

Measuring the Impact of Governance on Economic Growth in Islamic Countries: A Principal Component Analysis and Fixed Effects Panel Approach with Driscoll–Kraay Standard Errors

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Received: 16/08/2025

Accepted: 13/11/2025

Abstract:

This study analyzes the impact of governance on economic growth in 57 Islamic countries during 2000–2023. Using six World Bank governance indicators, a composite governance index was built through Principal Component Analysis. The relationship with GDP per capita growth was then estimated using fixed effects panel models with Driscoll–Kraay robust errors.

The results show that governance has a positive and significant effect on economic growth. Stronger institutions, political stability, and corruption control enhance economic performance. These findings suggest that improving governance is not only a political goal but also a key economic strategy for sustainable and inclusive development.

Key Words: Governance; Governance Indicators; Economic Growth; Islamic Countries; Panel Data.

JEL Classification : O17 ; O43, O53 ; C23.

1. Introduction

In recent years, governance has emerged as a central issue for policymakers, economists, and researchers worldwide, given its crucial role in ensuring sustainable economic growth and social stability. Strengthening governance through the consolidation of the rule of law, the improvement of government effectiveness, the enhancement of regulatory quality, and the fight against corruption constitutes a key driver for creating an attractive investment climate and building trust between governments and societies.

For Islamic countries, which encompass diverse economic, political, and institutional contexts, the importance of good governance becomes even more pronounced. These countries face structural challenges ranging from political instability and institutional weaknesses to developmental disparities. Consequently, improving governance systems is vital for stimulating economic growth, ensuring efficient resource allocation, and promoting inclusive and sustainable development.

In this context, the use of quantitative tools and international governance indicators has become essential for empirically analyzing the relationship between governance and economic growth. The six key governance indicators published by the World Bank control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and voice and accountability provide a comprehensive framework to measure the quality of governance across countries.

To capture this multidimensional concept, advanced econometric methods are required. Principal Component Analysis (PCA) allows the construction of a composite index that synthesizes the governance dimensions, while panel data models, specifically the fixed effects approach, make it possible to account for unobserved heterogeneity between countries. Furthermore, to ensure the robustness of the results and address econometric issues such as cross-sectional dependence, heteroskedasticity, and autocorrelation, the Driscoll–Kraay standard errors are applied.

1.1. Research Problem:

Governance has become one of the most central themes in contemporary economic discussions due to its direct and indirect effects on the overall economic performance of nations. Good governance goes beyond administrative or regulatory functions; it constitutes the institutional framework through which public policies are formulated, resources are managed, and mechanisms of accountability and transparency are defined. The presence of effective institutions, fair laws, and sound management is a fundamental prerequisite for achieving sustainable economic growth, as these elements foster trust, improve the business environment, attract both domestic and foreign investment, and enhance the efficiency of resource allocation. Despite the abundance of studies examining the relationship between governance and economic growth, empirical results remain inconclusive and non-uniform. While many studies suggest a positive and significant relationship between governance quality and economic growth, others indicate that this impact varies across countries depending on institutional and political contexts as well as the level of economic development. Economies with strong institutional frameworks tend to benefit more from good governance compared to those with weak or unstable institutions. Moreover, some specific governance dimensions such as control of corruption or government

effectiveness may exert a stronger influence than others depending on each country's structural characteristics.

Within this framework, a major methodological limitation in previous literature lies in the focus on individual governance indicators, which often leads to inconsistent results due to the high inter-correlation among these variables. The six World Bank governance indicators control of corruption, government effectiveness, regulatory quality, rule of law, political stability and absence of violence, and voice and accountability represent complementary and interrelated dimensions of a single concept: institutional quality. Consequently, analyzing each indicator separately may produce partial estimates that fail to capture the overall impact of governance on economic growth.

To overcome this methodological challenge, there is a need for a quantitative approach capable of integrating multiple governance dimensions into a single composite index that more accurately reflects the overall level of institutional quality. Principal Component Analysis (PCA) is a suitable statistical technique for this purpose, as it allows the extraction of a principal component that captures the common structure of governance indicators while reducing the problem of multicollinearity frequently encountered in econometric estimations involving correlated variables.

Previous studies have adopted various empirical methodologies to analyze the governance growth nexus, including fixed and random effects panel models (Al-Ajlouni, 2019); (Mohamed Mostafa, 2021), dynamic ARDL models (Ratia & Hossini, 2022), and Vector Error Correction Models (VECM) (Bouras & Kadoudou, 2021). Although these approaches yielded valuable insights, they did not integrate the multidimensional aspects of governance into a comprehensive composite index that adequately reflects institutional quality. Therefore, the present study employs Principal Component Analysis (PCA) to construct a composite governance index that provides a more holistic and realistic representation of governance performance.

