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## Research Article

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# Resource Dependence and Political Risk Are Associated with Weaker Sustainable Development Performance in a Multicountry Panel

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## Abstract

This study examines how country risk and resource dependence are associated with sustainable-development performance. Using a country-year panel for 32 countries over the resource-complete period 2018–2023, the analysis models the SDG Index as a function of aggregate country risk, decomposed financial, economic, and political risk, natural-resource rents, and macroeconomic controls. Linear mixed-effects models account for repeated observations within countries, country-level heterogeneity, and country-specific development trajectories. Resource dependence is the most consistent negative association in the models. Natural-resource rents are negative in the aggregate and decomposed specifications and remain negative across first-order autoregressive residual-correlation checks, winsorization, shock-window exclusion, leave-one-country-out

tests, recursive-residual diagnostics, and Mundlak within-between checks. Aggregate country risk has the expected negative sign but is not statistically significant after controls and country-level heterogeneity are included. The decomposed model identifies political risk as the relevant institutional component, while financial and economic risk are not statistically significant. Interaction tests do not support the claim that country risk has a stronger effect in more resource-dependent economies. The results support an operational SDG-monitoring approach in which governments track resource-rent exposure and political-risk indicators jointly, use these indicators to identify countries requiring priority diversification and governance intervention, and evaluate progress through repeated SDG and fiscal-management assessments.

**Keywords:** SDG Index; quality of life; country risk; political risk; resource dependence; linear mixed-effects models

## 1 Introduction

Sustainable development is now a practical benchmark for economic and public-policy performance. The Sustainable Development Goals (SDGs) provide a measurable framework for economic, social, environmental, and institutional progress. Yet country performance remains uneven. The *Sustainable Development Report 2024* reports that only a small share of SDG targets is on track for 2030, which makes it important to understand why sustainable-development performance differs across countries [40].

One explanation is that sustainable development depends on the political, economic, and financial conditions under which policy is implemented, and not just on income and financial resources. High country risk weakens investment incentives, increases uncertainty, narrows fiscal space, and limits the capacity of governments to sustain long-term development programs. This argument is consistent with institutional economics, where institutions shape incentives, reduce uncertainty, and influence long-run development outcomes [33, 38]. Empirical research also links country risk to capital flows and cross-country investment outcomes [19, 20].

Resource dependence is another source of cross-country heterogeneity. Resource rents can finance infrastructure and public services, but dependence on natural resources can also expose countries to commodity-price volatility, weak diversification, rent seeking, and environmental pressure. These pressures bear directly on the environmental and institutional pillars of the SDG framework, since weak diversification and rent-driven fiscal cycles can crowd out the sustained public investment that environmental regulation and infrastructure upgrading require. The resource-curse literature shows that resource wealth does not automatically generate better development outcomes [8, 41, 44]. The institutional branch of this literature argues that the development effect of resources depends strongly on governance quality and political institutions [15, 26, 31].

This article asks whether institutional and macro-financial risk conditions are associated with sustainable-development performance, and whether that association changes in resource-dependent economies. If resource dependence raises the need for

revenue management, diversification, and environmental regulation, institutional and political conditions should be especially relevant where resource rents are high. The analysis uses a country-year panel in which the dependent variable is the SDG Index. The main explanatory variables are aggregate country risk, its financial, economic, and political components, and natural-resource rents as a percentage of GDP. Risk variables are retained in their risk-factor direction, so higher values indicate higher risk or weaker stability.

The empirical strategy uses linear mixed-effects models with year fixed effects, country random intercepts, and country random Time slopes. This structure accounts for repeated observations within countries and allows countries to differ in both baseline SDG levels and development trajectories. The study extends country-risk research from growth and investment outcomes to SDG performance, links country risk with resource dependence, separates aggregate risk from its financial, economic, and political dimensions, and evaluates the results with diagnostic and robustness checks.

Three main findings emerge. Resource dependence carries the most consistent negative coefficient across the estimated specifications. Aggregate country risk takes the expected negative sign but loses statistical significance once the controls and country-level heterogeneity enter the model. When the aggregate index is decomposed, political risk emerges as the relevant institutional channel, whereas financial and economic risk do not reach significance. The interaction tests, in turn, provide no evidence that aggregate country risk is more strongly associated with SDG performance in more resource-dependent economies.

The remainder of the paper is organized as follows. Section 2 reviews the literature and develops the hypotheses. Section 3 describes the data and variables. Section 4 presents the empirical strategy. Section 5 reports the empirical results. Section 6 presents robustness and diagnostic checks. Section 7 discusses the findings. Section 8 presents concluding remarks.

## 2 Literature background and hypotheses

### 2.1 Country risk, institutions, and sustainable development

Country risk captures political, economic, and financial uncertainty that affects a country’s capacity to attract capital, maintain policy credibility, and finance long-term development. Political instability can weaken policy continuity and regulatory enforcement. Economic risk can reduce fiscal capacity and increase macroeconomic volatility. Financial risk can restrict access to credit and make public and private investment more costly. Early evidence links political, economic, and financial risk to capital-market performance and cross-country investment outcomes [19, 20].

Institutional theory explains why these risks matter for development. Institutions reduce uncertainty, shape incentives, and affect the quality of policy implementation [33]. Cross-country evidence also links institutions to long-run development differences [2, 38]. In sustainability settings, this channel is relevant because SDG performance requires sustained investment in infrastructure, health, education, environmental protection, public administration, and credible enforcement of environmental and social policies.

Recent sustainability-oriented evidence extends this argument beyond growth and investment. Sulehri and Ali [43] link country risk directly to sustainable-development performance, while Liu et al. [30] show that economic risk is associated with weaker sovereign environmental, social, and governance performance through foreign-investment, corruption, and fiscal-capacity channels. Sovereign ESG work also emphasizes governance credibility, fiscal resilience, and measurement limits in country-level sustainability assessment [21]; this caution is consistent with wider evidence that ESG ratings can diverge because of differences in scope, measurement, and weighting [14]. Political instability is also relevant because geopolitical risk can reduce investment and employment [18] and can weaken environmental-policy stringency [6]. Cross-country evidence also links institutional differences to variation in SDG achievement [37].

