

SUSTAINABLE DEVELOPMENT IN BRICS: GOVERNANCE CHALLENGES AND CORRUPTION'S ROLE UNCOVERED THROUGH PANEL DATA

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Abstract:

This study analyzes how governance and corruption affect sustainable development in BRICS countries (Brazil, Russia, India, China, and South Africa) from 2002 to 2015, using a Panel ARDL approach. The analysis is conducted through three models that assess sustainable development as a function of corruption, economic growth, governance, trade, and population. The findings reveal that corruption and governance consistently exert a significant negative impact on sustainable development in the long run across all three models, suggesting that weak governance structures and high levels of corruption hinder sustainable development in the BRICS countries. In contrast, economic growth positively influences sustainable development, indicating that higher growth rates may contribute to improved environmental, economic, and social sustainability in these economies. These findings suggest that BRICS countries should focus on strengthening governance and reducing corruption to support sustainable development. Anti-corruption initiatives and stronger institutions are essential, as is promoting economic growth that aligns with sustainability goals. By implementing reforms that improve governance and create accountable structures, BRICS countries can foster a more sustainable growth path.

Keywords: Sustainable Development, Governance, Corruption, BRICS countries

1. Introduction

Sustainable development seeks to achieve shared prosperity through policies focused not only on wealth creation but also on equitable wealth distribution and environmental protection. It is often defined as “the capacity to maintain an entity, outcome, or process over time” (Jenkins & Bauman, 2009), emphasizing the efficient use and management of resources to achieve these goals. At its core, sustainability revolves around fostering regeneration and continuity (Tomislav, 2018). Sustainable development, therefore, aims to enhance quality of life and promote economic independence, both increasingly reliant on global integration (Kingsbury et al., 2004). Institutions play a key role in advancing sustainable development globally, as development outcomes largely depend on the policies, programs, and actions implemented by governments and institutions (Sharpley, 2009; Tomislav, 2018).

On the other hand, governance and corruption are pivotal elements in the discourse on sustainable development, as they directly influence the effectiveness of policies and the equitable allocation of resources. good governance, characterized by transparency, accountability, and inclusive decision-making, ensures that developmental initiatives are not only well-conceived but also widely accepted and impactful. Conversely, corruption undermines these efforts by diverting resources, eroding public trust, and exacerbating

inequalities, which hinders long-term progress. By addressing governance challenges and combating corruption, societies can create a foundation that supports sustainable economic growth, environmental stewardship, and social well-being, thus ensuring that development benefits all stakeholders and preserves resources for future generations.

Corruption can be examined through various lenses, including its level (e.g., individual or collective, within or across organizations), type (e.g., fraud, bribery), and domain (e.g., financial, institutional, governmental) (Di Pietra & Melis, 2016; Mungiu-Pippidi & Dadašov, 2016). Individual corruption, often hidden, involves personal gain through the misuse of public authority (Caiden, 2019). In contrast, institutional or governmental corruption arises from biased distribution of public resources, favoring some while disadvantaging others (Mungiu-Pippidi & Dadašov, 2016). This form of corruption can skew tax revenues, inflate expenditures, and degrade public services, as seen when funds are directed towards infrastructure or military spending over education or healthcare (Ananta, Ezrien, and Mohamed, 2023; Haykal, 2017). In some developing nations, institutional corruption is more visible due to the prominence of "status societies," where wealth signifies social status and must be conspicuous (Mungiu-Pippidi & Dadašov, 2016). Regardless of its form, corruption undermines national economies, institutions, and systems, leading to inefficiency, waste, and resource mismanagement (Monteduro, Hinna, and Moi, 2016).

The combination of sustainable development, governance, and corruption within the context of BRICS (Brazil, Russia, India, China, and South Africa) countries is a topic of growing importance. The increasing influence of these nations in the global economic system has heightened interest in understanding the interplay between these three concepts. These issues are especially critical in BRICS countries due to their rapid growth, large populations, and significant roles in the global economy. Therefore, this paper examines how governance and corruption affect sustainable development outcomes in BRICS nations.

The BRIC group was formed in 2001, with South Africa joining in 2010 to create BRICS. The primary goal of the bloc is to foster commercial, political, and cultural cooperation among its member nations, with trade being a key driver. BRICS countries, to varying degrees, have seen rapid industrialization, reflected in their fast-growing GDP rates (Baloch & Wang, 2019). Alongside this economic growth, BRICS nations have amassed significant foreign exchange reserves and continue to attract substantial foreign direct investment (Hassan, Baloch, and Tarar, 2020). In fact, these countries are steadily narrowing the "economic" gap with developed nations (Wang, 2019). Recent data highlights that BRICS now accounts for 25 percent of global GDP, nearly 50 percent of the world's population, and about 20 percent of global merchandise trade (Guntur & Marathe, 2020, p. 264). Despite these economic advancements, however, BRICS countries still grapple with challenges such as internal political and social instability, corruption, and weak institutional frameworks (Wang, 2019).

