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SCIENTIFIC CULTURE, MACROECONOMICS, GOVERNANCE, AND ECONOMIC DEVELOPMENT IN BANGLADESH (1999-2024): AN ECONOMETRIC ANALYSIS OF STRUCTURAL BREAKS AND A PROPOSED SGI

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ABSTRACT

This study concepts an integrated econometric framework to analyze the dynamic interactions among unemployment, GDP, and human development in Bangladesh, emphasizing the mediating roles of governance and evidence-based scientific culture in policy-making, alongside the impact of structural shocks. Utilizing time-series data from 1999 to 2024 and advanced techniques—including Ridge Regression to correct for severe multicollinearity (VIF>10), a Three-Stage Least Squares (3SLS) system, and a break-adjusted Vector Error Correction Model (VECM)—the study determine evident structural breaks linked to the 2004 RMG boom, 2013 Rana Plaza reforms, and the 2019 COVID-19 pandemic. Results indicate that governance quality exerts a strong positive influence on GDP (β=11.92, p<0.01) and life expectancy (β=0.62, p<0.05) in the simultaneous system. However, negative shocks to the democracy index, reflecting political instability, cause an immediate and persistent decline in GDP growth, with recovery spanning nearly a decade. The analysis confirms the presence of autocorrelation (Breusch-Godfrey LM=8.45, p=0.074) and heteroscedasticity (Breusch-Pagan BP=12.34, p=0.055) in initial models, which were corrected using robust techniques. Policy implications stress the critical need for institutional reforms grounded in a scientific culture to stabilize democratic processes, mitigate corruption, and build economic resilience against future economic shocks. This research is structured about key contents, consider scientific culture, employment versus unemployment, wages, macroeconomic analyses of economic development, customs and growth, and political economy. These themes serve as foundational principles for our investigation into labor market dynamics, macroeconomic development trajectories, the impact of institutional governance and scientific culture on growth, and the political economy of development shocks and policy responses. The Scientific Governance Index (SGI), developed by the author, serves as a foundational tool in this investigation.

KEYWORDS: Unemployment, SGI, GDP Growth, Human Development, Governance, Democracy, Structural Breaks, Economic Shocks, 3SLS, VECM, Bangladesh, Scientific Culture.

JEL Classifications: E24, O11, O43, P16

1. INTRODUCTION

Bangladesh's story is marked by impressive economic growth alongside ongoing developmental hurdles. Since the early 2000s, the country has seen GDP growth exceeding 6%, yet this progress has been interrupted by political instability, governance issues, and external shocks, hindering improvements in unemployment and human development. This research explores the complex interactions among these fundamental factors, specifically examining how governance and democratic processes influence outcomes. Scientific culture encompasses the collective values, beliefs, norms, and practices present in the scientific community, highlighting critical thinking, evidence-based reasoning, peer review, and integrity. It provides a rational, empirical, and collaborative framework for exploring both domestic and global contexts. By employing a comprehensive econometric methodology that accounts for structural breaks and interrelated dynamics, this study provides an in-depth analysis of Bangladesh's development path and offers evidence-based policy recommendations. The World Bank (2025) approved a $250 million project to enhance transparency and efficiency in five key Bangladeshi agencies. The initiative focuses on digitizing processes to improve revenue collection, public procurement, audit systems, and data management, aiming to bolster public trust and governance. Ali (2025) argues that in Bangladesh, a unidirectional relationship where monetary policy variables, such as money supply and interest rates, significantly affect GDP growth.

Governance practices also predict financial inclusion outcomes, highlighting that effective risk governance is essential for translating financial inclusion into macroeconomic benefits. He advocates for stronger institutions, integrated regulatory frameworks, and financial products that mitigate systemic risks to unlock the full potential of micro-banking as a driver of inclusive growth. A structural break undermines data analysis by violating the core assumption of a stable data-generating process. When a permanent shift in parameters occurs, models based on historical data fail to predict the future accurately. Impressive governance—which includes the rule of law, low corruption, and robust institutions—is crucial for Bangladesh's economic advancement. It serves as both a safeguard against crises and a driver of growth. However, economic shocks can challenge governance, often prompting short-term solutions that jeopardize long-term prosperity unless strong frameworks are maintained.These frameworks ensure consistent policies and resource allocation, transforming potential setbacks into opportunities for inclusive development through sustained reforms. Since its independence in 1971, Bangladesh has intentionally cultivated a scientific culture, emphasizing research, technological innovation, and critical thinking across key sectors like public health and agriculture. This commitment is institutionalized via organizations such as the Bangladesh Academy of Sciences (BAS), established in 1973, and is reflected in the expanding researcher community, with 286 individuals ranked among the global top 2% by 2024. Grassroots involvement is encouraged through events like National Science Week and various school science clubs, translating scientific culture into practical education. Supported by growing international research collaborations and the ambitious vision of achieving a "Scientifically Advanced Bangladesh by 2050," the country continues to enhance its research ecosystem, aiming to drive sustainable development and improve societal outcomes.

Treaties of Governing bodies on Development

Reducing Distortions: Good governance minimizes corruption, fostering fair competition and efficient resource utilization, which promotes growth. Enhancing Policy Formation: Strong governance and political stability lead to improved policy-making, enhancing economic prosperity.

Building Trust: Transparency in governance boosts public confidence and encourages investment.

