural and institutional factors.

When we plotted the predicted SDG index scores against the observed scores, the overwhelming majority of scores for all countries fit tightly around the 45 degree reference line, with the best close fit for Eagle and Next countries and some greater deviation for Others; such unmodeled factors could involve conflict, ecological insecurity, or due to data incompleteness in lower income countries (Khan et al., 2016).

A second, more parsimonious OLS specification was performed on a 24-observation annual series for the purpose of checking if this result, which was based on 240 observations in highly varied countries, was an artifact of using such a measure. The same five predictors—ecology, HDI-GNI, trade/FDI, social investment, and governance efficiency—were employed in the estimation of that second specification. At this level of aggregation, the adjusted R^2 value for this second model was 0.4358 (R^2 was 0.5585) and as an overall model fit was significant ($F(5, 18) = 4.55$, $p = 0.0074$), meaning just over half of the variance in SDG index was explained by the predictors as a group at this level of aggregation.

Table 3. OLS Regression Results, Annual Series (Dependent Variable = SDG Index, $n = 24$)

Predictor	Coef. (β)	Std. Error	t-stat	p-value	Significance
Ecology	-0.0453	0.2828	-0.16	0.875	n.s.
HDI-GNI	+0.000112	0.000028	4.01	0.001	Sig. (1%)
Trade / FDI	-1.32e-11	8.01e-12	-1.65	0.117	n.s.

Social investment	−0.3096	0.8254	−0.38	0.712	n.s.
Governance efficiency	−0.2910	0.1621	−1.79	0.090	n.s. (marg.)
Constant	101.7301	14.8832	6.84	0.000	Sig. (1%)

Note. $R^2 = 0.5585$; Adjusted $R^2 = 0.4358$; $F(5, 18) = 4.55$, $p = 0.0074$; Durbin-Watson $d = 0.438$.
n.s. = not significant; marg. = marginal at the 10% level.

The two specifications differ in only two aspects: both ignore all variables except one; and they disagree about which variable it is. The human-development effect is positive and highly significant in this smaller annual specification which is the most stringent corroboration possible within this set of data: the effect persists when the sample size, the level of aggregation and the scale of the coefficients change (Bloom, Canning, & Sevilla, 2004). On the other hand, governance efficiency is important and strongly negative also in the full panel ($p = 0.000$), but not quite in the smaller series ($p = 0.090$), while social investment, ecology, and trade/FDI are all not significant in the smaller specification ($p = 0.712$, 0.875 , and 0.117 , respectively). This indicates that such negative governance and social-investment coefficients reflect, at least partly, the aggregation of a number of countries which have very different starting levels of institutions; it is informative that at a more aggregated level of analysis, respondent spending effect as discussed in the previous section becomes more difficult to identify statistically, notwithstanding the fact that the Granger causality results reported later in this section continue to point to its existence. As with the full-panel model, Durbin-Watson statistic indicates strong positive serial correlation ($d = 0.438$) which makes standard errors unreliable.

For the smaller (annual) specification, where there are 24 observations, Akaike's Information Criterion ($AIC = 65.75$) and the Bayesian Information Criterion ($BIC = 71.64$) suggest that the model has a reasonable fit, as lower values correspond to better fit, penalized for model complexity (Akaike, 1974; Schwarz, 1978). Although alternative specifications could also be tested for robustness, these information criteria do not indicate that the specification with the five predictors is too complex for the amount of variation explained.

The regression generally passed a battery of diagnostic tests with only one concern being identified. Similarly, heteroskedasticity tests were very reassuring; the ARCH-LM test was not significant ($\chi^2 = 2.75$, $p = 0.097$), as was White (1980) ($\chi^2 = 14.68$, $p = 0.794$) and the Breusch and Pagan (1979) / Cook-Weisberg test ($\chi^2 = 1.11$, $p = 0.293$) and the Cameron and Trivedi (1990) decomposition was very reassuring as well with skewness and kurtosis components also negligible. The variance inflation factor (VIF), a standard measure of multicollinearity, had a range of 1.09 to 2.25, which are all below the strict 10 rule, and the average VIF was 1.53. The only exception would be correlation of serial data. The null hypothesis of no autocorrelation was clearly rejected by the Breusch and Godfrey (1978) LM test ($\chi^2 = 15.29$, $p = 0.0001$) and the separate Durbin-Watson (1951) statistic of 0.44 in the full-panel model is well below the benchmark of 2, indicating strong positive autocorrelation of the residuals. The Jarque and Bera (1987) test for normality ($\chi^2 = 553.7$, $p \neq 0.000$) and the skewness/kurtosis test were also rejected, but with 240 observations there are few implications for this failure of normality. It is the autocorrelation which is more serious – this may not imply bias in the estimates but rather understatement of standard errors which explains that the significance levels found above are only indicative and that Newey and West (1987) robust standard errors are perhaps recommended, as well as the generalized least squares specification, for tighter inference in any further studies that might be undertaken.