Analyzing the effect of governance on economic growth also requires an econometric framework that accounts for temporal dynamics and structural heterogeneity across countries. For this reason, the study adopts a Fixed Effects Panel Model, which controls for unobserved country-specific characteristics such as geography, cultural attributes, or institutional development that may influence growth outcomes. To ensure robustness and to address potential econometric issues such as cross-sectional dependence, heteroskedasticity, and serial correlation, the study applies Driscoll–Kraay standard errors, a robust technique particularly suited for long-time-span panel data (Heid & Heba, 2024); (Abdellaoui, Makhzoumi, & Abdellaoui, 2020).

In the context of Islamic countries, this analysis gains special importance due to the substantial diversity in economic, political, and institutional systems. Some countries exhibit stable institutional frameworks and advanced governance practices, while others face weak legal structures, political instability, or bureaucratic inefficiencies that constrain growth performance. Hence, the core research problem stems from the absence of a comprehensive quantitative assessment that measures, in an integrated manner, the impact of governance considered as a composite and multidimensional concept on economic growth in these countries.

Accordingly, this study aims to fill the empirical and methodological gap in the literature by constructing a composite governance index through Principal Component Analysis (PCA) and by examining its effect on economic growth in a panel of Islamic countries over the period 2000–

2023. The analysis relies on a fixed-effects panel model with Driscoll–Kraay standard errors to strengthen the robustness and reliability of the empirical findings. The central research question can therefore be formulated as follows:

To what extent do governance indicators influence economic growth in Islamic countries during the period 2000–2023?

1.2. Research Hypotheses:

To address this research problem, the study relies on the following main hypothesis:

- **H1:** Governance exerts a significant and positive effect on economic growth in Islamic countries.
- **H2:** A composite governance index constructed through PCA better explains growth variations compared to individual governance indicators.

1.3. Research Objectives:

This study aims to:

- Construct a composite governance index for Islamic countries using Principal Component Analysis (PCA);
- Examine the effect of governance on economic growth using panel data econometric models;
- Ensure the robustness of findings through the application of Driscoll–Kraay standard errors;
- Provide empirical insights to policymakers in Islamic countries on the importance of strengthening governance as a lever for sustainable economic development.

1.4. Research Significance:

The significance of this study lies in its focus on the specific context of Islamic countries, which often face governance challenges that hinder their developmental trajectories. By adopting modern econometric approaches and using reliable data from the World Bank, the study contributes to filling a gap in the empirical literature. Its findings not only highlight the economic importance of governance reforms but also provide practical implications for policymakers seeking to enhance institutional quality and achieve long-term growth objectives.

1.5. Literature Review:

Previous empirical studies have consistently highlighted the crucial role of governance in promoting economic growth. Most research findings reveal a positive and significant relationship between good governance indicators, such as institutional quality, government effectiveness, control of corruption, and political stability, and the overall economic performance of countries.

The literature generally agrees that nations with stronger governance frameworks tend to experience higher and more sustainable growth rates, driven by improved resource allocation, better investment climates, and increased public sector efficiency. Conversely, weak governance structures are often associated with slower growth, inefficiency, and macroeconomic instability. The following are the most relevant studies in this field:

Study 1: (Bouras & Kadoudou, 2021)

This study examined the impact of governance on economic growth in North African countries (Algeria, Tunisia, and Morocco) during the period 2000–2017. Using panel data and the Vector Error Correction Model (VECM), the results revealed that governance indicators, particularly control of corruption and regulatory quality, had a positive and significant effect on long-term

economic growth. The findings suggest that improving governance systems contributes to economic stability and sustainable development in the region.

Study 2: (Ratia & Hossini, 2022)

This study focused on Algeria over the period 1996–2018, analyzing the relationship between World Bank governance indicators and economic growth using the ARDL model. The results showed that most governance indicators—such as government effectiveness, rule of law, and regulatory quality—positively and significantly affect long-term economic growth, while their short-term effects were weak or insignificant.

Study 3: (Heid & Heba, 2024)

This study aimed to analyze the effect of good governance on economic development in Egypt during the period 2002–2022. The authors conducted an applied analysis based on World Bank governance indicators and GDP data. The findings confirmed a positive relationship between the improvement of governance indicators and economic growth, though the strength of this relationship was influenced by the political changes that Egypt experienced over the last decade.

Study 4: (Al-Ajlouni, 2019)

This research investigated the role of good governance in achieving economic growth and sustainable development across a group of Arab countries during the period 1996–2011. Using fixed and random effects panel models, the author found that governance indicators—particularly control of corruption, rule of law, and quality of legislation—are positively and significantly associated with economic growth rates.

Study 5: (Mohamed Mostafa, 2021)

This study explored the relationship between good governance and economic growth in Egypt, using data from five North African countries (Egypt, Tunisia, Algeria, Morocco, and Mauritania) for the period 1996–2018. Employing the World Bank's Worldwide Governance Indicators (WGI), the researcher applied panel data models (fixed and random effects) in addition to multiple regression analysis. The results showed that governance indicators had a positive impact on economic growth, with variations in significance across countries. Control of corruption and political stability were found to be the most influential factors.

Study 6: (Abdellaoui, Makhzoumi, & Abdellaoui, 2020)

The study aimed to assess the effect of governance and economic openness on development and export diversification in a group of Arab countries from 1995 to 2018. Using a dynamic panel data methodology, the authors found that governance plays a crucial role in fostering an investment-friendly environment and promoting economic diversification. The results indicated a positive relationship between governance and sustainable economic growth.