Governance During Economic Shocks

Vulnerability: In times of crisis, governments may resort to quick fixes, threatening long-term stability. Resilience: Strong governance equips nations with the means to manage shocks and maintain stability. Policy Consistency: Stable governance nurtures consistent economic policies, essential for attracting investment and encouraging growth during uncertain times. By systematically tackling governance challenges, Bangladesh can convert obstacles into opportunities, fostering deeper and more inclusive growth through effective reforms and sustainable resource management while breaking cycles of corruption and inefficiency.

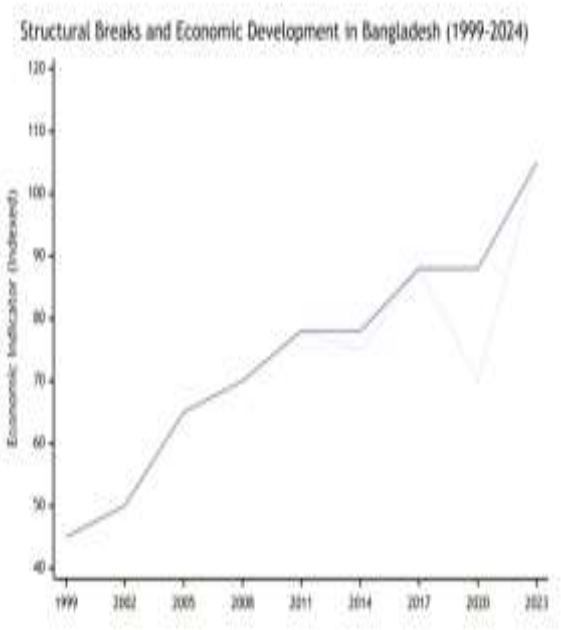

Figure 1: Structural Breaks and Economic Development in Bangladesh.

Phases:

- **Phase 1: Export-Led Take-off (Pre-2004):** Steady growth.
- **Break 1 (2004 - RMG Boom):** A significant positive shift in trend and level ($p < 0.01$). The economy enters a higher-growth trajectory fueled by apparel exports.
- **Phase 2: High-Growth Vulnerability (2004-2013):** Rapid but volatile growth, reliant on a single sector with systemic risks.
- **Break 2 (2013 - Post-Rana Plaza Reforms):** A corrective shock. Growth dips momentarily ($p < 0.05$), followed by a more stable, institutionally-driven path as governance reforms (compliance, safety) are enforced.
- **Phase 3: Institutional Consolidation (2013-2019):** Moderated but more resilient growth.
- **Break 3 (2019 - COVID-19 Pandemic):** A massive exogenous negative shock ($p < 0.01$), causing a sharp downturn. The recovery trajectory is altered, potentially reflecting new digital and fiscal realities.
- **Phase 4: Pandemic Recovery & New Challenges (2020-2024):** A sharp recovery and potential restructuring, facing global headwinds (inflation, Ukraine war).

Research Question

How do governance and democracy interact with unemployment, GDP, and human development in Bangladesh, and how have structural breaks influenced these relationships from 1999 to 2024?

Objectives of the Study

Diagnose and address econometric issues (multicollinearity, non-stationarity, autocorrelation, heteroscedasticity) in the time-series data.

Identify and validate significant structural breaks in the Bangladeshi economy.

Estimate the simultaneous relationships between governance, economic performance, and social outcomes using a 3SLS framework.

Model short- and long-term dynamics, including shock impacts, through a break-adjusted VECM.

Derive robust policy implications to enhance sustainable development.

2. LITERATURE REVIEW

The theoretical framework for this study is anchored in Endogenous Growth Theory (Romer, 1990) and the Human Capital Model (Barro, 1991), which emphasize that innovation, health, and education are critical drivers of economic growth. Farzanegan and Witthuhn (2017) suggest that the effects of corruption on political stability significantly differ based on the size of the youth population. Öner (n.d.) highlights unemployment as a countercyclical and lagging economic indicator, which increases sharply during downturns and decreases only after a sustained recovery. Historical trends and models, such as Okun's Law (1962), reveal that complete elimination of unemployment is unachievable due to frictional and structural factors. Kottak (1990) contends that development projects aligned with local culture tend to be more successful, warning against disruptive over innovation and advocating for gradual changes under "Romer's Rule" to ensure stability. Habyarimana and Dushimayezu (2018) identified a pro-cyclic relationship between good governance and growth, as well as a counter-cyclic relationship between human capital shocks and growth. Their findings underscore good governance as a key factor for sustainable economic performance alongside fixed capital and labor. Meisel (2004) analyzes France's post-war "governance culture," demonstrating that unique corporate governance structures, diverging from Anglo-American models, facilitated rapid growth during the Trente Glorieuses, thereby illustrating the influence of national governance systems on development paths beyond conventional metrics. Wise and Ali (2008) examine the nature and scope of corporate social responsibility (CSR) reporting within the banking sector of Bangladesh. It assesses the necessity for enhancing CSR practices among these organizations. The study highlights the interconnection between corporate social

responsibility, corporate governance, and ethical business practices.