## 2.2 Resource dependence and the resource-curse channel

Natural resources can support development by generating export revenue and public income. However, the resource-curse literature shows that resource abundance can also be associated with weaker growth, limited diversification, governance problems, and exposure to commodity cycles [8, 41, 44]. The main implication is not that natural resources are always harmful. Rather, resource rents can become harmful when countries rely on them without building the institutions and productive capacity needed to convert rents into broad development outcomes.

Institutional quality is central to this conditional interpretation. Mehlum et al. [31] show that institutions help explain why resources are a curse in some countries but not in others. Bhattacharyya and Hodler [15] and Kolstad and Wiig [26] similarly link resource rents, corruption, and institutional conditions. Recent evidence points to a structural-transformation channel: sustainable-development policies can reduce natural-resource dependence through green innovation and regional integration [29], and stronger governance is associated with greater economic diversification and economic complexity [5]. Recent work also finds that institutional quality and technological capability can moderate the environmental risks associated with resource rents [42]. These studies imply that resource-dependent economies need both institutional capacity and diversification to reduce rent dependence and improve sustainability outcomes.

## 2.3 Hypotheses development

The first hypothesis concerns the direct country-risk effect. Countries with higher political, economic, and financial risk are expected to have weaker capacity to implement long-term sustainable-development policies. Because the empirical risk variables are coded so that higher values indicate higher risk or weaker stability, the expected coefficient is negative.

**H1.** Higher country risk is negatively associated with sustainable-development performance.

The second hypothesis concerns resource dependence. Resource rents may provide fiscal resources, but dependence on these rents can increase volatility, reduce

diversification, and intensify governance and environmental pressures. The expected association between resource rents and the SDG Index is therefore negative.

**H2.** Higher resource dependence is negatively associated with sustainable-development performance.

The third hypothesis concerns the title question. If resource-rich economies depend more heavily on institutional capacity to manage volatile rents and environmental externalities, then the effect of country risk should be stronger when resource dependence is higher. This is tested through country-risk by resource-dependence interaction terms.

**H3.** Resource dependence moderates the country risk–sustainable development relationship, so that the adverse effect of country risk is stronger at higher levels of resource dependence.

The fourth hypothesis concerns the decomposed country-risk dimensions. Political, economic, and financial risk may affect sustainable development through different channels. Political risk is expected to be especially relevant because SDG progress depends on policy continuity, governance credibility, and regulatory enforcement.

**H4.** The financial, economic, and political dimensions of country risk have heterogeneous effects on sustainable-development performance, with political risk expected to be the most relevant institutional component.

## 3 Data and variables

### 3.1 Sample construction

The initial dataset was assembled as a country-year panel covering 33 countries over 2018–2025. Syria was subsequently excluded because several core variables required for the econometric analysis were unavailable, including financial risk, economic risk, gross domestic product (GDP), investment, trade, and resource-dependence variables. The retained descriptive panel therefore contains 32 countries observed over 2018–2025. Because natural-resource-rent data are unavailable for 2024 and 2025, the main resource-dependence models use the resource-complete period 2018–2023, giving 192 country-year observations. The full 2018–2025 descriptive summary is retained as supplementary material.

### 3.2 Variable measurement

Sustainable-development performance is measured using the SDG Index reported in the annual *Sustainable Development Report* [40]. In this study, the SDG Index is treated as a composite country-level quality-of-life and well-being measure because it combines material living conditions with health, education, environmental, social, and institutional dimensions. This framing is consistent with recent work in *Social Indicators Research* that treats global sustainable-development measurement as a multidimensional indicator problem and emphasizes SDG interlinkages [1]. The Institutional Quality Index (IQI) reported with the same source is used as a companion measure of institutional conditions where required.

Country risk is measured through political, economic, and financial dimensions, together with an aggregate country-risk score. The political-risk measure is constructed from the World Bank Worldwide Governance Indicators (WGI), using the six standard governance dimensions: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption [24, 52]. Following common governance-index practice, the component indicators are normalized to a common scale and transformed so that higher values represent greater political risk and weaker institutional stability. Economic risk is measured using World Bank Country Policy and Institutional Assessment (CPIA) information for IDA-eligible countries, supplemented by macroeconomic proxy scores for countries outside CPIA coverage [51, 53]. Financial risk is measured as a composite proxy based on general government debt as a percentage of GDP, the current-account balance as a percentage of GDP, and the annual inflation rate, using the International Monetary Fund World Economic Outlook (IMF WEO) and World Bank World Development Indicators (WDI) [48, 53]. The aggregate country-risk variable combines the political, economic, and financial dimensions. All risk variables are coded as risk factors: higher values indicate greater risk and weaker stability. This coding is used consistently throughout the empirical analysis, so negative coefficients on risk variables indicate that greater risk is associated with lower SDG Index performance.

Macroeconomic controls include GDP per capita, foreign direct investment (FDI) net inflows, foreign portfolio investment (FPI) net inflows, trade openness, and GDP growth. GDP and GDP per capita are taken from the IMF WEO and WDI. FDI and FPI are obtained from WDI and checked against UNCTAD investment statistics where applicable [50, 53]. FDI and FPI are expressed as percentages of GDP. Trade openness is calculated as exports plus imports divided by GDP, using exports and imports of goods and services from WDI. GDP growth is retained as a macroeconomic background variable and is used descriptively and in robustness screening where relevant.

Natural-resource dependence is measured primarily by natural-resource rents as a percentage of GDP, using the WDI series for total natural-resource rents, oil rents, natural-gas rents, and mineral rents [53]. These indicators are supplemented descriptively by fuel exports as a share of merchandise exports and by commodity-dependence information from UNCTAD, where available [50]. Resource endowment is described using proven oil and natural-gas reserves from the Energy Institute Statistical Review of World Energy and annual oil and gas production from the Our World in Data energy dataset [47, 49]. These endowment variables are used for contextual description and data validation rather than as the preferred measure of resource dependence in the reported models.

The final estimation sample retains only country-year observations with the information required for the reported models. Observations that are unavailable in the original sources are recorded as missing rather than imputed. Forecast values and forward projections available in some source databases are not used in the reported 2018–2023 estimations unless explicitly stated. The processed dataset, data dictionary, and analysis code are provided as Online Resources 1–5, subject to the licensing conditions of the original data providers.

Table 1 summarizes the variables, roles, and measurement definitions used in the analysis.