2. The Conceptual Framework of Governance:

This theoretical section on governance will address its definition, dimensions, and indicators.

2.1. Definition of Governance:

The United Nations defines governance as the process of decision-making and the way in which those decisions are implemented. (UNESCAP, 2009)

The World Bank defines it as the manner in which authority is exercised in the management of a country's economic and social resources for development. (World Bank, 1991, p. 15)

The World Bank also describes governance as the process of institutional management and reform related to administration, policy choices, improvement of coordination, and the provision of public services, using sound methods, responsibility, and transparency to achieve the set objectives and ensure sustainable development. (World Bank, 1992, p. 1)

Others argue that governance goes beyond administrative and economic reforms and the application of democratic principles; it also encompasses human rights, sustainable development, and related dimensions. Any deviation from these principles is considered an indicator of poor governance. (Weiss, 2000, p. 3)

The International Monetary Fund (IMF) defines governance as a mode of operation that ensures transparency in government performance and highlights the effectiveness of public resource management, while also guaranteeing the necessary environment for private sector activity. (Tawfiq, 2005, p. 25)

2.2. Dimensions of Governance:

Governance can be understood through several interrelated dimensions: (Al-Louzi, 2000, p. 71)

- **Political Dimension:** This aspect relates to the nature of political authority and the legitimacy of representation. It emphasizes the establishment of a balanced relationship between government and citizens, fostering mutual trust, cooperation, and a collective commitment to the public good. Such outcomes are attainable only when the state guarantees and strengthens the foundations of effective democracy.
- **Economic and Social Dimension:** This dimension highlights the role of governance in driving economic performance, advancing sustainable development, combating corruption, and reinforcing transparency. It also helps mitigate investment risks through the continuous and open disclosure of economic data. On the social side, governance contributes to ensuring distributive justice, improving living standards, and addressing poverty alleviation.
- **Administrative Dimension:** This dimension focuses on the sound and equitable management of a nation's financial and human resources, often facilitated through decentralization. The efficiency, sustainability, and fairness of public administration largely depend on the strength of institutional structures, the robustness of legal frameworks, and the quality of governance mechanisms implemented.

2.3. Good Governance Indicators:

The *Worldwide Governance Indicators (WGI)*, developed by the World Bank, are considered among the most comprehensive and reliable frameworks for assessing governance quality. They encompass political, economic, and institutional dimensions and are structured around six fundamental indicators: (Kaufmann, 2010, p. 37)

2.3.1. Voice and Accountability:

This indicator evaluates the degree to which citizens are able to participate in the selection of their leaders. It also reflects freedoms such as expression, association, and media independence. In essence, it highlights political rights, democratic processes, and civil liberties.

2.3.2. Political Stability and Absence of Violence/Terrorism:

This measures the likelihood of political unrest or violence motivated by political, social, or ethnic causes. It takes into account risks such as armed conflicts, terrorism, coups, social upheavals, constitutional instability, and political fragmentation.

- **2.3.3. Government Effectiveness:**

This indicator examines the performance and quality of public services, the independence of the civil service from political interference, and the consistency of policy formulation and implementation. It also considers the credibility of government commitments, institutional performance, administrative efficiency, and the quality of essential services such as public health.

- **2.3.4. Regulatory Quality:**

This reflects the government's capacity to design and enforce sound policies and regulations that foster private sector development, economic competitiveness, and sustainable growth.

- **2.3.5. Rule of Law:**

This dimension emphasizes both the neutrality of laws and the extent of citizens' compliance. It underlines the principle that all actors—whether rulers, officials, or citizens—are subject to the law. It assesses the reliability of legal systems, contract enforcement, property rights protection, and the efficiency of police and judiciary systems, as well as public confidence in avoiding crime and violence.

- **2.3.6. Control of Corruption:**

This measures the degree to which public authority is diverted for private purposes. It covers perceptions of corruption ranging from small-scale to systemic practices, including the undue influence of elites and vested interests. It also assesses how far political and economic powers exploit public resources for personal gain.

3. Presentation of Study Data:

3.1. Study Methodology:

The study proceeded through the following steps: calculation of correlation matrices and Variance Inflation Factors (VIF) to assess multicollinearity; application of the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests to verify data suitability; execution of Principal Component Analysis (PCA) to construct a composite governance index; and estimation of panel data models. To address cross-sectional dependence, autocorrelation, and heteroskedasticity, the Fixed Effects model was re-estimated using Driscoll–Kraay robust standard errors. All analyses were performed using R software.

3.2. Sample and Study Period:

The study covers the period 2000–2023, which was chosen based on the availability and completeness of data for the study variables. The sample includes 57 Islamic countries, as classified by the Organization of Islamic Cooperation (OIC). This coverage ensures diversity in terms of geographic regions, levels of economic development, and governance quality.