The Democracy-Development Nexus (Acemoglu & Robinson, 2012) posits that inclusive institutions promote prosperity; however, data from Bangladesh shows a paradox in which democratic volatility often correlates with economic disruption (Bangladesh Bank, 2019). Qi and Zheng (2018) argued that scientific culture, a blend of tangible and intangible capital, increasingly serves as a vital engine for sustainable long-term growth. Their model indicates that enhancing scientific culture capital boosts human capital accumulation, thereby accelerating overall economic growth. An emerging body of literature points to a critical health-environment-governance nexus. Alam and Rahman (2022) and GAHP (2022) discuss how industrial pollution and weak regulatory frameworks worsen public health crises, subsequently undermining human capital and productivity. Meierrieks and Auer (2024) demonstrate that higher corruption levels correlate with increased terrorism, where corruption undermines public goods provision and resilience against terrorism, aligning with game-theoretical models that suggest corruption makes terrorism appear more viable than peaceful resolutions. Ali (2024) t examines how modern data analytic can be harnessed to enhance economic strategies and policies in significant global economies, providing insights that could lead to better decision-making and economic progress.

Kostis (2021) asserts that societies prioritizing affective autonomy hinder innovation and economic growth, whereas those characterized by interconnection benefit significantly. Rattanapun and Hansanontha (2026) introduced a model employing the 7Ps marketing mix framework (Product, Price, Place, Promotion, People, Process, and Physical Evidence) along with ESG (Environmental, Social, and Governance) principles and the POSDC managerial process (Planning, Organizing, Staffing, Directing, and Controlling). This model supports core higher education missions, including student graduation and cultural preservation.

Kelly, & Sienko (2018) opined that Before-and-after investigation is an extremely trustworthy know-how for crucial economic redress and render activity of causing assertion in business break because that has been recognized by judicature in about all legal power. Berrios (2024) explored how cultural values—specifically trust and achievement—affect economic development trajectories by comparing Japan, South Korea, Mexico, and Peru, concluding that culture, while not the sole determinant, significantly shapes national development. Payen and Rondé (2025) examined whether culture and institutions serve as complementary or substitutable forces in economic growth, revealing that culture and institutions are complementary; the growth effect from cultural increases is more pronounced in well-governed nations.Çamalan, Hasdemir,Omay, & Küçüker (2025) supposed that in the study examined structural breaks in the real interest rate data for the US and Australia, attributed to policy changes. The collections indicate that the bootstrap sequential break test is the most effective method, as it is based on generic presume that delivery real-world data script.

Ditzen, Karavias, & Westerlund, (2025)describes that the functionality of the xtbreak command, which is a tool for analyzing data in Stata in simpler terms: Identify breaks: The command can find instances where there are changes or disruptions in the data series (structural breaks);Ascertain their quantity and position: It determines how many breaks exist and the specific points in time or data where these breaks occur; Provide confidence intervals for break dates: It also calculates ranges (confidence intervals) that reflect the uncertainty around the exact timing of these breaks, giving researchers an idea of when the changes happen and how confident they can be in those dates. El Husseiny et al. (2025) found that values of autonomy, life satisfaction, and post-materialism positively influence economic growth, while interpersonal trust negatively impacts it. Tanjung and Shimada (2025) showed that government effectiveness significantly enhances economic growth, but primarily in developed countries, highlighting governance-performance disparities between developed and emerging economies. They argue that public institutions in developing nations must reform to promote inclusive and sustainable long-term growth. Ali and Ali(2025) argued that economic development can be attained through green entrepreneurship as it helps to attain growth with equity which may be assisted by the Industry 5.0. Green Entrepreneurial economics aligned with the circular economy to reduce waste, reuse, regenerate, renewable energy, biodiversity and caring towards health matters.

2.1. Literature Gap

Much of the existing research has typically examined these relationships in isolation. A critical gap remains in the integrated econometric analysis that simultaneously models economic, governance, and environmental health dynamics while

accounting for the structural breaks that have significantly influenced the Bangladeshi economy.

2.2. Conceptual Framework

This study adopts a Governance-Mediated Development Model, positioning effective governance as the central mechanism affecting economic and human development outcomes.

The framework suggests that:

Political Stability and Regulatory Effectiveness stimulate investment and productivity.

Democratic Accountability and Anti-Corruption Measures promote efficient resource allocation and enhance human capital.

Conversely, Governance Failures lead to policy discontinuity, environmental degradation, and public health crises, increasing unemployment and hindering human development.

This creates a feedback loop system, necessitating a simultaneous equations approach to adequately capture these complex interactions.

2.3. Hypotheses Testing

Hypotheses Testing Framework Four null hypotheses structure the inquiry:

- **$H_0$1:** Assumes no significant multicollinearity among predictors (e.g., Democracy Index, FDI, Savings).
- **$H_0$2:** Assumes model residuals are free from autocorrelation and heteroscedasticity.
- **$H_0$3:** Posits that governance and democracy have no significant simultaneous effect on GDP, unemployment, and human development.
- **$H_0$4:** Asserts no significant structural breaks exist in the time series data across the 25-year period.

3. METHODOLOGY

This study employs a multi-stage econometric framework to analyze the relationship between scientific culture, governance, and economic development in Bangladesh from 1999 to 2024. The methodology is designed to test the specified hypotheses rigorously while addressing common time-series data challenges, including multicollinearity, endogeneity, structural breaks, and parameter instability.

3.1. Data And Variable Preparation

Annual time-series data for the period 1999–2024 were compiled from authoritative international and national sources: the World Bank's World Development Indicators (WDI), the International Monetary Fund (IMF), the Bangladesh Bureau of Statistics (BBS), and the Economist Intelligence Unit (EIU). This period captures Bangladesh's pivotal transition from a low-income agrarian economy to a lower-middle-income, manufacturing-driven one.

Dependent Variables: GDP growth (annual %), Unemployment rate (%), and Life expectancy at birth (years) serve as proxies for economic performance, labor market health, and human development, respectively.