According to Granger (1969), the granger causality tests provide light on the time-ordering which the

contemporaneous regression cannot. The results show that social investment ($X^2 = 29.72$, $p < 0.001$), governance efficiency ($X^2 = 14.39$, $p = 0.001$), ecological disorder ($X^2 = 12.70$, $p = 0.002$) and HDI ($X^2 = 8.75$, $p = 0.013$) each Granger-cause the SDG index; that is, the history of each of these variables provides information that is predictive of future performance of the SDG index in addition to what can be learned from the SDG index's own history.

Table 4. Granger Causality Test Results — Predictors of the SDG Index

Equation	Excluded variable	χ^2	df	Prob > χ^2
SDG index	Ecology	12.701	2	0.002
SDG index	HDI–GNI	8.7524	2	0.013
SDG index	Social investment	29.716	2	0.000
SDG index	Governance efficiency	14.393	2	0.001
SDG index	All predictors (joint)	71.302	8	0.000

Note. Trade/FDI excluded from this subset due to zero degrees of freedom in the underlying VAR specification. Full causality matrix, including reverse-direction and cross-variable equations, available from the author.

The interactions are not necessarily bi-directional. The SDG index does not significantly Granger-cause trade/FDI, ecology, or social investment, suggesting an asymmetric relationship such that institutional, social and ecological factors affect SDG outcomes more than in turn. There are other feedbacks in the system: Governance effectiveness has bidirectional relationships with both the SDG index and ecology variable, and HDI is Granger-caused by trade, governance and ecology — a pattern that Lemos and Agrawal (2006) and Ostrom (2009) attribute to environmental governance in interlinked-systems. A recursive CUSUM plot of the SDG index revealed that the cumulative residual line tracked outside the 95% confidence band starting in 2020, likely due to a structural break and suggesting that coefficients estimated using the entire sample period 2000–2023 may not be as meaningful during the pandemic.

This SDG index is non-stationary and the Johansen (1991) cointegration test was applied to help determine whether SDG performance and its most important correlates (government effectiveness, HDI–GNI, social investment, trade/FDI and ecological disorder) share a common long-run trend at the level of the individual country. The results really varied. In the six countries studied in detail, the trace statistic was smaller than the 5% critical value (e.g 77.0 in the former country, 72.2 in the latter); thus, in such countries, the institutional, ecological and developmental indicator series do not seem to be moving towards a common equilibrium. In the other four countries, the trace statistic was above the critical value at rank zero but below at rank one, which provides ample evidence for the presence of one cointegrating relation, implying that the trade, ecological stress, human development, and governance quality variables have a cointegrating relationship in these countries in the long run. The dichotomy of the split aligns with other research which has indicated that cointegration between development indicators is more probable when the institution is very stable, and human-development investments are maintained (Dhrifi, Jaziri, & Alnahdi, 2023; Narayan & Popp, 2021) and points to a more general caution in the literature regarding the assumption of concerted movement between environmental, institutional, and economic systems (Bai & Ng, 2022; Gani & Sharma, 2021). From a practical perspective, it suggests that policy interventions have different effects under various circumstances: in cointegrated countries, improvements in one domain – say, ecological stewardship

– is likely to facilitate improvements in others, while in non-cointegrated countries, the improvements are less likely to occur unless intentional efforts by governments are made to link the domains structurally and institutionally (Lemos & Agrawal, 2006).

Discussion

Human development is the only variable in this sample negatively and significantly related to SDG outcomes in both the full-panel and smaller annual regression specifications; it Granger-causes SDG outcomes and is part of the cointegrating relationships in a sub-sample of countries. That income and education are not the key determinants of GDP growth and that health improvements have an unlikely effect on economic growth can be explained by theory, which suggests that improvements in health, education and income create the base that sustainable development ultimately relies on (Bloom, Canning, & Sevilla, 2004; Becker, 2009); this is an unusually robust outcome for a single-country-panel study in that every other predictor loses significance as specifications change and as the sample is expanded.