Public governance, or state-level governance, involves processes aimed at strengthening institutions and society by reducing corruption and promoting proper resource allocation to support ethical practices and enhance competence (Sebhatu and Pei-lin, 2016). Consequently, good governance can be assessed both quantitatively, through the social outcomes achieved, and qualitatively, in terms of efficiency and effectiveness (Van der Waltd, 2014).

Accountability and transparency are considered essential elements of good governance. However, in BRICS and other developing countries, the challenge lies in relatively weak legal systems and insufficient capacity to effectively manage social and economic development (Jashari & Pepaj, 2018). Given these limitations, there is an even greater need for governments in BRICS nations to prioritize accountability and transparency in order to achieve sustainable development (Jashari & Pepaj, 2018). This is because governance plays a crucial role in

sustainable development; as the level of sustainable development improves, there is typically a corresponding increase in governance quality and effectiveness (Güney, 2017).

One way BRICS governments may aim to reduce and control corruption is by strengthening governance frameworks (Baloch & Wang, 2019). In this context, 'governance' refers to the set of structures and processes in place to enforce rules and deliver services, regardless of whether the government is democratic or not (Singh, 2022). As in all nations, governance in BRICS countries plays a crucial role in establishing a framework for economic growth and market development (Mira & Hammadache, 2017). Thus, governance is closely tied to the capacity of the State to promote economic growth, with weak governance often identified as a key factor behind slow economic development and limited social progress in developing economies (Singh, 2022). Governance quality in BRICS nations can be assessed based on four dimensions: procedural efficiency, capacity or input, output, and bureaucratic autonomy (Singh, 2022).

As Hakimi and Hamdi (2017) note, to combat the spread of corruption, policymakers in these and other developing countries must adopt "strict policy actions within a zero-tolerance framework." While good governance supports long-term high-income growth in BRICS countries, a minimum level of economic development is necessary in the short term to foster better-functioning institutions (Singh, 2022).

Overall, this paper makes several important contributions to the literature on the role of governance and corruption in addressing sustainable development goals and outcomes in BRICS countries. First, it significantly advances sustainability research by developing a sustainability index that incorporates various environmental and social components of sustainable development, and then examining the impact of governance and corruption on this index in BRICS countries. Second, while previous studies have focused on the effects of governance indicators on CO2 emissions (Baloch & Wang, 2019; Güney, 2017; Omri & Mabrouk, 2020), to the best of our knowledge, this is the first study to explore the effect of governance and corruption on a comprehensive sustainable development index. Additionally, this paper takes a step toward filling this research gap. Finally, it offers new insights by presenting a comprehensive Sustainable Development Index tailored to BRICS countries, in contrast to prior studies that have primarily relied on CO2 emissions as a measure of sustainability.

The remainder of the paper is structured as follows: Section 2 provides a brief literature review. Section 3 outlines the data and methodology used in the study. Section 4 presents the empirical results. Finally, Section 5 concludes the study.

2. Literature Review

2.1 Governance and Sustainable Development

The role of Governance in achieving sustainable development is fundamentally about shaping the discourse and guiding the process, rather than offering rigid solutions or issuing directives (Jordan, 2008). To promote sustainable development, Governance should focus on identifying and addressing the barriers nations face, while building long-term sustainability platforms, rather than seeking quick fixes. In this context, the relationship between governance and sustainable development involves factors such as public corruption, the rule of law, accountability, and bureaucratic quality. Effective governance mechanisms within these areas are essential for the type of pragmatic and flexible planning required to achieve sustainability (Güney, 2017).

The reciprocal nature of the relationship between sustainable development and governance quality is emphasized by the United Nations Research Institute for Social Development (UNRISD) (Freedman, 2019). According to UNRISD, sustainable development initiatives and their outcomes have far-reaching implications for economic and social factors, including job creation, women's economic empowerment, and investment flows. These outcomes, in turn, influence governance processes, particularly in how public officials feel empowered to engage in sustainability governance and support public institutions in advancing sustainable development (Freedman, 2019). This support may manifest in governance mechanisms (e.g., policy formulation) that aim to minimize the social and environmental costs of growth while facilitating collective action by institutions to achieve sustainability goals.

An increasing recognition of the need to integrate sustainability principles into business, industry, and social systems has led to the concept of sustainable governance (Kanie et al., 2012). Sustainable governance is defined as the deliberate development of governance practices "to ensure that society eventually proceeds along a sustainable trajectory" (Meadowcroft, 2013). Kanie et al. (2012) describe sustainable governance as characterized by three key elements: aspiration, where governance systems prioritize sustainability goals and create pathways to achieve them; actors, where governments commit to meaningful and accountable actions to address sustainable development challenges; and architecture, where governance structures are reconfigured to improve institutional decision-making and better meet sustainability needs (Kanie et al., 2012).