3.3. Data Sources:

All data used in this study were obtained from reliable international databases. Specifically, the six Worldwide Governance Indicators (WGI) (Worldwide Governance Indicators, 2025) were collected from the World Bank's World Governance Indicators database. The economic growth variable, represented by the annual growth rate of GDP per capita, was also extracted from the World Bank's World Development Indicators (WDI) database. (World Bank Indicators, 2025) This reliance on a single, consistent source ensures data comparability across countries and over time.

3.4. Study Variables:

A detailed description of the study variables, their definitions, measurement scales, and data sources is presented in Table (1).

Table 1: Variables Constituting the Study Model

Variable Code	Variable Name	Variable Nature	Data Represented by the Variable	Source
CC	Control of Corruption	Independent	Index ranging from -2.5 (weak control) to +2.5 (strong control)	World Bank – WGI
GE	Government Effectiveness	Independent	Index ranging from -2.5 (low effectiveness) to +2.5 (high effectiveness)	World Bank – WGI
PS	Political Stability and Absence of Violence/Terrorism	Independent	Index ranging from -2.5 (low stability) to +2.5 (high stability)	World Bank – WGI
RQ	Regulatory Quality	Independent	Index ranging from -2.5 (low quality) to +2.5 (high quality)	World Bank – WGI
RL	Rule of Law	Independent	Index ranging from -2.5 (weak rule of law) to +2.5 (strong rule of law)	World Bank – WGI
VA	Voice and Accountability	Independent	Index ranging from -2.5 (low participation /freedom) to +2.5 (high participation/freedom)	World Bank – WGI
GDP	GDP per Capita Growth (Annual %)	Dependent	Annual growth rate of GDP per capita in constant prices	World Bank – WDI

Source: Prepared by the researcher

4. Descriptive Statistics for Study Variables:

The descriptive statistics presented in Table (2) summarize the main characteristics of the study variables for the 57 Islamic countries over the period 2000–2023. Overall, the governance indicators, measured on a scale from -2.5 to +2.5, exhibit predominantly negative mean and median values, indicating that, on average, governance quality in the sample lies below the global benchmark.

Table 2: Descriptive Statistics for Study Variables

Variable Code	Minimum Value	Maximum Value	Median	Mean
CC	-1.8487	1.5587	-0.7431	-0.6486
GE	-2.4402	1.6043	-0.6666	-0.5934
PS	-3.312951	1.387127	-0.561567	-0.703100
RQ	-2.5477	1.1962	-0.6052	-0.5796

RL	-2.5909	0.9807	-0.6801	-0.6458
VA	-2.2593	0.6056	-0.8565	-0.8368
GDP	-49.1279	91.7814	2.1276	1.9308

Source: Prepared by the researcher based on R software

- Control of Corruption (CC) recorded a mean value of -0.6486 and a median of -0.7431, with values ranging from a minimum of -1.8487 to a maximum of 1.5587, reflecting considerable variation among countries in controlling corruption;
- Government Effectiveness (GE) showed similar patterns, with a mean of -0.5934 and a median of -0.6666, suggesting that public sector efficiency remains relatively low for most countries in the sample;
- Political Stability and Absence of Violence/Terrorism (PS) displayed the lowest median among governance indicators (-0.5616) and the widest range (-3.3130 to 1.3871), highlighting significant disparities in political stability across Islamic countries;
- Regulatory Quality (RQ) and Rule of Law (RL) also had negative averages (around -0.58 and -0.65, respectively), indicating that most countries face institutional and legal system challenges;
- Voice and Accountability (VA) registered the lowest median (-0.8565) and mean (-0.8368) of all governance indicators, suggesting limited citizen participation and restricted political rights in many countries;
- Regarding economic performance, GDP per capita growth (GDP) exhibited a wide range from -49.1279% to 91.7814%, with a median of 2.1276% and a mean of 1.9308%. This indicates that while some countries experienced high growth in certain years, others faced severe economic contractions.

5. Stability Analysis of Study Variables:

In this study, before proceeding with the estimation of the panel data models, the stability of all variables was directly examined without applying any prior data transformation or adjustments. The analysis relied on two widely used unit-root tests in panel data: the Levin-Lin-Chu (2002) and the Im-Pesaran-Shin (2003) tests, conducted at the 5% significance level. These tests allow for the detection of the presence or absence of a unit root in the series. Acceptance of the null hypothesis indicates non-stationarity, whereas rejection confirms the stationarity of the variable.

Table 3: Results of Unit-Root Tests on Study Variables

Variable	Levin-Lin-Chu Unit-Root Test	Im-Pesaran-Shin Unit-Root Test	Decision
CC	1.228e-09	5.515e-07	Stable
GE	0.0008782	0.000209	Stable
PS	1.263e-10	8.338e-10	Stable
RQ	2.436e-07	4.639e-06	Stable
RL	2.134e-07	6.75e-07	Stable
VA	< 2.2e-16	2.653e-13	Stable
GDP	< 2.2e-16	< 2.2e-16	Stable

Source: Prepared by the researcher based on R software

From Table (3), it is evident that, in both tests, all variables recorded statistical values lower than the 5% critical value. This indicates that all variables are stationary at the 5% significance level.