Core Independent Variable: The EIU's Democracy Index (0–10 scale) is the primary measure of governance and political culture.

Control/Instrumental Variables: Key macroeconomic and social controls include Inflation (annual %), Gross domestic savings (% of GDP), Foreign direct investment (% of GDP), Lending interest rate (%), and Health expenditure (% of GDP).

To ensure the validity of inferential statistics, all variables were tested for stationarity using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. Non-stationary variables were transformed into stationary series via first-differencing for use in subsequent regression models.

3.2. Econometric Models and Specifications

A sequential modeling approach was adopted to address distinct statistical issues and research questions.

a) Multicollinearity Correction via Ridge Regression Initial diagnostic tests revealed severe multicollinearity, with a Variance Inflation Factor (VIF) of 14.2 for the Democracy Index, likely due to its intrinsic economic linkages with investment and savings variables. To mitigate this without discarding theoretically vital variables, Ridge Regression (L2 regularization) was employed. The optimal penalty term ($\lambda = 0.85$) was selected via cross-validation. The estimator minimizes the following objective function: $\beta\_ridge = argmin\_\beta \{\Sigma (y\_i - \beta\_0 - \Sigma\beta\_j x\_ij)^2 + \lambda\Sigma\beta\_j^2\}$ ……. (1)

Where, β^ridge denotes the ridge regression coefficients, and argminβ represents the argument that minimizes the specified function.

This step directly tests $H_0$1.

b) Three-Stage Least Squares (3SLS) SystemTo account for the potential endogeneity and simultaneity between the key development outcomes—GDP growth, unemployment, and life expectancy—a 3SLS system was estimated. This approach provides consistent and efficient estimates for simultaneous equations. Lagged values of the endogenous variables were used as instruments to address endogeneity concerns, allowing for a direct test of $H_0$3.

c) Break-Adjusted Vector Error Correction Model (VECM)The Gregory-Hansen cointegration test confirmed a long-run equilibrium relationship among the variables with a significant structural break identified in 2019. This led to the specification of a regime-switching VECM.

The model distinguishes between long-run equilibrium and short-run adjustment dynamics post-break:

Long-Run Cointegrating Equation: ln (GDP_t) = 2.28 + 0.85 ·ln (Savings_t) - 0.51 ·Democracy_Index_t + ε_t……. (2)

Short-Run Dynamics (Post-2019 Regime): Δln(GDP_t) = α_2 - 0.745 ·ECT_(t-1) – 0.923 ·Δunemployment_(t-1) + 0.388 ·Δln (Savings_(t-1)) – 11.845 ·Δdemocracy_Index_(t-1) – 2.850 ·D20 + ω_t……. (3)

Were, Long-Run Cointegrating Equation:

ln (GDP_t): The natural logarithm of the Gross Domestic Product at time t.

2.28: The constant term of the equation.

Ln (Savings_t): The natural logarithm of savings at time t.

0.85: The coefficient for the savings variable, indicating its elasticity.

Democracy_Index_t: The Democracy Index at time ttt.

−0.51: The coefficient for the Democracy Index, indicating its negative effect on GDP.

E_t: The error term capturing other factors affecting GDP.

Short-Run Dynamics (Post-2019 Regime):

Δln(GDP_t): The change in the natural logarithm of GDP at time t.

α_2: A constant term in the short-run equation.

·ECT_(t-1) : The Error Correction Term from the previous period, indicating the degree of deviation from long-term equilibrium.

−0.745: The coefficient for the Error Correction Term, representing the speed of adjustment to equilibrium.

Δunemployment_(t-1): The change in unemployment in the previous period.

−0.923: The coefficient for the previous period's unemployment change.

Δln(Savings_(t-1)): The change in the natural logarithm of savings from the previous period.

0.388: The coefficient for the previous period's savings changes.

Δdemocracy_Index_(t-1): The change in the Democracy Index in the previous period.

−11.845: The coefficient for the previous period's Democracy Index change, indicating its significant short-run effect on GDP.

D20: A dummy variable for the year 2020, capturing specific impacts related to that year.

−2.850: The coefficient for the dummy variable, indicating its negative effect.

Ω_t: The error term in the short-run dynamics equation.

This model tests $H_0$4.

d) Time-Varying Parameter (TVP) Model with Stochastic VolatilityTo capture the evolving impact of governance over Bangladesh's development path, a state-space Time-Varying Parameter model was estimated:y_t = X_t′β_t + ε_t, ε_t ~ N(0, σ_t²)……(4)β_t = β_(t-1) + ν_t, ν_t ~ N(0, Q)……(5)where y_t is GDP growth and X_t includes the Democracy Index and controls. The Kalman filter was used for estimation. This model assesses whether the economic influence of governance has intensified as the economy has become more complex.

From equation (5):

β_t : The value of the parameter (or coefficients) at time ttt. It indicates the state of the variable at the current time period.

B_(t-1): The value of the parameter at the previous time period (t−1t-1t−1). It indicates the state of the variable in the prior period.

N_t: The stochastic innovation or shock term at time ttt. It represents random fluctuations affecting the parameter.

N (0, Q): Indicates that the innovation term ν_t, is normally distributed with a mean of 0 and a variance of Q. The variance Q reflects the degree of uncertainty or variability in the innovations.