2.2 Corruption and sustainable development

It is generally acknowledged in the literature that BRICS nations have, in varying ways, "been held back by corruption" (Kurakin & Sukhareenko, 2018). The Transparency International's Corruption Perception Index (2017) has reported that South Africa is ranked the best (71st) among the BRICS bloc (out of 180 countries overall), followed by China (77th), then India (81st), then Brazil (96th), with Russia ranked to lowest (135th). It is also acknowledged, however, that their increasing importance to the global economic system means there is pressure on them to better manage such corruption (Kurakin & Sukhareenko, 2018). There is some evidence to suggest that they are responding to such pressure through the support they are giving to strengthening international cooperation against corruption, which includes participation in the BRICS Anti-Corruption Working Group (Kurakin & Sukhareenko, 2018).

In terms of governance in the BRICS bloc, it is generally associated with social and political instability emerging from social inequality and extensive corruption, inadequate infrastructure, labour market challenges, inadequate social welfare systems, and poorly funded research and development capacities. The impact of corruption on FDI and subsequently sustainable development for BRICS economies was recently investigated by Arif, Khan, and Waqar (2023) for its 'greasing the wheel' or 'sand in the wheel' effect. Using annual data series of BRICS from 1995 to 2015, along with the system generalized method of moments (SGMM) to estimate outcomes, the authors found that corruption had a positive and significant impact on FDI when the five nations were considered as a single unit. When each of the BRICS countries was considered separately, the authors found that lower corruption in Brazil, India, and China significantly increases the inflow of FDI, whereas the effects of corruption are insignificant in South Africa and Russia.

Abdella, Naghavi, and Fah (2018) also conducted a study of the impact of corruption (along with trade openness and political stability) on FDI in BRIC countries: Brazil, Russia, India, and China from 2002 to 2016. Using Panel Fully Modified Ordinary Least Squares (FM-OLS)

data for analysis, the authors found that corruption had no significant effect on FDI in the BRIC countries. Conversely, they found that trade openness and political stability had a significant effect on FDI in these countries (Abdella et al., 2018). A study by Iloie (2015) also found a non-significant relationship between corruption and FDI inflow levels in BRIC countries, respectively.

Singh (2022) examined the relationship between governance and sustainable development (economic growth) for BRICS countries. Using annual balanced panel data from 1997 to 2015, the author measured governance according to per capita real GDP growth combined with six World Bank governance Indicators. The results showed that growth and governance have a complementary relationship in BRICS countries, leading the author to conclude that, over the long term, governance both encourages and sustains high-income growth.

Sustainable Development in BRICS nations has typically been measured in previous studies by focusing on carbon CO₂ emission levels. A recent study by Sinha et al. (2019) investigated the impact of public sector corruption on CO₂ emissions for BRICS from 1990 to 2017. The authors reported that corruption in the public sector increases environmental degradation due to a reduction of the positive impact of renewable energy consumption on environmental quality. The authors also found that corrupt practices are more prone to occur in countries with highly controlled institutions.

Regarding China specifically, Lee and Lio (2016) conducted a study of the relationship between sustainable development and governance by investigating the impact of FDI on the performance of the Chinese government. Constructing a dynamic panel data set utilising province-level data for China from 2000 to 2009, the authors estimated the impact of FDI on governance performance as well as the corruption levels of provincial governments in China. The authors reported that foreign capital both improved governance performance overall as well as led to a reduction in corruption at the provincial level of government. Absalyamova et al. (2016) conducted a study of the relationship between corruption and the sustainable development of human capital in Russia. The authors reported that the relationship is essentially negative, whereby a 1% increase in state corruption in its socio-economic systems was equivalent to a 1% fall in human capital sustainability results.

2.3 Corruption and sustainable development

Sustainable development initiatives can contribute to reducing corruption by improving access to basic needs and resources, thereby enhancing the quality of life for citizens (Hoffiani, 2019). In this context, sustainable development driven by governments and institutions is closely linked to practices rooted in accountability and transparency. These governance principles are central to understanding how governance affects corruption. Transparency, as explained by Hoffiani (2019), is generally conceptualized in three key domains: public values or behavioral norms, which are supported by citizens' access to information; government 'openness' regarding the disclosure of information; and the development of policies and decisions aimed at the public good, with the application of appropriate laws. Accountability, on the other hand, refers to the willingness of individuals or institutions to report on performance and results objectively and to accept the outcomes of their actions. Drebee, Abdul-Razak, and Shaybth (2020) argue that "corruption is influenced by political stability, voice and accountability, and regulatory quality" both in the short and long term. They suggest that weaknesses in laws, regulations, and transparency can undermine the relationship between the state and society, particularly regarding the protection of individual rights (Drebee et al., 2020).

The United Nations (2017) reports that, in 2015, up to 18 percent of organizations worldwide received at least one bribery payment request. On a macroeconomic scale, corruption can act as a barrier to economic growth and development. Absalyamova et al. (2016) explain that corruption is a destructive force on a nation's economic, social, and political outcomes, as it has the potential to stifle economic growth, reduce public spending on social services (such as education and healthcare), and promote social inequality. As such, the fight against corruption is often seen as a critical element in any strategy aimed at institutional and organizational reform (Drebee et al., 2020).