6. Correlation Analysis and Multicollinearity Test:

6.1. Correlation Matrix of the Variables:

Analyzing the correlation matrix is an essential preliminary step before undertaking any multivariate analysis, as it helps to understand the nature of the relationships between the studied variables and to determine whether strong correlations exist that may indicate a multicollinearity problem.

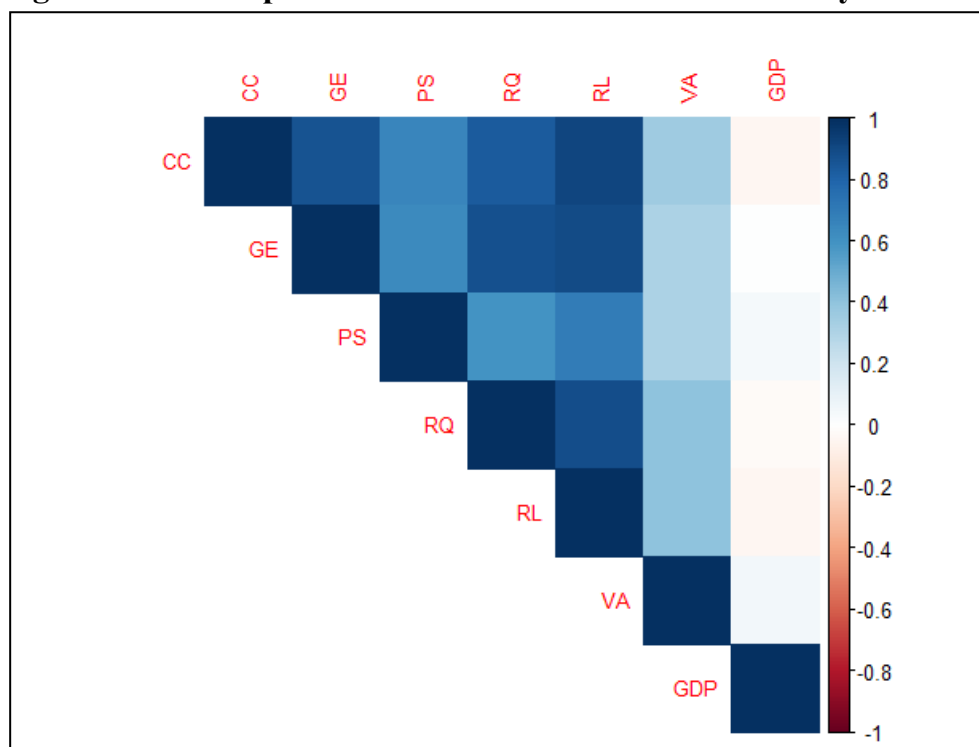
Table (4) and Figure (1) present the correlation coefficients among the six governance indicators—Control of Corruption (CC), Government Effectiveness (GE), Political Stability and Absence of Violence (PS), Regulatory Quality (RQ), Rule of Law (RL), and Voice and Accountability (VA) as well as the economic growth indicator (GDP per capita growth).

Table 4: Correlation Matrix of the Study Variables

	CC	GE	PS	RQ	RL	VA	GDP
CC	1.0000	0.8621	0.6588	0.8301	0.9144	0.3544	-0.0498
GE	0.8621	1.0000	0.6365	0.8799	0.8964	0.3162	0.0040
PS	0.6588	0.6365	1.0000	0.5938	0.6908	0.3173	0.0469
RQ	0.8301	0.8799	0.5938	1.0000	0.8857	0.4088	-0.0295
RL	0.9144	0.8964	0.6908	0.8857	1.0000	0.4051	-0.0455
VA	0.3544	0.3162	0.3173	0.4088	0.4051	1.0000	0.0521
GDP	-0.0498	0.0040	0.0469	-0.0295	-0.0455	0.0521	1.0000

Source: Prepared by the researcher based on R software

Figure 1: Heatmap of the Correlation Matrix of the Study Variables



Source: Prepared by the researcher based on R software

The results reveal a strong and positive association among most governance indicators, with correlation coefficients generally exceeding 0.70. This high degree of interrelationship suggests that improvements in one governance dimension tend to be accompanied by improvements in others. For instance, Rule of Law (RL) exhibits a strong correlation with Control of Corruption (CC) and Government Effectiveness (GE), reflecting their interconnected nature in institutional quality.

Conversely, the correlations between governance indicators and GDP growth are relatively weak and, in some cases, slightly negative. This indicates that short-term variations in GDP growth are not necessarily aligned with changes in governance quality over the same period.

The heatmap (Figure 1) visually confirms these patterns, where darker blue shades represent strong positive correlations and lighter or reddish shades indicate weaker or negative associations. This visual tool reinforces the conclusion that governance indicators are highly interdependent, while their relationship with GDP growth is less pronounced.

Given the high correlations among governance indicators, it becomes essential to assess potential multicollinearity issues before proceeding with regression analysis, an aspect addressed through the Variance Inflation Factor (VIF) in the following subsection.