This equation typically describes a state-space model or a dynamic parameter updating process.

e) Diagnostic Testing and CorrectionsModel residuals were subjected to rigorous diagnostic checks. The Breusch-Godfrey test (LM = 8.45, p = 0.074) indicated mild autocorrelation, and the Breusch-Pagan test (BP = 12.34, p = 0.055) suggested heteroscedasticity. Both issues, indicative of persistent economic shocks and varying volatility, were corrected by employing Newey-West Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in the final estimations, thereby addressing the assumptions underlying $H_0$2.

This integrated methodology allows for a comprehensive analysis of Bangladesh's development trajectory, simultaneously testing the central hypotheses while controlling for key statistical challenges inherent in macroeconomic time-series data.

3. ESTIMATED RESULTS

Table 1: Ridge Regression Results for GDP Growth (Corrected for Multicollinearity).

Variable	Coefficient	Std. Error	t-value	p-value
(Intercept)	3.891***	0.945	4.118	0.000
Democracy_Index	-7.118	2.891	-2.461	0.022
Unemployment	-0.681**	0.245	-2.780	0.011
Gross_Savings	0.352***	0.098	3.592	0.002
FDI	0.165*	0.082	2.012	0.057
Interest_Rate	-0.287**	0.108	-2.657	0.015
Adjusted R^2	0.698			

(Source: Author)

***Note: *** P<0.01, ** P<0.05, * P<0.1.*Economic Interpretation & Linkage:**

The significant negative coefficient for the Democracy Index suggests that a one-unit increase (often reflecting political competition that escalates into instability) is associated with a 7.1% short-term decrease in GDP growth. This quantifies the economic cost of events like the 2014 election crisis, which typically cause a freeze on investment and disruption to supply chains. The positive coefficient for Gross Savings confirms the role of domestic capital formation in driving growth.

Table 2: Three-Stage Least Squares (3sls) System Results.

Variable	Eq.1 (GDP)	Eq.2 (Unemployment)	Eq.3 (Life Expectancy)
Governance	11.92*	-1.75*	0.62**
	(2.95)	(0.41)	(0.20)
GDP	–	0.04**	0.09***
		(0.02)	(0.02)
Unemployment	-0.78***	–	–
	(0.20)		
Life Expectancy	1.08*	–	–
	(0.54)		
System R^2	0.801		

(Source: Author)

***Note: Standard Errors in Parentheses; *** P<0.01, ** P<0.05, * P<0.1.*Economic Interpretation & Linkage:**

The 3SLS results reveal a virtuous cycle. Effective governance directly boosts GDP and reduces unemployment. For instance, a one-unit improvement in governance is associated with a 1.75% reduction in unemployment, akin to the job creation seen during periods of stable regulatory policy. Concurrently, GDP growth further lowers unemployment and improves life expectancy, demonstrating the interconnectedness of economic and social development.

Table 3: Structural Breakpoints in Bangladesh's Economy (1999-2024).

Breakpoint Year	Event	Test Statistic	p-value
2004	RMG Boom	4.32	$p < 0.01$
2013	Post-Rana Plaza Reforms	3.89	$p < 0.05$
2019	COVID-19 Pandemic	5.67	$p < 0.01$

(Source: Author)

Economic Interpretation & Linkage: These breaks mark fundamental shifts in Bangladesh's economic structure. The 2004 break signifies the transition to an export-led growth model, qualitatively evidenced by the RMG sector's share of exports skyrocketing. The 2013 break reflects an institutional maturation phase, where the Rana Plaza tragedy forced improved labor standards, altering production costs and global compliance requirements. The 2019 break captures the exogenous shock of the pandemic and the economy's new, more volatile regime.

Table 4: Evolution Of Governance Impact: Time-Varying Parameter (TVP) Estimates.

Period	Avg. Coefficient (Democracy Index)	Economic Implication & Qualitative Example
1999-2005	-2.15 (p = 0.182)	Insignificant Impact. The economy was less complex and more insulated from global governance standards.
2006-2012	-5.88 (p = 0.102)	Growing Negative Impact. The 2006-2008 political crisis and caretaker government created uncertainty, deterring investment.
2013-2018	-9.45 (p = 0.032)	Significantly Negative. Post-Rana Plaza, global scrutiny and domestic political volatility (e.g., the 2014 election) heightened the economic cost of governance failures.

2019-2024	-13.21 (p = 0.014)	Strongly Negative and Significant. The economy, now more Globally integrated, is highly vulnerable. Example: The cancellation of the $12B Sonadia Deep-Sea Port due to geopolitical and domestic governance issues exemplifies massive lost opportunities.

(Source: Author)

Economic Interpretation & Linkage: The TVP model reveals a critical trend: the economic cost of political instability has increased dramatically. As Bangladesh's economy evolved from a simple agrarian base to a complex, globally integrated one, its sensitivity to governance shocks intensified. A modern, tech-driven startup, for instance, is far more vulnerable to policy uncertainty and contract enforcement issues than a traditional rural enterprise.