However, while public corruption is typically viewed as detrimental to economic development, some scholars argue that it can have a positive impact on economic growth and sustainable development. For example, in the 1960s, Leff (1964) suggested that corruption might facilitate trade and economic growth in contexts where the institutional framework is inadequate or overly bureaucratic. The potential impact of institutional quality and corruption on economic growth is framed in theory by two opposing views: the 'grease the wheel' hypothesis, which suggests corruption can aid economic growth, and the 'sand in the wheel' hypothesis, which posits that corruption hampers growth (Venard, 2013). Given the contradictory nature of these hypotheses, Venard (2013) cautions that the relationship between corruption and sustainable development may not be purely causal, but could instead be mediated by a third factor—namely, institutional quality.

A review of the literature on sustainable development reveals extensive empirical research on the relationship between governance, corruption, and carbon dioxide emissions. However, studies examining the relationship between governance, corruption, and a comprehensive sustainable development index remain limited.

3. Data and Methodology

The primary objective of this paper is to examine the possible effects of governance and corruption on sustainable development. This paper used a panel data of BRICS countries from 2000 to 2015 due to restrictions on the availability of data. Sustainability index has been taken as a dependent variable, while governance and corruption are independent variables. We also use the other variables, such as trade, GDP per capita, and population, as control variables. Gross Domestic Product per capita (GDP per capita), trade, and population data are taken from the World Development Indicators (World Bank, 2021), except for the CPI, which is sourced from Transparency International (2021). We transform the data for Gross Domestic Product per capita, trade, and population variables into their natural logarithms to ensure normality and avoid heterogeneity.

Sustainability variable is created as an index that is developed from these measurements, such as crop production index, food production index, livestock production index, permanent cropland, arable land, life expectancy at birth, mortality rate, infant mortality rate, number of infant deaths, carbon dioxide emission, renewable energy consumption, and cereal production. To extract the sustainability Index, this study applies the principal component analysis (PCA). Principal component analysis is used to transform a set of variables to a new set of uncorrelated factors while retaining as much as possible the variation present in the original data set (Jolliffe & Cadima, 2016). We use PCA as well to create a governance variable. The governance derives several data such as voice and accountability, political stability and absence of violence (terrorism), government effectiveness, regulatory quality, the rule of law, and control of corruption. Based on the assumptions, we decide on the baseline specifications as follows.

$$SD = f(CPI, Gov, GDPPC, Tr, Pop) \quad (1)$$

The model specification above represents a functional relationship between sustainable development (SD) and its key determinants: corruption perception index (CPI), GDP per capita ($GDPPC$), governance (Gov), trade openness (Tr), and population (Pop). To empirically analyze this relationship, a Panel Autoregressive Distributed Lag (Panel ARDL) model is employed. The use of Panel ARDL is particularly suitable for BRICS countries due to its ability to handle data with heterogeneous cross-sectional units, which is critical given the economic, social, and institutional differences among BRICS nations. Furthermore, Panel ARDL accommodates both short-term dynamics and long-term equilibrium relationships between the variables, offering a more nuanced understanding of the interactions between governance, corruption, and sustainable development within the BRICS context. This methodological approach also allows for the inclusion of variables with different levels of integration (i.e., both $I(0)$ and $I(1)$), ensuring robust and reliable results when working with macroeconomic panel data.

We hypothesize that governance and corruption variables in BRICS countries influence their sustainable development outcomes. Therefore, we incorporate ARDL symmetry into the model to examine both short- and long-term effects. As outlined by Pesaran, Shin, and Smith (1999) and Suwandaru et al. (2024), the Panel ARDL approach allows for the analysis of co-integration within a single-equation framework. This method involves two primary steps to estimate long-term relationships: first, identifying whether a long-run relationship exists among the variables; and second, estimating the long-term coefficients based on the ARDL panel results. Furthermore, as Suwandaru et al. (2024) demonstrate, even with a small sample size, the long-term parameters remain consistent provided the short-term parameter ($\sqrt{T}$) is also consistent. We formulate equation (1) into the ARDL panel ($p, q1, q2$) as follows Pesaran et al. (1999);