6.2. Variance Inflation Factors (VIF):

The correlation matrix revealed strong positive correlations among most of the governance indicators, particularly between CC, GE, RQ, and RL, with coefficients exceeding 0.85 in several cases. Such high correlation values indicate the potential presence of multicollinearity in the dataset.

Table 5: Variance Inflation Factors (VIF) for the Study Variables

Variable	CC	GE	PS	RQ	RL	VA
VIF	6.517	6.702	1.959	5.879	10.616	1.264

Source: Prepared by the researcher based on R software

To further investigate this issue, the Variance Inflation Factor (VIF) test was conducted. The results show that several variables have VIF values exceeding the commonly accepted threshold of 5, with RL (10.616) and GE (6.702) presenting notably high levels of collinearity. High VIF values confirm the redundancy of information among these indicators, which may bias the estimates in subsequent regression or multivariate analyses.

Given these findings, the application of Principal Component Analysis (PCA) is justified at this stage. PCA will help to reduce dimensionality, eliminate redundancy, and extract uncorrelated components that retain most of the original information, thereby ensuring the robustness of subsequent statistical modeling.

7. Principal Component Analysis (PCA):

7.1. Data Suitability Tests for PCA:

Before applying Principal Component Analysis (PCA), it is essential to assess whether the dataset is suitable for this type of analysis. Two widely used tests were conducted: the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

Table 6: PCA Suitability Tests

Test	Statistic / Value						Interpretation
Kaiser-Meyer-Olkin (Overall)	0.89						High sampling adequacy
KMO by Variable	CC: 0.89	GE: 0.89	PS: 0.95	RQ: 0.89	RL: 0.84	VA: 0.87	All variables suitable for PCA
Bartlett's Test of Sphericity	Chi-Square = 8000.674			p < 0.001			Correlations are significant

Source: Prepared by the researcher based on R software

The Overall KMO value of 0.89 indicates a high degree of sampling adequacy, suggesting that the correlations among the governance indicators are sufficiently strong for PCA.

Individual KMO values for all six variables range from 0.84 to 0.95, further confirming the suitability of each variable for inclusion in the PCA.

Bartlett's Test of Sphericity yielded a Chi-Square value of 8000.674 with a p-value < 0.001, indicating that the correlation matrix is significantly different from an identity matrix. This result confirms that the variables are sufficiently correlated to justify the application of PCA.

Both KMO and Bartlett's test results demonstrate that the dataset is appropriate for PCA. Therefore, the six governance indicators can be transformed into principal components to reduce dimensionality and address potential multicollinearity issues.

7.2. Interpretation of PCA Results:

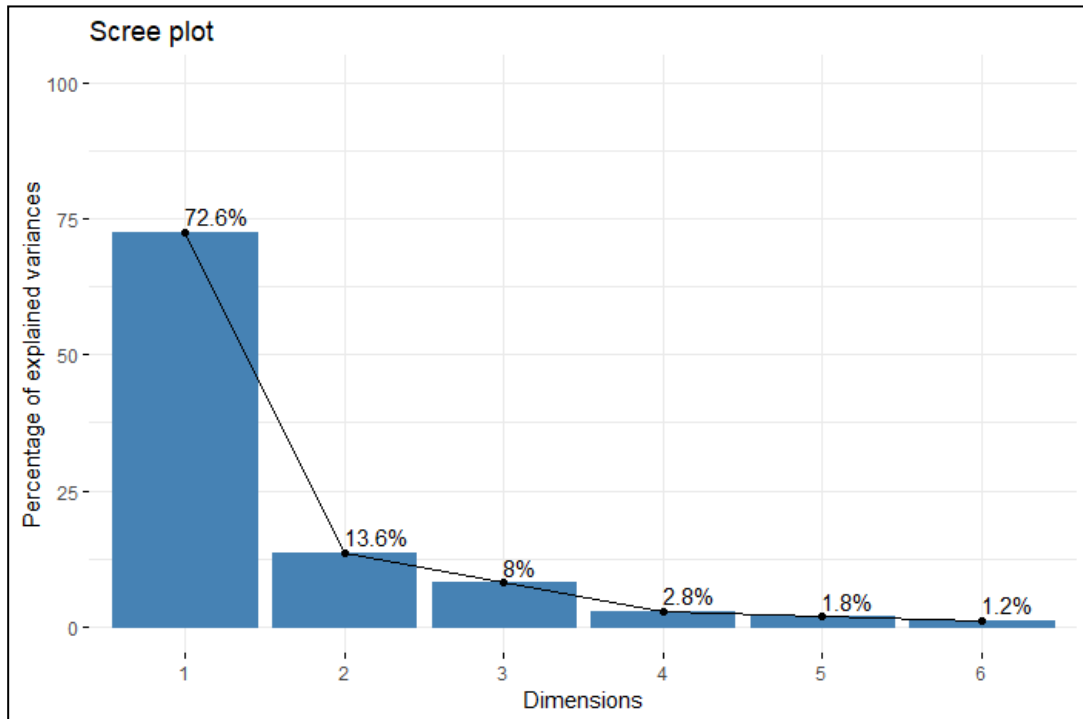
The results in Table (7) and Figure (2) reveal that the first principal component (PC1) has an eigenvalue of 4.3558, explaining 72.60% of the total variance in the governance dataset. As shown in Table (8), PC1 exhibits strong positive loadings for all governance indicators, with coefficients above 0.76 for each variable and the highest loading (0.9647) for Rule of Law (RL). This confirms that PC1 represents a comprehensive governance quality index, synthesizing institutional strength, regulatory effectiveness, political stability, and control of corruption into a single uncorrelated dimension.