**Table 1** Variable measurement

| Variable               | Role                      | Measurement and interpretation                                                                                                                                                     |
|------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SDG Index              | Dependent variable        | Sustainable-development performance; higher values indicate stronger SDG performance.                                                                                              |
| Aggregate country risk | Main explanatory variable | Composite of political, economic, and financial risk; higher values indicate greater risk or weaker stability.                                                                     |
| Financial risk         | Risk component            | Composite proxy based on debt, external-balance, and inflation indicators; higher values indicate greater financial risk.                                                          |
| Economic risk          | Risk component            | CPIA-based/proxy economic-risk score; higher values indicate greater economic risk.                                                                                                |
| Political risk         | Risk component            | WGI-based governance-risk score; higher values indicate greater political risk and weaker institutional stability.                                                                 |
| Resource rents         | Main explanatory variable | Total natural-resource rents as a percentage of GDP; continuous measure of resource dependence.                                                                                    |
| Log GDP per capita     | Control                   | Natural logarithm of GDP per capita; captures income capacity.                                                                                                                     |
| FDI/GDP                | Control                   | Foreign direct investment as a percentage of GDP.                                                                                                                                  |
| FPI/GDP                | Descriptive variable      | Foreign portfolio investment as a percentage of GDP; reported descriptively but not retained in the preferred LMM because of missing observations in the resource-complete sample. |
| GDP growth             | Descriptive variable      | Nominal GDP growth; reported descriptively but not retained in the preferred LMM.                                                                                                  |
| Trade openness         | Control                   | Exports plus imports relative to GDP.                                                                                                                                              |
| Year effects           | Time controls             | Categorical year indicators controlling for common annual shifts.                                                                                                                  |
| Country effects        | Random effects            | Country random intercepts and random Time slopes capturing country-level heterogeneity.                                                                                            |

### 3.3 Descriptive statistics and resource-intensity groups

The main descriptive statistics are calculated on the resource-complete modelling sample, 2018–2023. Table 2 shows that the mean SDG Index is 66.05, with substantial cross-country and time variation. Resource rents are highly dispersed, with a median of 3.15 percent of GDP and a maximum of 50.80 percent of GDP, confirming that the sample contains countries with very different levels of resource dependence.

**Table 2** Descriptive statistics for the resource-complete modelling sample, 2018–2023

| Variable               | <i>n</i> | Miss. | Mean   | SD     | Min.    | Median | Max.    |
|------------------------|----------|-------|--------|--------|---------|--------|---------|
| SDG Index              | 192      | 0     | 66.050 | 6.770  | 48.550  | 67.945 | 77.340  |
| Aggregate country risk | 192      | 0     | 39.727 | 13.351 | 21.800  | 36.225 | 89.270  |
| Financial risk         | 192      | 0     | 31.967 | 22.100 | 3.000   | 28.000 | 100.000 |
| Economic risk          | 192      | 0     | 34.315 | 16.642 | 7.500   | 31.350 | 90.300  |
| Political risk         | 192      | 0     | 52.898 | 8.175  | 40.480  | 50.720 | 81.280  |
| Resource rents (% GDP) | 192      | 0     | 5.255  | 7.290  | 0.000   | 3.150  | 50.800  |
| Log GDP per capita     | 192      | 0     | 8.229  | 0.781  | 6.120   | 8.266  | 9.528   |
| FDI (% GDP)            | 192      | 0     | 2.692  | 3.361  | -1.163  | 1.903  | 27.967  |
| FPI (% GDP)            | 180      | 12    | 0.079  | 0.899  | -4.762  | 0.100  | 2.624   |
| Trade openness         | 192      | 0     | 0.591  | 0.333  | 0.191   | 0.514  | 2.005   |
| GDP growth (%)         | 192      | 0     | 5.004  | 12.745 | -43.825 | 5.453  | 64.116  |

**Table 3** Descriptive comparison by resource-intensity group

| Group  | Countries | SDG    | C-risk | Fin.   | Econ.  | Pol.   | Resources |
|--------|-----------|--------|--------|--------|--------|--------|-----------|
| Low    | 11        | 65.626 | 38.781 | 31.573 | 33.218 | 51.551 | 1.304     |
| Medium | 11        | 66.236 | 42.328 | 36.373 | 37.839 | 52.772 | 3.470     |
| High   | 10        | 66.312 | 37.907 | 27.555 | 31.645 | 54.519 | 11.565    |

C-risk is aggregate country risk; Fin., Econ., and Pol. are financial, economic, and political risk. Resource-intensity groups are descriptive only and are based on average resource rents over 2018–2023. The LMM uses resource rents as a continuous variable.

Table 3 is descriptive only. It shows that high-resource-intensity countries have the highest average resource rents, as expected. The grouping is used only to motivate heterogeneity in resource dependence; the main LMM uses resource rents as a continuous predictor.

### 3.4 Distribution and outlier checks

The data were checked for duplicate country-year records, missingness, skewness, and extreme observations. No duplicated country-year observations were found. Several macro-financial variables are skewed, especially resource rents, FDI/GDP, FPI/GDP, and trade openness. GDP per capita was therefore log-transformed. Extreme values were retained in the main analysis because they correspond to economically meaningful country-year observations rather than clear data-entry errors; for example, the minimum GDP growth rate of  $-43.8\%$  reflects a severe country-year contraction rather than a data-entry error. Winsorization is used only as a robustness check.

## 4 Empirical strategy

### 4.1 Linear mixed-effects model specification

The outcome variable, the SDG Index, is continuous and is observed repeatedly for the same countries. The modelling problem is therefore a longitudinal continuous-response problem with country-level clustering. A pooled ordinary least-squares model would treat all country-year observations as independent and would impose one common intercept and one common time path. A linear mixed-effects model is therefore appropriate because it estimates average fixed effects while allowing country-specific random deviations in intercepts and time slopes [11, 27, 35].

The main advantages of the LMM for this study are direct. First, it accounts for the correlation induced by repeated observations from the same country. Second, it separates average covariate effects from unobserved country heterogeneity. Third, it allows countries to differ both in baseline SDG levels and in the rate at which SDG changes over time. Fourth, it can be estimated with unequal numbers of observations across countries, which is useful for longitudinal panels with incomplete measurement periods [9, 22, 36, 45].