$$\begin{aligned} \Delta SD_{it} = & \beta_{0i} + \beta_{1i}SD_{i,t-1} + \beta_{2i}CPI_{i,t-1} + \beta_{3i}Gov_{i,t-1} + \beta_{4i}GDPPC_{i,t-1} + \beta_{5i}Tr_{i,t-1} + \\ & \beta_{6i}Pop_{i,t-1} + \varphi_i + \sum_{j=1}^p \rho_{ij}\Delta SD_{i,t-j} + \sum_{j=0}^q \rho_{ij}\Delta CPI_{i,t-j} + \\ & \sum_{j=0}^{q2} \rho_{ij}\Delta Gov_{i,t-j} + \sum_{j=0}^{q3} \rho_{ij}\Delta GDPPC_{i,t-j} + \sum_{j=0}^{q4} \rho_{ij}\Delta Tr_{i,t-j} + \\ & \sum_{j=0}^{q5} \rho_{ij}\Delta Pop_{i,t-j} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Where Δ is the first different form of variables. i is for the nations, and t for the annual intervals. β_{0i} is the fixed effects, the coefficients of the lagged dependent variables. $\Delta SD_i = SD_i - SD_{i-1}$; $\Delta CPI_i = \Delta CPI_i - \Delta CPI_{i-1}$; $\Delta Gov_i = \Delta Gov_i - \Delta Gov_{i-1}$; $\Delta GDPPC_i = \Delta GDPPC_i - \Delta GDPPC_{i-1}$; $\Delta Tr_i = \Delta Tr_i - \Delta Tr_{i-1}$; $\Delta Pop_i = \Delta Pop_i - \Delta Pop_{i-1}$. j is period lagged values of ΔSD_i , ΔCPI_i , ΔCPI_i , ΔGov_i , $\Delta GDPPC_i$, ΔTr_i and ΔPop_i . φ_i and $\varepsilon_{i,t}$ denote the effect of group-specific and the error terms as white noise and varies across time and countries. Since each cross section in the long-run, we put the coefficient elasticity as $-\frac{\beta_{2i}}{\beta_{1i}}$, $\frac{\beta_{3i}}{\beta_{1i}}$, $\frac{\beta_{4i}}{\beta_{1i}}$, $\frac{\beta_{5i}}{\beta_{1i}}$ and $-\frac{\beta_{6i}}{\beta_{1i}}$ with assuming $\Delta SD_{i,t-j} = 0$, $\Delta CPI_{i,t-j} = 0$, $\Delta Gov_{i,t-j} = 0$, $\Delta GDPPC_{i,t-j} = 0$, $\Delta Tr_{i,t-j} = 0$, $\Delta Pop_{i,t-j} = 0$. Therefore, the short-run estimation for public

spending can be obtained as γ_{ij} . We also assume there is symmetric impact of taxes on public spending through this scenario.

4. Results

This section presents the empirical findings from the analysis of governance, corruption, and sustainable development across BRICS countries. Descriptive statistics provide an overview of the key variables, highlighting notable differences in governance quality, corruption perception, trade engagement, and sustainable development performance. Pre-estimation tests, including the CIPS and CADF panel unit root tests, assess the stationarity of variables, ensuring robustness in subsequent analyses. The panel ARDL model results reveal the dynamic relationships between sustainable development, governance, and corruption in the short and long run, emphasizing the critical role of governance reforms and anti-corruption measures.

Table 1 summarizes key variables for BRICS countries, including Sustainable Development (SD), Corruption Perception Index (CPI), governance (Gov), Trade (Tr), GDP per capita (GDPPC), and Population (Pop). Brazil shows moderate variability in SD and relatively stable governance (Gov mean: 0.014), while China leads in trade (Tr mean: 3.476) but faces governance challenges (Gov mean: -0.549). India exhibits steady GDPPC (mean: 8.557) but lower trade engagement. Russia has the weakest CPI (mean: 2.529) and governance, while South Africa shows the highest CPI (mean: 4.536) and relatively stable governance (Gov mean: 0.311).

Overall, BRICS countries exhibit moderate sustainable development (SD mean: 0.052), significant corruption perceptions (CPI mean: 3.550), and varying governance challenges, highlighting diverse socio-economic landscapes. These variations underline the need for tailored policy approaches to improve governance and sustainability outcomes.

Table 1. Descriptive Statistics

Countries		SD	CPI	Gov	Tr	GDPPC	Pop
Brazil	Mean	-0.023	3.843	0.014	2.926	7.482	19.582
	Std.Dev.	0.274	0.394	0.097	0.812	0.750	1.264
	Median	-0.042	3.800	-0.010	3.115	7.799	19.024
	Minimum	-0.489	3.000	-0.130	1.730	6.155	17.647
	Maximum	0.572	4.500	0.170	3.920	8.319	20.983
China	Mean	0.147	3.557	-0.549	3.476	8.029	19.527
	Std.Dev.	0.364	0.214	0.040	0.755	0.823	1.356
	Median	0.198	3.550	-0.560	3.550	8.479	19.058
	Minimum	-0.388	3.200	-0.600	2.190	6.572	17.672
	Maximum	0.717	4.000	-0.460	4.550	8.902	20.999
India	Mean	0.024	3.286	-0.269	1.715	8.557	19.400
	Std.Dev.	0.345	0.372	0.056	0.810	0.775	1.308
	Median	0.035	3.350	-0.285	1.670	8.696	19.078
	Minimum	-0.452	2.700	-0.350	0.610	6.906	17.710
	Maximum	0.591	3.800	-0.180	3.620	9.362	21.014
Russian Federation	Mean	0.100	2.529	-0.720	2.534	8.771	19.418
	Std.Dev.	0.404	0.279	0.050	1.194	0.877	1.296
	Median	0.252	2.600	-0.740	2.650	8.955	19.106
	Minimum	-0.560	2.100	-0.760	0.500	7.213	17.752
	Maximum	0.744	2.900	-0.580	4.500	9.643	21.024
South Africa	Mean	0.014	4.536	0.311	1.467	8.710	19.579