Table 7: Eigenvalues and Variance Explained by Principal Components

Component	Eigenvalue	Percentage of Variance (%)	Cumulative Percentage (%)
PC1	4.3558	72.60	72.60
PC2	0.8142	13.57	86.17
PC3	0.4823	8.04	94.21
PC4	0.1693	2.82	97.03
PC5	0.1080	1.80	98.83
PC6	0.0702	1.17	100.00

Source: Prepared by the researcher based on R software

Figure 2: Scree Plot of the Principal Components for Governance Indicators



Source: Prepared by the researcher based on R software

Table 8: Variable Loadings on Principal Components

Variable	PC1	PC2	PC3	PC4	PC5
CC	0.9336	-0.1219	-0.0785	-0.2998	-0.0475
GE	0.9319	-0.1708	-0.1451	0.1039	0.2641
PS	0.7685	-0.0512	0.6347	0.0589	-0.0112
RQ	0.9253	-0.0445	-0.2157	0.2414	-0.1823
RL	0.9647	-0.0749	-0.0727	-0.0822	-0.0413
VA	0.4883	0.8718	-0.0194	-0.0129	0.0316

Source: Prepared by the researcher based on R software

The second principal component (PC2), although accounting for 13.57% of the variance, is primarily driven by Voice and Accountability (VA) (loading = 0.8718) and captures a narrower dimension related to citizen participation and political freedoms. However, its contribution to the total variance is far less substantial than that of PC1.

Given that PC1 alone captures more than 70% of the information contained in the six governance indicators—and presents a balanced representation of all dimensions—it will be used as the sole governance proxy in the subsequent panel data estimation. This choice is methodologically justified by the Kaiser criterion (PC1 eigenvalue > 1) and by the scree plot, which displays a clear "elbow" after the first component, indicating diminishing returns from retaining additional components.

By relying exclusively on PC1 in the econometric model, the study ensures that multicollinearity among governance variables is fully eliminated, while preserving the maximum explanatory power for the governance construct.

8. Estimating the study model:

The panel data analysis approach relies on estimating three models: the pooled regression model, the fixed effects model, and the random effects model. The optimal model among them is determined by performing specific statistical tests.

In the present study, GDP is modeled as a function of the first principal component (PC1), which serves as a composite governance index summarizing the common variance among the original governance indicators. The estimation results obtained using the R software are summarized in Table (9).

Table 9: Results of Panel Data Models Estimation

Explanatory Variables	Pooled Regression Model	Fixed Effects Model	Random Effects Model
Constant	1.930810 (***)	–	1.930810 (***)
PC1	-0.037591	1.005500 (***)	0.298430 (.)

Source: Prepared by the researcher based on R software

8.1. Test for Individual and Time Effects

After estimating the three models, the Lagrange Multiplier (Breusch–Pagan) test was applied to examine the presence of individual effects and to compare the pooled regression with the random effects model. The null hypothesis states that no individual effects are present, implying that the pooled regression model is adequate.

Table 10: Results of the Individual Effects Test

Test Type	p-value	Decision (5% level)
Lagrange Multiplier Test (Breusch–Pagan)	2.139e-11	Pooled regression model is not optimal

Source: Prepared by the researcher based on R software

The probability value obtained ($p < 0.05$) indicates rejection of the null hypothesis, confirming the presence of significant individual effects. Consequently, the pooled regression model is excluded from further consideration, and the choice between fixed effects and random effects models is addressed in the next step.

8.2. Comparison between Fixed Effects and Random Effects Models:

The Hausman test was conducted to determine the more consistent model between the fixed effects and random effects specifications. The null hypothesis suggests that the random effects model is the preferred specification.

Table 11: Results of the Hausman Test

Test Type	p-value	Optimal Model
Hausman Test	0.002003	Fixed Effects Model

Source: Prepared by the researcher based on R software

The p-value is less than 5%, leading to rejection of the null hypothesis. Therefore, the fixed effects model is identified as the optimal specification for the study.

8.3. Tests for Detecting Major Issues in the Standard Economic Model in the Estimated Model:

At this stage, we will verify that the selected random effects model, identified as the optimal model for this study, is free from major issues commonly encountered in standard econometric analysis, including:

- Linear correlation between variables (interindividual correlation);
- Autocorrelation of residuals;
- Heteroscedasticity.