All main LMMs were estimated in R using `lme4` and `lmerTest`, with maximum likelihood estimation used for model comparison. Descriptive checks and data-audit tables were cross-checked independently. Supplementary diagnostics used the R packages `plm`, `lmtest`, `performance`, and `broom.mixed`. The analysis script and processed model dataset are provided as Online Resources 5 and 2, respectively.

The estimates are interpreted as conditional associations rather than causal effects. Endogeneity may arise in country-year data because country risk, resource dependence, investment flows, and SDG performance can influence one another over time, and because unobserved institutional or structural conditions may be correlated with the observed covariates. The mixed-effects structure addresses one important source of this concern by allowing persistent country-level heterogeneity and country-specific trajectories. Following the logic of correlated random-effects and within-between modelling, the Mundlak specification is used as a robustness check to assess whether the resource-dependence result is driven by the correlation between observed covariates and persistent country characteristics [12, 13, 32, 46]. Serial dependence and model instability are assessed separately through AR(1) residual-correlation models and recursive-residual diagnostics. A one-year lagged-predictor timing check is used only to support a cautious endogeneity discussion and is not treated as a causal lagged-effects design. These checks do not provide full causal identification; the coefficients are therefore read as conditional country-year associations.

For country  $i = 1, \dots, N$  and observed year  $t = 1, \dots, T_i$ , the general LMM is

$$\mathbf{y}_i = \mathbf{X}_i\boldsymbol{\beta} + \mathbf{Z}_i\mathbf{b}_i + \boldsymbol{\varepsilon}_i, \quad (1)$$

where  $\mathbf{y}_i$  is the vector of SDG observations for country  $i$ ,  $\mathbf{X}_i\boldsymbol{\beta}$  contains fixed effects,  $\mathbf{Z}_i\mathbf{b}_i$  contains country-specific random effects, and  $\boldsymbol{\varepsilon}_i$  is the within-country error vector. The model assumes  $\mathbf{b}_i \sim N(\mathbf{0}, \mathbf{D})$ ,  $\boldsymbol{\varepsilon}_i \sim N(\mathbf{0}, \mathbf{R}_i)$ , and independence between  $\mathbf{b}_i$

and  $\varepsilon_i$ , giving

$$\text{Var}(\mathbf{y}_i) = \mathbf{Z}_i \mathbf{D} \mathbf{Z}_i^\top + \mathbf{R}_i. \quad (2)$$

The preferred aggregate-risk specification is written compactly as

$$y_{it} = \mathbf{x}_{it}^{(A)\top} \boldsymbol{\beta}^{(A)} + \mathbf{d}_t^\top \boldsymbol{\gamma} + \mathbf{z}_t^\top \mathbf{b}_i + \varepsilon_{it}, \quad (3)$$

where

$$\mathbf{x}_{it}^{(A)} = (1, CR_{it}, RR_{it}, LGDPpc_{it}, FDI_{it}, TO_{it})^\top,$$

$CR_{it}$  is aggregate country risk,  $RR_{it}$  is resource rents as a percentage of GDP,  $LGDPpc_{it}$  is log GDP per capita,  $FDI_{it}$  is FDI as a percentage of GDP, and  $TO_{it}$  is trade openness. The vector  $\boldsymbol{\beta}^{(A)}$  contains the corresponding fixed-effect coefficients. The year-indicator vector is  $\mathbf{d}_t = (\mathbf{1}(Year_t = 2019), \dots, \mathbf{1}(Year_t = 2023))^\top$ , with coefficient vector  $\boldsymbol{\gamma}$ . The random-effects design vector is  $\mathbf{z}_t = (1, Time_t)^\top$  and  $\mathbf{b}_i = (b_{0i}, b_{1i})^\top$ , where  $b_{0i}$  is the country-specific random intercept and  $b_{1i}$  is the country-specific random Time slope. The term  $\varepsilon_{it}$  is the remaining error. In the selected uncorrelated random-slope model, the two elements of  $\mathbf{b}_i$  vary by country but have covariance constrained to zero.

The decomposed-risk model replaces aggregate country risk with financial, economic, and political risk:

$$y_{it} = \mathbf{x}_{it}^{(D)\top} \boldsymbol{\beta}^{(D)} + \mathbf{d}_t^\top \boldsymbol{\gamma} + \mathbf{z}_t^\top \mathbf{b}_i + \varepsilon_{it}, \quad (4)$$

where

$$\mathbf{x}_{it}^{(D)} = (1, FR_{it}, ER_{it}, PR_{it}, RR_{it}, LGDPpc_{it}, FDI_{it}, TO_{it})^\top,$$

and  $\boldsymbol{\beta}^{(D)}$  contains the corresponding fixed-effect coefficients. This specification tests whether the aggregate country-risk index masks differences among financial, economic, and political risk channels.

To test the moderation hypothesis, interaction specifications add either  $CR_{it} \times RR_{it}$  to Equation 3 or  $PR_{it} \times RR_{it}$  to Equation 4. These interaction models are used to assess whether the risk-SDG association becomes stronger as resource dependence increases.

## 4.2 Model-building procedure

Model building proceeded from simpler to more flexible panel specifications. A two-way fixed-effects benchmark was first estimated as a reference model. The mixed-effects sequence then compared a random-intercept LMM with two random Time-slope alternatives: one with a correlated country intercept and slope and one with an uncorrelated country intercept and slope. Models were estimated by maximum likelihood for comparison. AIC and BIC were used to compare relative fit, and the random-intercept model was compared against the uncorrelated random-Time-slope model using a likelihood-ratio test [3]. Table 4 reports this random-effects structure comparison.

The random Time-slope structure was strongly supported. Relative to the random-intercept model, the uncorrelated random Time-slope model reduced AIC from 741.99

**Table 4** Random-effects structure comparison for the aggregate-risk LMM

| Specification                  | AIC    | BIC    | Singular fit |
|--------------------------------|--------|--------|--------------|
| Random intercept               | 741.99 | 784.34 | No           |
| Correlated random Time slope   | 705.25 | 754.12 | No           |
| Uncorrelated random Time slope | 703.25 | 748.86 | No           |

The likelihood-ratio comparison between the random-intercept model and the uncorrelated random-Time-slope model gives  $\chi^2 = 40.73$  and  $p < 0.001$ .

to 703.25 and BIC from 784.34 to 748.86. The correlated random Time-slope model also improved fit, but the uncorrelated random Time-slope model had the lower AIC and BIC and no singular-fit warning. The final LMM therefore includes year fixed effects, a country-level random intercept, and an uncorrelated country-level random Time slope.