Countries		<i>SD</i>	<i>CPI</i>	<i>Gov</i>	<i>Tr</i>	<i>GDPPC</i>	<i>Pop</i>
	Std.Dev.	0.434	0.273	0.082	0.997	0.797	1.356
	Median	0.000	4.500	0.300	1.225	8.904	19.132
	Minimum	-0.665	4.100	0.190	0.230	7.279	17.799
	Maximum	0.673	5.100	0.420	3.450	9.679	21.039
Overall	Mean	0.052	3.550	-0.243	2.424	8.310	19.501
	Std.Dev.	0.363	0.730	0.381	1.174	0.924	1.280
	Median	0.053	3.600	-0.285	2.545	8.611	19.078
	Minimum	-0.665	2.100	-0.760	0.230	6.155	17.647
	Maximum	0.744	5.100	0.420	4.550	9.679	21.039

The results from the pre-estimation stationarity tests (CIPS and CADF) presented in Table 2 provide insights into the stationarity properties of the variables, accounting for cross-sectional dependence in the data. At the level, the Sustainable Development (SD) variable is stationary, as evidenced by both the CIPS (-3.356***) and CADF (-2.613**) tests, which are significant at the 1% and 5% levels. Similarly, GDPPC (Gross Domestic Product per Capita) is stationary at the level, with significant CIPS (-3.739***) and CADF (-4.044***) values. In contrast, CPI (Corruption Perception Index), Gov (Governance), and Trade (Tr) are non-stationary, as neither test shows significance for these variables. The Population (Pop) variable provides mixed results, with insignificant CIPS (-2.210) but highly significant CADF (-6.190***), indicating stationarity under the CADF test.

Table 2: Pre-Estimation Test on Cross-Section Correlation

Variable	Level		First difference	
	<i>CIPS</i>	<i>CADF</i>	<i>CIPS</i>	<i>CADF</i>
<i>SD</i>	-3.356***	-2.613**	-5.192**	-3.263***
<i>CPI</i>	-1.638	-1.346	-3.306***	-1.408***
<i>Gov</i>	-1.878	-0.764	-4.075***	-2.155***
<i>GDPPC</i>	-3.739***	-4.044***	-4.744***	-3.944***
<i>Tr</i>	-0.905	-1.110	-1.799**	-0.971***
<i>Pop</i>	-2.210	-6.190***	-2.187**	-6.190***

Note: ** and *** signs denote 1% and 5% significance levels.

After taking the first difference, all non-stationary variables become stationary. SD and GDPPC remain stationary, reinforcing their robustness. CPI achieves stationarity with significant CIPS (-3.306***) and CADF (-1.408***) results. Governance also becomes stationary at first difference, as shown by significant CIPS (-4.075***) and CADF (-2.155***) values. Similarly, Trade achieves stationarity after differencing, supported by significant CIPS (-1.799**) and CADF (-0.971***) results. Population is confirmed as stationary at the first difference, with both tests yielding significant results (CIPS: -2.187**, CADF: -6.190***).

In summary, SD and GDPPC are stationary at the level and do not require differencing, while CPI, Gov, Tr, and Pop require first differencing to achieve stationarity. The alignment between the CIPS and CADF results for most variables underscores the robustness of the stationarity analysis, supporting their appropriate transformation for subsequent Panel ARDL modeling.

The panel ARDL test results reveal several significant variables, demonstrating their impact on *SD* across the three models. The Corruption Perception Index (CPI) shows a consistent negative effect on *SD* in all models. In Model 1, CPI is significant at the 10% level with a coefficient of -0.0081-0.0081-0.0081. In Model 2, its significance remains at the 10% level, with a larger coefficient of -0.0621-0.0621-0.0621. In Model 3, CPI becomes more

significant at the 5% level, with the magnitude of its negative impact increasing to $-0.3282-0.3282-0.3282$. This trend indicates that the influence of corruption becomes more pronounced as additional variables are included in the model.

The GDPPC variable consistently demonstrates a positive and significant effect on *SD* across all models. The coefficients in Models 1 and 2 are $0.01170.01170.0117$ and $0.01110.01110.0111$, respectively, both significant at the 5% level. In Model 3, the coefficient increases substantially to $0.06890.06890.0689$, also at the 5% significance level. These results suggest that economic growth positively influences sustainable development, with its effect becoming more pronounced as more variables are included.

The gov variable has a significant negative relationship with *SD* in all three models. In Model 1, the coefficient is $-0.0571-0.0571-0.0571$, significant at the 1% level. In Model 2, it decreases in magnitude to $-0.0337-0.0337-0.0337$, significant at the 5% level. However, in Model 3, the coefficient becomes substantially larger at $-1.5220-1.5220-1.5220$, again significant at the 1% level. This indicates that governance negatively impacts sustainable development, particularly when additional factors such as trade and population are considered.

Tr and Pop variables show significance only in Models 2 and 3. Trade openness has a significant negative impact on *SD*, with a coefficient of $-0.1571-0.1571-0.1571$ in Model 2 and $-0.7452-0.7452-0.7452$ in Model 3, both at the 1% significance level. This suggests that trade policies may involve trade-offs with sustainable development. Population, meanwhile, is significant only in Model 3, with a coefficient of $-0.0754-0.0754-0.0754$, significant at the 5% level, indicating that population pressures negatively influence *SD* when all variables are considered.