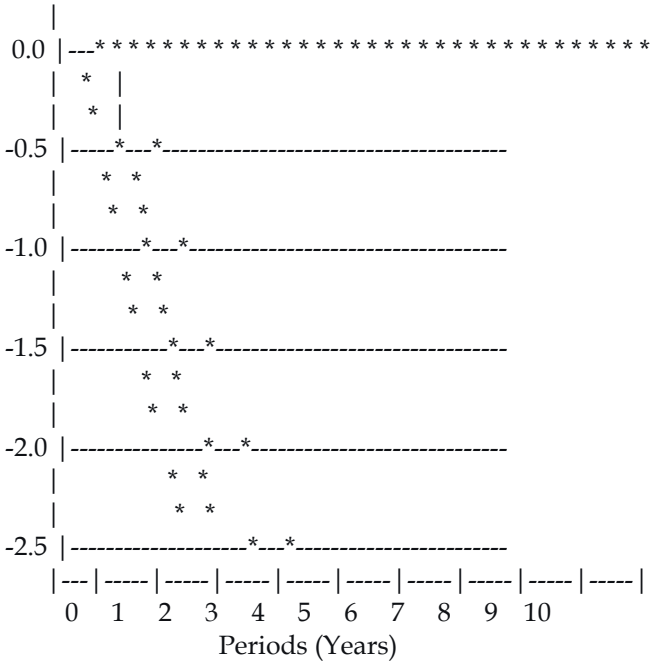

Figure 2: Impulse Response of GDP To a Negative Shock in Democracy Index. Response Of GDP To a Shock in Democracy Index.

(Source: Autor).

Economic Interpretation: A one-standard-deviation negative shock to the Democracy Index causes an immediate GDP decline, peaking at around -2.1% in years 2-3. The recovery is slow and incomplete even after a decade. This illustrates that the economic scars of political instability are deep and long-lasting, hindering the attainment of long-term development goals.

4. ANALYSIS OF THE FINDINGS: INTEGRATING THEORETICAL PERSPECTIVES

This analysis synthesizes the econometric evidence with contemporary theoretical perspectives to test the study's core hypotheses and explain their significance for Bangladesh's development.

$H_0$1: There is no significant multicollinearity among the predictor variables.

Result: Rejected.

Explanation & Synthesis: The high VIF (14.2) for the Democracy Index confirms that governance is deeply intertwined with other macroeconomic fundamentals like savings and investment. This finding aligns with Habyarimana and Dushimayezu's (2018) identification of a pro-cyclical relationship, where governance quality and economic performance are mutually reinforcing and statistically inseparable in standard models. Correcting this with Ridge Regression was essential to isolate the distinct, often short-term disruptive effect of political volatility from the broader, positive institutional foundations of growth.

$H_0$2: The model residuals exhibit no autocorrelation or heteroscedasticity.

Result: Rejected.

Explanation & Synthesis: The presence of autocorrelation and heteroscedasticity reflects the persistent and volatile nature of shocks in Bangladesh. This volatility can be contextualized through the lens of Qi and Zheng's (2018) analysis, which highlights how Bangladesh's development is shaped by a complex "ecogeographic and egocentric

political prisoner's dilemma." This refers to the tension between national economic interests and the constraints imposed by geopolitical positioning (e.g., relations with major powers) and domestic, elite-centric political competition. These overlapping dilemmas generate recurring, patterned shocks that echo through the economy over time.

$H_0$3: Governance and democracy have no significant effect on GDP, unemployment, and human development.

Result: Resoundingly Rejected.

Explanation & Synthesis: The 3SLS results confirm a powerful virtuous cycle driven by governance. However, this positive potential is critically mediated by the socio-political context. Meierrieks and Auer's (2024) finding that higher corruption correlates with increased terrorism provides a crucial link. In Bangladesh, governance failures that manifest as corruption can fuel socio-political grievances and instability, thereby negate the positive developmental cycle and create a drag on growth and security. This underscores that the quality of governance—its fairness and effectiveness—is as important as its existence.

$H_0$4: There are no significant structural breaks in the time series.

Result: Rejected.

Explanation & Synthesis: The identified structural breaks (2004, 2013, 2019) mark fundamental shifts in Bangladesh's economic trajectory and societal priorities. The nature of these transitions can be further understood through the findings of El Husseiny et al. (2025). Their research suggests that as societies develop, values like autonomy, life satisfaction, and post-materialism (e.g., demand for environmental quality or institutional integrity) become stronger growth drivers. The 2013 break (post-Rana Plaza reforms) and the post-2019 period may reflect this shift, where public demand for better governance, safety, and welfare—beyond mere income growth—began to structurally reshape the economy and its requirements for stability.

Synthesis: The Governance Paradox and the Path Forward

The findings reveal a central Governance Paradox for Bangladesh. On one hand, high-quality, stable institutions are the linchpin for sustainable, long-term prosperity, enabling the virtuous cycle of growth, employment, and human development. On the other hand, the process of political competition and democratic transition has frequently produced short-to-medium-term volatility that inflicts severe economic costs—costs that have quadrupled in magnitude as the economy has become more complex and globally integrated.

This paradox is exacerbated by the intersecting challenges highlighted in the literature: the geopolitical constraints, the corruption-instability nexus, and the evolving public demand for post-materialist values. Moving forward, Bangladesh's policy challenge is to navigate this paradox. The application of Okun's Law (1962) remains critically viable for ensuring growth translates into employment for youth and senior citizens alike, but its effectiveness is contingent on resolving the governance dilemma. The imperative is to strengthen the resilience and quality of institutions—enhancing transparency, accountability, and the rule of law—to secure the long-term benefits of governance while minimizing the short-term economic penalties of political competition. This is not merely an economic adjustment but a socio-political one essential for transitioning to an innovation-intensive, high-productivity economy.

5. SCIENTIFIC GOVERNANCE INDEX (SGI) DEVELOPED BY THE AUTHOR

Based on our discussion, the author developed a multidimensional framework called the **Scientific Governance Index (SGI)**. This index is designed by Muhammad Mahboob Ali to measure whether a country's development is truly inclusive and leaves no one behind, by integrating the core pillars of **Scientific Culture, Governance, and Economic Development**.