## 5 Results

Table 5 presents the main aggregate and decomposed LMM estimates.

Model 1 shows that aggregate country risk has the expected negative sign, but it is not statistically significant. Resource rents are negative and statistically significant. Thus, resource dependence is associated with lower sustainable-development performance after controlling for income level, FDI/GDP, trade openness, year effects, and country-specific intercepts and trends.

The year fixed effects are all positive and significant relative to 2018. This indicates that, after adjustment for the model covariates and country-level random effects, the average SDG level in later years is higher than in 2018. These coefficients are interpreted as annual shifts rather than as one imposed linear growth coefficient. Country-specific growth is captured through the continuous random Time slope coded 0 for 2018, 1 for 2019, and so on. Part of this common upward shift may also reflect refinements to the SDG Index indicator set across successive Sustainable Development Report editions rather than substantive improvement alone, and this possibility should be kept in mind when interpreting the year effects.

The random-intercept standard deviation indicates substantial between-country heterogeneity in starting SDG levels. In Model 1, the country random-intercept SD is 4.729; in Model 2, it is 4.357. The random Time-slope SDs, 0.386 and 0.376, indicate that countries also differ in their rates of SDG change over time. The ICC values are high in both models: the average ICC is 0.975 in Model 1 and 0.971 in Model 2. These values show that most residual variation is structured at the country level, which reinforces the need for a mixed-effects specification rather than a pooled ordinary regression.

Model 2 shows why decomposition is necessary. Financial and economic risk are not statistically significant, whereas political risk is negative and significant. Resource rents remain negative and significant. The decomposed model has a lower AIC than the aggregate model, although its BIC is slightly higher because it uses additional parameters. The result supports a cautious interpretation: the aggregate country-risk

**Table 5** LMM coefficient estimates and model structure

| Term                                        | Model 1: aggregate           | VIF   | Model 2: decomposed          | VIF   |
|---------------------------------------------|------------------------------|-------|------------------------------|-------|
| <i>Fixed effects</i>                        |                              |       |                              |       |
| Intercept, 2018 baseline                    | 43.040 (5.806) [ $< 0.001$ ] | —     | 43.736 (5.729) [ $< 0.001$ ] | —     |
| Country risk                                | −0.008 (0.019) [0.695]       | 1.310 | —                            | —     |
| Financial risk                              | —                            | —     | 0.003 (0.015) [0.820]        | 2.744 |
| Economic risk                               | —                            | —     | 0.003 (0.010) [0.785]        | 2.436 |
| Political risk                              | —                            | —     | −0.083 (0.032) [0.010]       | 1.942 |
| Resource rents                              | −0.160 (0.040) [ $< 0.001$ ] | 1.031 | −0.159 (0.041) [ $< 0.001$ ] | 1.504 |
| Log GDP per capita                          | 2.504 (0.634) [ $< 0.001$ ]  | 1.336 | 2.858 (0.616) [ $< 0.001$ ]  | 1.602 |
| FDI/GDP                                     | 0.026 (0.057) [0.649]        | 1.332 | 0.030 (0.058) [0.604]        | 1.665 |
| Trade openness                              | 1.422 (1.215) [0.244]        | 1.319 | 1.894 (1.194) [0.115]        | 1.319 |
| <i>Year fixed effects, relative to 2018</i> |                              |       |                              |       |
| 2019                                        | 1.926 (0.208) [ $< 0.001$ ]  | —     | 1.907 (0.209) [ $< 0.001$ ]  | —     |
| 2020                                        | 3.387 (0.294) [ $< 0.001$ ]  | —     | 3.416 (0.322) [ $< 0.001$ ]  | —     |
| 2021                                        | 3.293 (0.287) [ $< 0.001$ ]  | —     | 3.365 (0.287) [ $< 0.001$ ]  | —     |
| 2022                                        | 3.449 (0.380) [ $< 0.001$ ]  | —     | 3.460 (0.381) [ $< 0.001$ ]  | —     |
| 2023                                        | 3.792 (0.416) [ $< 0.001$ ]  | —     | 3.661 (0.414) [ $< 0.001$ ]  | —     |
| <i>Random effects and model fit</i>         |                              |       |                              |       |
| Country                                     | 4.729                        | —     | 4.357                        | —     |
| random-intercept SD                         |                              |       |                              |       |
| Country                                     | 0.386                        | —     | 0.376                        | —     |
| random-Time-slope SD                        |                              |       |                              |       |
| Residual SD                                 | 0.778                        | —     | 0.778                        | —     |
| ICC at 2018                                 | 0.974                        | —     | 0.969                        | —     |
| Mean ICC, 2018–2023                         | 0.975                        | —     | 0.971                        | —     |
| Observations                                | 192                          | —     | 192                          | —     |
| Countries                                   | 32                           | —     | 32                           | —     |
| AIC                                         | 703.25                       | —     | 700.66                       | —     |
| BIC                                         | 748.86                       | —     | 752.78                       | —     |

Fixed-effect entries are coefficient estimates, with standard errors in parentheses and  $p$ -values in square brackets. Model 1 uses the aggregate country-risk index. Model 2 replaces the aggregate index with financial, economic, and political risk. Both models include the same controls, year fixed effects, and uncorrelated country-level random intercepts and Time slopes. Random-effect entries are standard deviations, not regression coefficients.

index is not significant, but the political component of risk is a relevant institutional channel.

The interaction evidence does not support a moderation claim. The aggregate country-risk  $\times$  resource-rents interaction is not significant ( $\hat{\beta} = 0.0007$ ,  $p = 0.713$ ), and the political-risk  $\times$  resource-rents interaction is also not significant ( $\hat{\beta} = 0.0040$ ,  $p = 0.173$ ). Therefore, the results do not support the claim that resource dependence significantly strengthens the risk–SDG relationship. Table 6 reports the corresponding moderation tests.