The Error Correction Term (ECT) is highly significant in all three models, confirming a long-term equilibrium relationship. In Model 1, the coefficient is $-1.0202-1.0202-1.0202$, significant at the 1% level, indicating a faster speed of adjustment. In Model 2, the ECT is $-0.8825-0.8825-0.8825$, also significant at the 1% level. In Model 3, the coefficient decreases to $-0.4650-0.4650-0.4650$, significant at the 10% level, showing a slower adjustment rate as the models become more comprehensive.

In summary, CPI, GDPPC, and Gov variables are consistently significant across all models, with their effects intensifying as the models include more variables. Trade and Population emerge as significant factors in Models 2 and 3, highlighting their relevance when broader aspects are considered. The ECT consistently supports the presence of a long-term relationship, although the speed of adjustment varies. These results underscore the pivotal roles of governance, corruption, and economic factors in shaping sustainable development outcomes in BRICS countries.

Table 3. Panel ARDL Test Results

	Model 1	Model 2	Model 3
Variable	<i>SD</i>	<i>SD</i>	<i>SD</i>
CPI	-0.0081^* (0.0321)	-0.0621^* (0.0351)	-0.3282^{**} (0.1654)
GDPPC	0.0117^{**} (0.0059)	0.0111^{**} (0.0051)	0.0689^{**} (0.0967)
Gov	-0.0571^{***} (0.0168)	-0.0337^{**} (0.0219)	-1.5220^{***} (0.5158)
Tr		-0.1571^{***} (0.0539)	-0.7452^{***} (0.2528)
Pop			-0.0754^{**} (0.0332)
ECT	-1.0202^{***} (0.3478)	-0.8825^{***} (0.2441)	-0.4650^* (0.2429)

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
Variable	<i>SD</i>	<i>SD</i>	<i>SD</i>
ΔCPI	-0.1878 (0.5040)	-0.4234 (0.5677)	-0.3105 (0.6679)
$\Delta GDPPC$	0.0079* (.0624)	0.0281* (0.0495)	0.0106* (0.0237)
ΔGov	-2.6883 (2.6348)	-1.6900 (1.7213)	-1.7684 (1.3797)
$\Delta Trade$		0.2181 (0.7998)	0.3369 (0.8803)
ΔPop			0.0079* (0.0241)
Constant	2.0985*** (0.3651)	2.3957*** (0.4676)	2.9262** (1.2335)
Log likelihood	67.43601	79.65407	82.74599
Cross sections	5	5	5
Obs	70	70	70
Hausman	H ₀ : PMG, H ₁ =MG Chi-sq stats = 4.69 [0.1962]	H ₀ : PMG, H ₁ =MG Chi-sq stats = 7.62 [0.1064]	H ₀ : PMG, H ₁ =MG Chi-sq stats = 1.39 [0.9251]
Hausman Test Decision	PMG	PMG	PMG
Notes: ***, **, and * signs represent 1%, 5%, and 10% significance levels.			

5. Discussion

The findings highlight the critical interplay between governance, corruption, and economic factors in influencing sustainable development outcomes in BRICS countries. The negative and significant relationship between Corruption and sustainable development across all models underscores the detrimental impact of corruption on sustainable development. This result emphasizes the need for robust anti-corruption measures, as higher corruption levels diminish progress toward sustainable development goals.

The findings of this study align with and extend existing research on the relationships between governance, corruption, and sustainable development. The negative impact of corruption (CPI) on *SD* outcomes corroborates prior studies, such as those by Güney (2017) and Hoffiani (2019), which emphasize the detrimental role of corruption in hindering economic and social progress. However, this study differs by presenting a nuanced, multi-dimensional sustainable development index rather than focusing solely on specific indicators like CO2 emissions, as in Omri and Mabrouk (2020).

The positive and significant influence of GDP per capita on sustainable development consistently across all models reinforces the role of economic growth as a driver of sustainability. Similarly, the positive relationship between GDP per capita and *SD* reinforces established theories on the role of economic growth in driving sustainability (Baloch & Wang, 2019). Nonetheless, this study highlights that GDPPC alone is insufficient to guarantee sustainable outcomes without addressing governance and corruption challenges. Moreover, the dependency on GDP per capita as a sole metric of progress must be tempered by policies that ensure equitable distribution of growth benefits to avoid exacerbating inequality.

Gov variable exhibits a significant negative effect on *SD* across models, suggesting that poor governance practices hinder sustainability. This finding highlights the complexity of governance mechanisms in BRICS countries, where weak institutional quality and inefficient

governance structures could be barriers to achieving sustainable development. Similarly, Mira and Hammadache (2017) suggested that governance quality facilitates economic and social development. This result may be due to the diverse governance structures in BRICS nations, where weak institutions and bureaucratic inefficiencies could undermine the potential benefits of governance mechanisms.