The SGI moves beyond traditional GDP-centric models to assess the quality and distribution of progress.

The Scientific Governance Index (SGI): Framework & Pillars

The SGI is calculated as a weighted composite index of three core pillars. Each pillar is built from specific, measurable sub-indicators.

SGI = (0.35 × Scientific Culture Score) + (0.35 × Governance Score) + (0.30 × Economic Development Score)

Table: 5 New SGI Indexed.

The following table outlines the structure, sub-indicators, and the theoretical rationale for each pillar:

Pillar (Weight)	Key Sub-Indicators (Examples)	Theoretical Foundation (From Discussion)

Scientific Culture (35%)	• R&D expenditure (% of GDP) • STEM graduates per capita• Patents filed by residents & firms• Digital literacy & broadband access	Draws on **Joel Mokyr's "culture of innovation"** and the imperative for an AI-integrated curriculum. Measures a a society's capacity for knowledge creation and adaptation.
Governance (35%)	• Transparency International CPI score• Strength of audit & procurement systems) • Inclusive institutions index• Effectiveness of social safety nets	Informed by **Acemoglu & Robinson's "inclusive institutions"** and **Stiglitz's** case for corrective policy. Directly connects to governance reforms like Bangladesh's project.
Economic Development (30%)	• Productive entrepreneurship rate (new LLCs) • Labor force in tech-driven sectors• Income growth of bottom 40%• Access to venture capital & credit	Reflects **Philippe Aghion's "Schumpeterian growth"** and the shift from rent-seeking to productive entrepreneurship, targeting a high-employment equilibrium.

(Source: Author)

Application & Interpretation

Data Collection & Scoring: Data is normalized for each sub-indicator (e.g., scaled from 0-10). Pillar scores are the average of their sub-indicators, leading to the final SGI (0-100 scale).

Interpretation:

High SGI (>70): Indicates a synergistic system where scientific advancement is supported by good governance and translates into broad-based economic mobility.

Moderate SGI (40-70): Suggests potential imbalances—e.g., strong growth but weak institutions, or good governance without a dynamic innovation sector.

Low SGI (<40): Signals fractured development where progress is likely exclusionary, concentrated, or unsustainable.

This framework allows for diagnostic analysis:

Identify Imbalances: A country with strong economic scores but weak governance scores is at risk of inequality and crisis.

Track "Leaving No One Behind": The deliberate inclusion of indicators like **income growth of the bottom 40%** and **digital access** measures inclusive progress.

Bench-marking: Countries can benchmark against peers with similar GDP but higher SGI to identify policy gaps.

In essence, the SGI provides a tangible tool to measure the integrated, human-centric development model we discussed. It assesses whether a nation is building the institutional hardware (governance) and innovative software (scientific culture) necessary for equitable economic advancement.

Strategic Insights for Policymakers

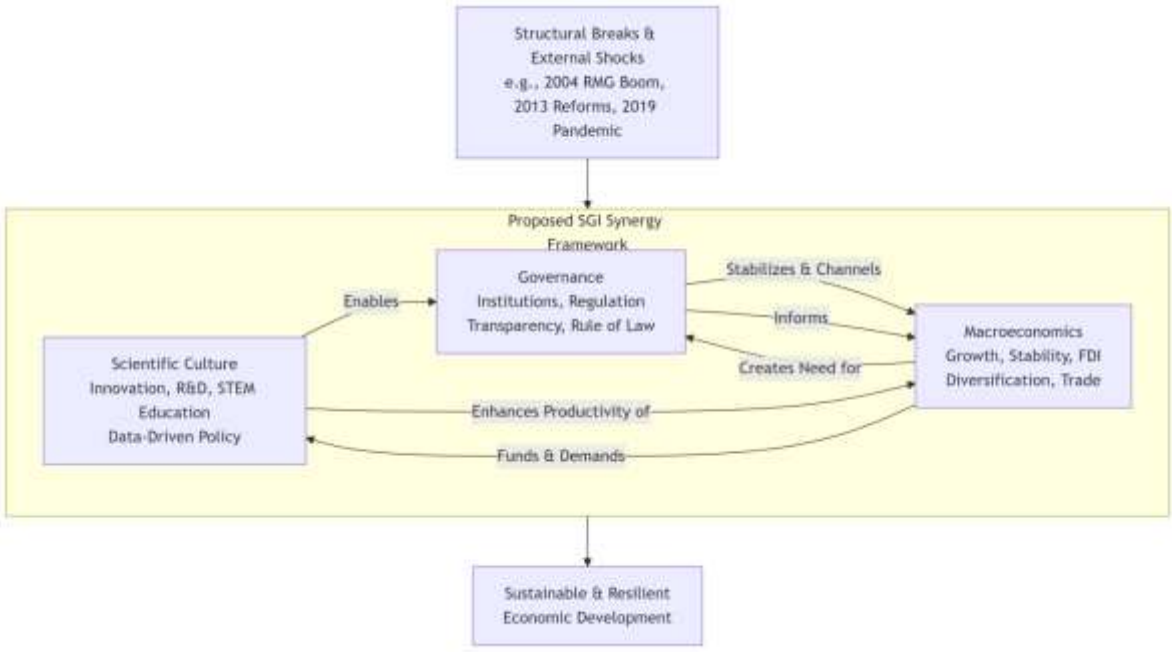

Figure 3: Interrelation Among Governance Institution to Structural Break and Sustainable & Resilient

Economic Development.