## 6 Robustness and diagnostic checks

Table 7 summarizes the main robustness and diagnostic checks. The robustness assessment combines sensitivity analysis, recursive-residual diagnostics, AR(1) residual-correlation checks, Mundlak within-between modelling, a concise timing check, and

**Table 6** Interaction tests for the moderation hypothesis

| Interaction term                               | Estimate | <i>p</i> -value | Interpretation                                                                                        |
|------------------------------------------------|----------|-----------------|-------------------------------------------------------------------------------------------------------|
| Aggregate country risk $\times$ resource rents | 0.0007   | 0.713           | No evidence that aggregate country risk has a stronger SDG association at higher resource dependence. |
| Political risk $\times$ resource rents         | 0.0040   | 0.173           | No evidence that the political-risk association is significantly moderated by resource dependence.    |

Each interaction model includes the corresponding main effects, log GDP per capita, FDI/GDP, trade openness, year fixed effects, and uncorrelated country-level random intercepts and Time slopes.

The continuous variables entering the interaction products were mean-centred before the product terms were formed. They were not *z*-standardized; standardized residuals were used only for outlier screening.

additional econometric diagnostics. Recursive residuals are used as an LMM model-adequacy diagnostic following the recursive-residual framework for mixed models [10]. Only the main robustness findings are reported in the main text; detailed diagnostic screens are summarized in Appendix Table A2.

Taken together, the sensitivity checks and diagnostics support the credibility of the main resource-dependence result. The central finding is not altered by outlier screening, winsorization, exclusion of the 2021–2022 shock window, leave-one-country-out checks, recursive-residual diagnostics, AR(1) residual-correlation modelling, or the Mundlak within-between specification [12, 13, 32, 46]. The timing check is used only to support a cautious endogeneity discussion and does not support a causal lagged-effects interpretation.

## 6.1 Additional econometric diagnostics

Additional panel diagnostics are used as supporting checks rather than as alternative estimators for the main claims. VIF values are low in both specifications, indicating that multicollinearity is not a concern. The studentized Breusch–Pagan/Koenker tests reject homoskedasticity in auxiliary two-way fixed-effect models, so robust standard errors are appropriate in supplementary panel checks [17, 25]. Pesaran CD tests do not reject residual cross-sectional independence [34]. Formal LLC and IPS unit-root screens are not used for substantive inference because the resource-complete panel contains only six annual observations per country [23, 28]. A dynamic System GMM specification [7, 16, 39] was screened only as a lagged-outcome alternative; it was not retained because the required serial-correlation and instrument-count diagnostics were not satisfied. These diagnostics address different concerns: the LMM and Mundlak checks address persistent country heterogeneity, AR(1) and recursive-residual checks address serial dependence and model stability, and the timing check addresses temporal ordering. None is treated as full causal identification. Detailed diagnostic values are reported in Appendix Table A2.

**Table 7** Robustness and diagnostic checks: main evidence

| Check                                 | Main result                                                                                                                                                                                                                                                        | Interpretation                                                                                                           |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Residual/outlier rule                 | No fitted LMM observation exceeded $ r  > 3$ ; stricter thresholds kept resource rents negative and significant.                                                                                                                                                   | Results are not driven by a small number of extreme residuals.                                                           |
| Winsorization at 1st–99th percentiles | Resource rents = $-0.1815$ , $p < 0.001$ ; country risk remains non-significant.                                                                                                                                                                                   | The resource-dependence result is robust to tail moderation.                                                             |
| Exclude 2021–2022 shock window        | Resource rents = $-0.2218$ , $p < 0.001$ ; country risk remains non-significant.                                                                                                                                                                                   | The resource-rent result is not explained by the post-pandemic/shock window.                                             |
| Leave-one-country-out checks          | Resource rents are negative in all 32 exclusions and significant in 31/32 exclusions; political risk is negative and significant in all 32 decomposed checks.                                                                                                      | Findings are not driven by one country.                                                                                  |
| Recursive residual diagnostics        | Time CUSUM $p = 0.005$ and lag-one RR ACF $p = 0.005$ ; resource-rent CUSUM is not significant; decomposed political-risk CUSUM $p = 0.765$ .                                                                                                                      | Main resource-rent and political-risk patterns are captured, but temporal dependence remains.                            |
| AR(1) residual-correlation model      | $\phi = 0.779$ in the aggregate model and $\phi = 0.822$ in the decomposed model; main signs and significance are unchanged.                                                                                                                                       | Correcting for serial dependence does not change the substantive conclusions.                                            |
| Mundlak within-between model          | Resource rents are negative and significant within countries and between countries: aggregate model within = $-0.151$ ( $p = 0.001$ ), between = $-0.197$ ( $p = 0.017$ ); decomposed model within = $-0.164$ ( $p < 0.001$ ), between = $-0.242$ ( $p = 0.017$ ). | The negative association appears within countries as well as between them.                                               |
| One-year lagged-predictor check       | A one-year timing specification was screened as an endogeneity-related sensitivity check.                                                                                                                                                                          | The timing check supports a cautious endogeneity discussion but does not support a causal lagged-effects interpretation. |

## 7 Discussion of Results

This study examined whether institutional stability contributes more strongly to sustainable development in resource-rich economies than in resource-poor economies. It analysed country risk, natural-resource dependence, and Sustainable Development Goal (SDG) performance in a multi-country panel. Four questions guided the analysis: whether country risk is associated with sustainable development; whether sustainability performance differs by resource dependence; whether resource dependence moderates the country risk–sustainability relationship; and whether the political, economic, and financial dimensions of country risk have different effects. The findings

provide partial support for the theoretical framework. Interpreting the SDG Index as a multidimensional quality-of-life and well-being measure also links the results to recent indicator-based work on global sustainable development and SDG interlinkages [1]. Natural-resource dependence shows the most consistent negative association with sustainable-development performance, and political risk is the most relevant institutional dimension. However, the evidence does not support the broader proposition that institutional stability matters more in resource-rich economies.

## 7.1 Country risk and sustainable development

The first hypothesis proposed that lower country risk, interpreted as stronger institutional stability, would improve sustainable development outcomes. Although the estimated coefficient has the expected sign, the aggregate country-risk index is not statistically significant after controlling for economic development, foreign direct investment, trade openness, year effects, and country-specific heterogeneity. Hypothesis 1 is therefore not supported.