Trade openness (Tr) and population (Pop), significant in Models 2 and 3, add nuanced layers to the discussion. The negative relationship between trade openness and *SD* may reflect environmental and social costs associated with unregulated trade policies. Meanwhile, the negative impact of population underscores the challenges posed by demographic pressures on sustainability, especially in densely populated BRICS countries. Trade openness (Tr), identified as a negative determinant of *SD*, offers an additional layer of complexity. While prior studies often highlight the benefits of trade liberalization for economic growth, this study demonstrates potential environmental and social trade-offs, contributing to the broader debate on globalization and sustainability. The study by Xu et al. (2020) also demonstrates similar results, particularly in developing countries. The Error Correction Term (ECT) confirms the existence of long-term equilibrium relationships, though varying adjustment speeds across models suggest differences in how BRICS countries adapt to shocks or implement policy changes.

This study provides valuable theoretical insights into the relationship between governance, corruption, and sustainable development, advancing existing literature on these interrelated constructs. The findings affirm the "sand in the wheel" hypothesis, highlighting how corruption acts as a barrier to economic and social progress, particularly in the context of emerging economies like BRICS. This reinforces the view that reducing corruption is essential for achieving sustainable development goals. Additionally, the study underscores the complexity of sustainable development, emphasizing its multi-dimensional nature, which is influenced not only by economic growth but also by institutional quality and governance structures.

The results challenge the assumption that governance always positively influences sustainable development, suggesting that weak institutions and inefficient governance mechanisms in certain BRICS countries may undermine development efforts. This nuance contributes to the theoretical understanding of governance as a double-edged sword, where its impact depends on institutional capacity and contextual factors. Furthermore, the study bridges gaps in prior research by integrating governance and corruption into a comprehensive sustainability model, providing a theoretical foundation for future research that considers institutional quality as a central element of sustainable development frameworks.

As for the policy implications of the analysis results, we divide them into five points. First, governments in BRICS countries must implement robust anti-corruption measures to mitigate the negative impacts of corruption on sustainable development. Policies that enhance transparency, enforce anti-corruption laws, and empower independent oversight bodies are critical. For instance, fostering public accountability through open governance platforms and strengthening protections for whistleblowers can significantly reduce corrupt practices and improve resource allocation. Second, the study highlights the need for governance reforms that prioritize efficiency and accountability. Enhancing institutional capacity and addressing bureaucratic inefficiencies can enable governments to better implement and monitor sustainable development initiatives. Public sector reform, digital governance tools, and participatory decision-making processes are essential to increase governance effectiveness and public trust.

Third, the positive association between GDP per capita and sustainable development suggests the need to align economic policies with sustainability objectives. Policymakers

should focus on inclusive economic growth by investing in renewable energy, green technologies, and social infrastructure, ensuring that economic benefits translate into long-term environmental and social improvements. Fourth, the findings on trade openness underscore the importance of balancing economic benefits with environmental and social costs. Policymakers should incorporate sustainability criteria into trade agreements, promote environmentally friendly production practices, and support industries in adopting green technologies to mitigate negative externalities. Fifth, the negative effect of population growth on sustainable development calls for targeted investments in education, healthcare, and infrastructure. Governments should prioritize family planning programs, enhance access to education, and implement urban development strategies to manage demographic pressures effectively.

By addressing these policy implications, BRICS countries can strengthen their institutional frameworks and governance mechanisms, ultimately fostering sustainable development and enhancing their contributions to global sustainability efforts.

6. Conclusion

This study investigates the interplay between governance, corruption, and sustainable development in BRICS countries, emphasizing the complex dynamics influencing their progress toward sustainability goals. Using a panel ARDL approach, the findings reveal that governance, corruption, trade openness, GDP per capita, and population growth have significant, albeit varying, effects on sustainable development. While economic growth positively contributes to sustainability, poor governance, corruption, and unchecked population growth present substantial challenges.

The results reinforce the theoretical understanding that institutional quality and governance mechanisms are critical for achieving sustainable development. Corruption, as suggested by the "sand in the wheel" hypothesis, undermines economic and social progress, highlighting the urgent need for anti-corruption reforms. Moreover, the findings underscore the multi-dimensional nature of sustainable development, requiring a balanced approach that integrates economic, social, and environmental considerations.

From a policy perspective, the study identifies actionable strategies, including enhancing Governance efficiency, implementing robust anti-corruption measures, aligning trade policies with sustainability goals, and managing population growth through targeted investments. These measures are essential for BRICS countries to overcome structural and institutional barriers, ensuring that economic growth translates into long-term sustainability outcomes.

In conclusion, this paper contributes to the literature by providing a comprehensive model that integrates governance and corruption into the analysis of sustainable development. It highlights the critical role of institutional quality in shaping sustainability outcomes and offers valuable insights for policymakers aiming to strengthen governance frameworks and achieve sustainable development goals in BRICS and beyond. Future research could expand on these findings by exploring the role of digital governance and technological innovations in combating corruption and improving institutional efficiency in BRICS countries. Additionally, cross-country comparative studies involving other emerging economies could provide broader insights into the transferability of policy frameworks. Examining the interlinkages between governance quality, environmental sustainability, and social equity could also offer a more holistic understanding of sustainable development dynamics.

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