Table 12: Results of Tests Detecting Major Problems in Econometrics

Problem	Test Type	P-Value	Decision at 5% Significance Level
Cross-sectional dependence	Breusch-Pagan LM test for cross-sectional dependence	$< 2.2\text{e-}16$	There is cross-sectional dependence between variables
	Pesaran CD test for cross-sectional dependence	$< 2.2\text{e-}16$	
Autocorrelation of errors	Breusch-Godfrey/Wooldridge test for serial correlation in panels	$8.261\text{e-}07$	There is autocorrelation of errors
Heteroskedasticity	Breusch-Pagan test against heteroskedasticity	$< 2.2\text{e-}16$	There is heteroskedasticity

Source: Prepared by the researcher based on R software

9. Re-estimation of the Study Model Using Driscoll–Kraay Standard Errors:

Given the diagnostic test results reported in Table (12), the presence of cross-sectional dependence, autocorrelation, and heteroskedasticity in the residuals indicates that the standard fixed effects model may produce biased standard errors. To address these econometric issues while retaining the consistency of the coefficient estimates, the fixed effects model was re-estimated using Driscoll–Kraay heteroskedasticity and autocorrelation consistent (HAC) standard errors, which are robust to such violations in panel data with relatively large time dimensions ($T \approx 23$).

Table (13) presents the estimation results of the fixed effects model with Driscoll–Kraay standard errors.

Table 13: Estimation Results of the Fixed Effects Model with Driscoll–Kraay Standard Errors

Explanatory Variable	Estimate	Std. Error	t-value	p-value	Significance
PC1	1.005460	0.293010	3.4314	0.0006199	***

Source: Prepared by the researcher based on R software

The results indicate that the PC1 variable representing the composite governance index—has a positive and statistically significant impact on GDP at the 1% significance level. Specifically, a one-unit increase in PC1 is associated with an average increase of approximately 1.005 units in GDP, holding other factors constant. The robustness of these results after applying Driscoll–Kraay standard errors suggests that the estimated relationship remains valid even in the presence of cross-sectional dependence, autocorrelation, and heteroskedasticity.

10. Analysis and Interpretation of Final Estimation Results:

The final estimation, based on the Fixed Effects model with Driscoll–Kraay robust standard errors, reveals a positive and statistically significant relationship between the composite governance index (PC1) and economic growth, measured by GDP per capita growth. Specifically, the coefficient of PC1 is 1.005 ($p < 0.01$), indicating that a one-unit improvement in governance quality—as captured by the PCA-derived index—leads, on average, to an increase of approximately 1 percentage point in the annual growth rate of GDP per capita.

From a statistical standpoint, the significance at the 1% level and the robustness of the results after correcting for cross-sectional dependence, autocorrelation, and heteroskedasticity confirm the reliability of this relationship. The adoption of PCA ensured that multicollinearity among governance variables was eliminated, and the Driscoll–Kraay approach safeguarded against potential bias in standard error estimation, strengthening the validity of the findings.

Economically, this result suggests that improvements in governance—reflected in better control of corruption, stronger rule of law, higher government effectiveness, improved regulatory quality, enhanced political stability, and greater citizen voice—have a tangible and direct impact on economic performance in OIC countries. Such governance reforms can foster a more predictable institutional environment, attract investment, enhance public sector efficiency, and reduce transaction costs, all of which contribute to sustained economic growth.

Moreover, the magnitude of the coefficient is economically meaningful: for countries with relatively low governance scores, even modest institutional reforms could generate noticeable improvements in growth rates. For instance, raising the governance index by 0.5 units could potentially add around 0.5 percentage points to GDP per capita growth annually—an effect that, if sustained, could significantly improve living standards over time.

These findings align with much of the empirical literature that emphasizes the pivotal role of governance in fostering economic development, particularly in developing and emerging economies. However, the results also highlight that the governance–growth nexus is complex, and reforms must be comprehensive across multiple governance dimensions to maximize their impact.

11. Conclusion:

This study demonstrates that governance plays a decisive role in promoting economic growth in Islamic countries during the period 2000–2023. The results show that improvements in institutional quality, particularly in government effectiveness, control of corruption, rule of law, and political stability are significantly associated with higher levels of economic performance. This confirms that governance is not only a political dimension but also a key economic driver. The interpretation of these findings indicates that good governance reduces uncertainty, strengthens investor confidence, lowers transaction costs, and creates a favorable environment for innovation and private sector development. On the other hand, persistent weaknesses in

governance tend to constrain growth and reinforce structural inefficiencies, which explains the divergence observed among Islamic countries in their development trajectories.

Based on these results, several recommendations emerge. Islamic countries should give priority to comprehensive institutional reforms, focusing on strengthening the rule of law, enhancing transparency, fighting corruption, and consolidating political stability. At the same time, adopting inclusive policies that promote accountability and citizen participation can generate virtuous cycles where governance improvements translate into sustainable economic growth.

In conclusion, governance appears as both an economic imperative and a strategic priority. For Islamic countries aspiring to close developmental gaps and ensure long-term prosperity, investing in stronger governance frameworks represents one of the most effective levers to foster inclusive and sustainable growth.

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