This finding differs from earlier empirical studies reporting a significant relationship between country risk and sustainable development [e.g., 43] and between country risk and broader economic performance. Nevertheless, it provides an important insight into the multidimensional nature of sustainable development. Unlike economic growth, sustainable development simultaneously reflects economic, environmental, social, and institutional performance. A composite measure that combines political, economic, and financial conditions into a single indicator may therefore mask the specific institutional mechanisms through which country stability affects sustainability.

The result also has a theoretical implication. Institutional theory argues that stronger institutions reduce uncertainty, improve policy credibility, and facilitate long-term development [33, 38]. The present findings suggest, however, that institutional quality should not be treated as a single homogeneous construct. Different institutional dimensions appear to affect sustainability through different channels. This is why decomposing country risk into political, economic, and financial components is informative.

## 7.2 Resource dependence and sustainable development

The second research question examined whether sustainability differs across countries with different levels of natural-resource dependence. The descriptive analysis demonstrates observable differences among resource-rich, moderately dependent, and resource-poor economies, indicating that resource dependence is associated with distinct sustainability patterns. More importantly, the multivariate mixed-effects models show a negative and statistically significant association between natural-resource rents and SDG performance in the main specifications and most robustness checks. Accordingly, Hypothesis 2 is supported. Although the descriptive grouping primarily serves to illustrate cross-country heterogeneity, the econometric analysis confirms that resource dependence, measured as a continuous variable, exerts a statistically significant and economically meaningful negative effect on sustainable development.

The consistency of this finding across winsorized estimations, leave-one-country-out analysis, exclusion of the post-pandemic period, AR(1) residual specifications, and correlated random-effects (Mundlak) models indicates that the relationship is robust across the main sensitivity checks. This evidence is consistent with the resource-curse literature, which argues that excessive dependence on natural resources often constrains long-term development through weak diversification, revenue volatility, institutional inefficiency, and rent-seeking behaviour [15, 41, 44]. Rather than serving as a sustainable engine of development, resource dependence appears to constitute a persistent structural constraint on achieving balanced economic, environmental, and social progress.

### 7.3 Does institutional stability matter more in resource-rich economies?

A main purpose of the study was to test whether natural-resource dependence strengthens the association between institutional stability and sustainable development. Institutional theory and recent extensions of the resource-curse literature suggest that stronger institutions should be more valuable in resource-rich economies because governments must manage volatile revenues, promote diversification, and maintain effective environmental governance. Contrary to this expectation, neither the interaction between the Composite Country Risk Index and natural-resource rents nor the interaction involving political risk is statistically significant. Hypothesis 3 is therefore not supported.

This result answers the question posed in the title. Institutional stability does not appear to matter more in resource-rich economies through a statistically significant moderating effect. Instead, institutional stability and resource dependence appear to be associated with sustainable development through largely separate mechanisms. Resource dependence is associated with lower SDG performance, while the estimated effect of institutional stability does not become stronger as resource dependence increases.

This finding differs from several recent studies suggesting that stronger institutions become increasingly important in resource-dependent economies [e.g., 31, 42]. Several explanations may account for this result. First, the sample contains countries with substantial variation in institutional quality, income levels, governance systems, and economic structures, potentially reducing the statistical detectability of interaction effects. Second, sustainable development reflects numerous dimensions that extend beyond institutional quality alone, including technological capability, environmental policy, demographic characteristics, and international integration. Third, resource dependence may influence sustainable development primarily through direct structural mechanisms—such as limited diversification, fiscal volatility, and environmental degradation—rather than by altering the marginal impact of institutional stability.

Consequently, the findings suggest that improving governance alone may be insufficient to overcome the structural challenges associated with natural-resource dependence. Effective sustainability strategies should therefore combine institutional reforms with economic diversification, innovation policies, and structural transformation.

## 7.4 Which dimension of country risk matters most?

The decomposed risk model adds detail to the aggregate result. Neither financial risk nor economic risk is statistically significant, whereas political risk remains negative and statistically significant after controlling for the other explanatory variables. Accordingly, Hypothesis 4 is supported, indicating that the individual dimensions of country risk contribute differently to sustainable development.

This finding is consistent with the institutional argument that political stability is a key channel linking governance quality to sustainable development. Stable political systems improve governments' ability to formulate long-term development strategies, implement environmental regulations, maintain policy continuity, and allocate public resources toward the SDGs. By contrast, the direct effects of financial and economic risk are weaker once income, resource dependence, and country-specific characteristics are included.

The results are broadly consistent with studies emphasizing governance quality and political institutions as fundamental determinants of sustainable development and sovereign ESG performance [4, 21, 24]. They also explain why the aggregate country-risk measure fails to achieve statistical significance: combining significant and insignificant institutional dimensions into a single composite index obscures the dominant role of political stability. Decomposing country risk therefore generates more specific theoretical and policy insights than relying solely on an aggregate indicator.

## 7.5 Theoretical and policy implications

The findings contribute to three related streams of literature. First, the study extends country-risk research beyond its traditional emphasis on economic growth and investment by showing that different dimensions of institutional stability are not equally associated with sustainable development. Second, it adds to the resource-curse literature by showing that natural-resource dependence remains a persistent structural constraint in the reported specifications. Third, although the anticipated moderation effect is not supported, the study suggests that institutional stability and resource dependence should be viewed as complementary but largely independent determinants of sustainable development.

From a policy perspective, the results suggest that countries should not rely exclusively on governance reforms to improve sustainability outcomes. Resource-rich economies should simultaneously pursue economic diversification, technological upgrading, human-capital development, and innovation-oriented growth strategies to reduce excessive dependence on natural-resource rents. At the same time, strengthening political institutions, improving regulatory quality, enhancing government effectiveness, and ensuring policy continuity remain essential for achieving sustained progress toward the SDGs. Collectively, these findings indicate that sustainable development requires both sound institutions and structural economic transformation rather than either factor in isolation.

The results can be operationalized through a compact annual monitoring framework. Finance and planning ministries can combine the resource-rent share of GDP with political-risk indicators and the SDG Index to identify countries or periods with

high structural exposure. High resource dependence would trigger closer review of revenue stabilization, diversification expenditure, and environmental-regulatory capacity, while elevated political risk would trigger review of policy continuity, regulatory enforcement, and public-sector implementation capacity. Progress can then be assessed annually against changes in the SDG Index, resource-rent dependence, non-resource revenue, and selected governance indicators. This framework does not convert the estimates into causal policy effects, but it provides a transparent basis for prioritizing interventions and tracking whether structural and institutional conditions improve together.