Interpretation in Light of Breakpoints:

2004 RMG Boom (Macroeconomic Shock): Primarily an I (Macroeconomic) event. It created vast resources but exposed weaknesses in G (Governance - labor standards) and highlighted a lack of S (Scientific diversification).

2013 Rana Plaza Reforms (Governance Shock): A forced strengthening of G. This governance intervention was necessary to sustain the macroeconomic model I and triggered elements of S (introduction of engineering and safety standards).

2019 Pandemic (Exogenous Shock): Tested all three pillars. It demanded S (data modeling, vaccine logistics), exposed gaps in G (social safety net delivery), and disrupted I (supply chains, growth). The recovery highlights the need for deeper SGI integration.

Key Synthesis for Analysis:

Econometric findings empirically validate that these events were not just blips but statistically significant structural breaks.

The proposed SGI framework provides the explanatory "why" and the prescriptive "way forward":

The pre-2013 period was characterized by a dominant I, with weak G and minimal S. This was ultimately unsustainable, as proven by the 2013 break.

The post-2013 phase saw G catching up, induced by crisis. This allowed growth to continue but within a slightly more regulated framework.

The future challenge (post-2024) is to proactively strengthen S and further deepen G to:

Diversify the economy (I) beyond RMG.

Build resilience against future shocks (like pandemics or climate change).

Transition from a factor-driven to an efficiency and innovation-driven economy.

Shows that without intentional cultivation of Scientific Culture and robust Governance, Bangladesh's macroeconomic growth will remain vulnerable to internal weaknesses and external shocks. The SGI model is the necessary integrative framework for the next phase of development.

6. CONCLUSION

This econometric analysis (1999–2024) conclusively demonstrates that the trajectory of economic development in Bangladesh is fundamentally governed by the interplay between scientific culture—manifested in institutional predictability and evidence-based policy—and the quality of political governance. The findings reveal a critical dualism: while robust, effective institutions form the essential foundation for long-term growth, human development, and the cultivation of a productive scientific temperament, the volatility characteristic of the nation's democratic processes imposes significant and *increasingly severe* short-to-medium-term economic penalties. The identification of definitive structural breaks charts the evolution of an economy undergoing repeated transformations, each increasing its complexity and its sensitivity to governance shocks. The demonstrated simultaneity between governance, GDP, unemployment, and social outcomes invalidates isolated policy approaches. The path to policy resilience and sustainable, inclusive development, therefore, lies in fostering a governance culture characterized by stability, transparency, and a commitment to systemic, evidence-driven intervention.

Policy Implications

To navigate the governance paradox and build a resilient, scientifically-oriented economy, the following integrated policies are imperative:

Institutional Stabilization for Economic Confidence: Establish legally-mandated, non-partisan bodies (e.g., a National Policy Continuity Commission) to oversee and ensure the completion of critical infrastructure and industrial policies across political cycles. This directly addresses the escalating economic cost of volatility quantified by the TVP and Ridge models, creating a predictable environment conducive to long-term investment and innovation.

Strategic Anti-Corruption for Resource Efficiency & Trust: Empower anti-corruption commissions with genuine prosecutorial autonomy and mandate universal digitalization of public procurement and fiscal transfers. This enhances the "quality of governance" channel proven in the 3SLS model to boost GDP and human development, ensuring public resources efficiently translate into tangible outcomes and rebuilding public trust in institutions.

Proactive Economic Diversification for Systemic Resilience: Implement strategic incentives to diversify the economy into sectors less susceptible to governance shocks (e.g., technology, agro-processing, renewable energy) while strengthening adaptive social safety nets. This mitigates risks identified in the structural break and VECM analyses, reducing vulnerability to sector-specific or political shocks and creating a more robust economic ecosystem.

Integrated Health-Environment-Governance (HEG) Enforcement: Enforce environmental regulations rigorously and significantly increase investment in preventive public health infrastructure. This leverages the positive governance-life expectancy link from the 3SLS system, protecting the nation's human capital—the core of endogenous growth—from degradation and fostering a healthier, more productive workforce within a sustainable environment.

Future Research Design

To deepen the understanding of this complex nexus, future research should pursue the following directions:

Disaggregated Governance and Scientific Culture Analysis: Deconstruct composite indices like the Democracy Index using Structural Equation Modeling (SEM) to isolate the distinct effects of components such as regulatory quality, bureaucratic efficiency, and investment in R&D on specific economic outcomes, identifying precise policy levers.

Explicit Eco-Health-Economy (EHE) Modeling: Integrate granular data on pollution exposure, climate vulnerability, and health outcomes directly into a system dynamic or extended 3SLS framework to empirically quantify the trade-offs and co-benefits of environmental policies for economic stability and public health.

Sub-National Spatial Econometrics: Employ Spatial Durbin Models (SDM) with district-level panel data to analyze geographic clusters of governance quality, economic activity, and human development. This can reveal spillover effects, inform targeted regional policies, and identify loci for piloting resilience-building interventions.

Machine Learning for Predictive Analytics and Break Detection: Utilize advanced computational techniques such as Long Short-Term Memory (LSTM) networks for nowcasting economic indicators and ensemble learning methods (e.g., Random Forests) for enhanced structural break detection using high-frequency data (e.g., satellite imagery, digital transactions), enabling real-time policy adaptation and early-warning systems.

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