Second, one should not interpret the negative short-run effects of governance efficiency and social investment as manifesting the fact that the improvement of institutions and promotion of public expenditure are bad for sustainability. The causality results by Granger are just the other way round: governance (along with social investment) cannot be predicted by SDG performance; rather governance affects SDG performance. An intuitive interpretation is that when SDG performances are poor, the governments intensify their governance actions and raise spending on social protection, etc., leading to a negative association contemporaneous to fiscal mega adjustments despite the positive causal effect, which is textbook “reactive” policy response, also known as reverse-causal policy response (Hussain, 2017; Grindle, 2017). Such a difference is relevant for policy communication: a negative coefficient at the cross-sectional snapshot should not be interpreted as a reason for a halt in continuous investment into governance or social programmes, which echoes the cautionary note that agrees with Kaufmann, Kraay and Mastruzzi (2010), who put forth that governance indicators should not be read literally.

Third, the results of the cointegration analysis suggest that the dimensions measured in this paper do not depend on the income category of the country, but on the extent to which the different elements of the concept (governance, ecological management, and human development) are aligned, which is reflected in the developmental tier (Eagle, Next, and Others) which has no explanatory power in addition to the other factors in the model. This shifts the debate on the policy level beyond comparisons between “developed” and “developing” and toward institutional coordination as the more concrete tool; a finding in line with Dhrifi, Jaziri, and Alnahdi (2023) who found that cointegration is more a reflection on institutional stability than on the level of development per se. This does not mean that the regional descriptive trends are uninformative – group membership is correlated with institutional coherence, which is consistently linked to being high-performing in the SDG index, governance, social investment and HDI at the same time – but instead that the mechanism to which they are a correlate is found in institutional coherence.

It is worth to note that the structure break, which was found around 2020, points to the non-stability of these linkages. The results can temporarily uncorrelate variables that in “normal times” tend to move in tandem (Brown, Durbin, & Evans, 1975), so any forecasting or policy applications of such results should make “boots and socks” of these results for the post-2020 period, even better if the models account explicitly for structural breaks or time-varying coefficients. For states that are cointegrated, the results suggest integrated, cross-sectoral development strategies can be pursued with reasonable confidence that improvements in one sector will spill over to others, as demonstrated in this instance (Lemos & Agrawal, 2006; Ostrom, 2009). In the cases of countries not cointegrated, the main and initial priorities are different: they are strengthening the institutional and monitoring system

to link governance, management and development of the ecosystems, which do not (automatically) reinforce each other (Gani & Sharma, 2021). In both cases, the consistently positive effect of HDI suggests that making investments in education, health and income growth a first then second option policy is better for enhancing it than reducing it in the face of low SDG scores during a certain period (Becker, 2009); and the asymmetry of the causality suggests that HDI should be maintained even when SDG performance appears weak, rather than invested in, or cut down on, during such periods (Hussain, 2017).

3 restrictions should be noted: From the regression diagnostics, there was assumed to be a meaningful amount of serial correlation in the OLS residuals, which reduces standard errors and so the exactness of the statement of the p-values presented here should be viewed as approximate only; robust or GLS estimation that takes into account serial correlation as in Newey and West (1987) would lead to more precise conclusions in the future. The non-standard and non-stationary scale of the SDG index makes it difficult to interpret regression coefficients in level form, which makes the complementation of using the Johansen (1991) cointegration approach preferable. Lastly, the cross-country cointegration analysis was performed on a relatively short time series (23 yearly observations per country), and for such cases, the common practice suggests that the statistical power to identify long-run relationships is quite weak and the generalization of the four-out-of-ten cointegration split beyond this sample should be done with caution (Bai & Ng, 2022).

Conclusion

The aim of this study was to identify the effect that governance efficiency, social investment and human development have on the SDG performance of a panel of developed, emerging and developing countries, as well as to see if this effect changes under ecological volatility. Institutional Theory (North, 1990), Trade and Development Theory (Krueger, 1998; Grossman & Helpman, 1991) and Environmental Governance Theory (Lemos & Agrawal, 2006; Ostrom, 2009) as the guiding framework of this study suggests that there can be a James Crowder dissent between the cross-sectional snapshot of institutional, ecological and developmental indicators, and actual long-run equilibrium, where cross survivability is identified not as a proxy, but as a state of neither excess nor deficiency. These data suggest that public policy focus should move from the overall idea of "developed vs. developing world" towards the institutional mechanisms of coordination of policies for governance, social investment, and human development that enable these policies to reinforce each other rather than simply coincide (Rodrik, Subramanian, & Trebbi, 2004). In the future, such an extension of this framework, with greater confidence in the shape of the standard errors, a larger sample after 2020 and country specific structural models could be helpful in confirming and refining these findings.

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