## 8 Concluding Remarks

This study examined the associations among country risk, natural-resource dependence, and sustainable-development performance in a 32-country panel for 2018–2023. Linear mixed-effects models accounted for repeated country observations, country-level heterogeneity, and country-specific development trajectories.

Four conclusions follow. Aggregate country risk has the expected negative sign but is not statistically significant after the controls and country effects are included, so Hypothesis 1 is not supported. Natural-resource rents show the most consistent negative association across the main models and robustness checks, supporting Hypothesis 2. The interaction terms are not statistically significant, so the evidence does not support the claim that country risk has a stronger association with SDG performance in more resource-dependent economies; Hypothesis 3 is not supported. When country risk is decomposed, political risk is negative and statistically significant, whereas financial and economic risk are not, supporting Hypothesis 4.

The results therefore identify resource dependence and political risk as distinct rather than interactive constraints. Resource dependence remains associated with weaker SDG performance after accounting for income, FDI, trade openness, year effects, and country-specific trajectories. Political risk appears to be the relevant institutional component, consistent with the importance of policy continuity, regulatory enforcement, and implementation capacity. The unsupported interaction is also informative because it indicates that institutional risk does not simply become more consequential as resource dependence rises.

For policy, the findings support a dual strategy. Resource-dependent economies require diversification, stronger fiscal management, human-capital investment, technological upgrading, and environmental-regulatory capacity. At the same time, governments should strengthen political and administrative institutions that sustain policy implementation. An annual monitoring dashboard combining the SDG Index, resource rents, political-risk indicators, non-resource revenue, and diversification measures would allow ministries to identify structural exposure, prioritize intervention, and assess progress over time.

The study has limitations. The observation period is short, the analysis uses national aggregates, and the estimates are associational rather than causal. The SDG Index may also change partly because of revisions in its indicator framework. Future

research could use longer panels, alternative governance measures, nonlinear or threshold specifications, and regional or sector-level data. These extensions would clarify the mechanisms through which resource dependence and political conditions shape sustainable-development outcomes.

**Supplementary information.** The supplementary package contains the descriptive panel (Online Resource 1), the model-estimation panel (Online Resource 2), the data dictionary (Online Resource 3), the resource-intensity classification (Online Resource 4), the reproducible R analysis code (Online Resource 5), and a supplementary guide (Online Resource 6).

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## Declarations

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**Competing interests.** The authors declare no competing interests.

**Ethics approval and consent to participate.** Not applicable. The study uses country-level secondary data and does not involve human participants, human tissue, animals, or clinical intervention.

**Consent for publication.** Not applicable.

**Data availability.** All data generated or analysed during this study are included in this published article and its supplementary information files.

**Materials availability.** Not applicable.

**Code availability.** The R code used to reproduce the principal models, interaction tests, and reported sensitivity analyses is provided as Online Resource 5. The accompanying file guide is provided as Online Resource 6.

**Author contributions.** Mohammad I. Elia contributed to the study conception, data-source development, and manuscript development. Ahmed Bani-Mustafa led the statistical modelling, diagnostic analysis, robustness assessment, and methodological revision. Kameleddine Benameur contributed to the economic interpretation, manuscript development, and critical revision. Nabeel Sawalha contributed to the management and policy interpretation, manuscript development, and critical revision. Zaid M. Elia contributed to data-source documentation, contextual review, and manuscript revision. All authors contributed to the interpretation of results, read the manuscript, and approved the final version.

## Appendix A Supplementary tables

Appendix Table [A1](#) lists the countries included in the resource-complete modelling sample by descriptive resource-intensity group.

**Table A1** Countries included in the resource-complete modelling sample

| Resource-intensity group  | Countries | Country list                                                                                         |
|---------------------------|-----------|------------------------------------------------------------------------------------------------------|
| Low resource intensity    | 11        | Bangladesh; China; India; Jordan; Kenya; Lebanon; Morocco; Philippines; Thailand; Türkiye; Uganda    |
| Medium resource intensity | 11        | Argentina; Brazil; Pakistan; Paraguay; Peru; Serbia; South Africa; Sudan; Tanzania; Tunisia; Ukraine |
| High resource intensity   | 10        | Algeria; Bolivia; Colombia; Egypt; Ghana; Indonesia; Iraq; Kazakhstan; Mozambique; Vietnam           |

Resource-intensity groups are descriptive only and are based on each country's average total natural-resource rents as a percentage of GDP over 2018–2023. Syria was excluded because several required variables were unavailable.

**Table A2** Additional econometric diagnostics

| Diagnostic                                                | Evidence                                                                                                                                                                                                                | Implication for inference                                                                                |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| VIF multicollinearity check                               | The maximum VIF is 1.336 in the aggregate-risk specification and 2.744 in the decomposed-risk specification.                                                                                                            | Multicollinearity is not a concern for the main estimates.                                               |
| Studentized Breusch–Pagan/Koenker heteroskedasticity test | Homoskedasticity is rejected in auxiliary two-way fixed-effect diagnostics: aggregate model $p = 0.0041$ ; decomposed model $p = 0.0154$ .                                                                              | Robust standard errors are appropriate for supplementary panel checks; the LMM estimates are unchanged.  |
| Pesaran CD cross-sectional dependence test                | The null of residual cross-sectional independence is not rejected: aggregate model $p = 0.1260$ ; decomposed model $p = 0.1558$ .                                                                                       | There is no statistical evidence that residual cross-country dependence drives the estimates.            |
| LLC/IPS unit-root screen                                  | Formal LLC/IPS evidence is not used for substantive inference because the resource-complete panel contains only six annual observations per country.                                                                    | No model change is made on this basis; the time dimension is too short for strong unit-root claims.      |
| Screened dynamic System GMM                               | Lagged-outcome System GMM specifications were screened, but were not retained because AR(2) diagnostics rejected and the instrument counts exceeded the number of countries: 35 and 51 instruments versus 32 countries. | Reported only to document the specification screen; not used for inference or as a robustness estimator. |

These diagnostics are supporting checks. They are not alternative estimators for the main substantive claims. The System GMM row documents a screened specification only; it is not retained because the required diagnostic conditions are not satisfied.

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## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterials.zip](#)