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Governance Quality and Innovation Capability: Insights from Indonesia

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Abstract

Innovation is a key driver of national competitiveness, and its advancement increasingly relies on the strength of governance quality. However, empirical evidence linking governance performance to national innovation outcomes in the Indonesian literature remains limited. This study addresses this gap by assessing how the Worldwide Governance Indicators (WGI), used as a proxy for governance quality, affect Indonesia's innovation capability as measured by the Global Innovation Index (GII). The analysis also incorporates additional factors that commonly influence innovation capabilities, including economic growth, foreign direct investment, and the labor force. By adopting a decomposition model to evaluate the individual contributions of each WGI dimension, and employing Gaussian Identity-link GLMs and robust least squares methods, the results show that governance quality overall has a positive and significant effect on Indonesia's GII. When each component of the WGI is assessed individually, most dimensions display positive effects, with voice and accountability, political stability, and rule of law showing notably significant impacts. These findings imply that strengthening governance structures, particularly in transparency, stability, and legal certainty, is essential for advancing Indonesia's innovation capability.

Introduction

Innovation is widely recognised as a foundational engine of long term national competitiveness, productivity growth, and structural economic transformation [1,2]. Countries that successfully strengthen their innovation systems tend to exhibit higher economic resilience, more dynamic industrial development, and stronger adaptive capacity in the face of global challenges [3,4]. For Indonesia, improving national innovation performance has become increasingly important as the economy continues its transition toward higher value added activities and seeks to escape the middle income trap [5,6].

Despite various government initiatives to foster research capacity, digitalisation, and technological upgrading, Indonesia's overall innovation performance remains consistently low compared with many countries in the same income group [7,8]. This persistent condition is reflected in the Global Innovation Index (GII), which places Indonesia in a modest position. As shown in Figure 1, Indonesia's GII trend from 2011 to 2023 is relatively unstable and consistently ranges between a score of 20 and 30, placing the country in a medium to low position globally. This pattern highlights weaknesses in several areas, including research output, knowledge diffusion, and institutional readiness [9,10].

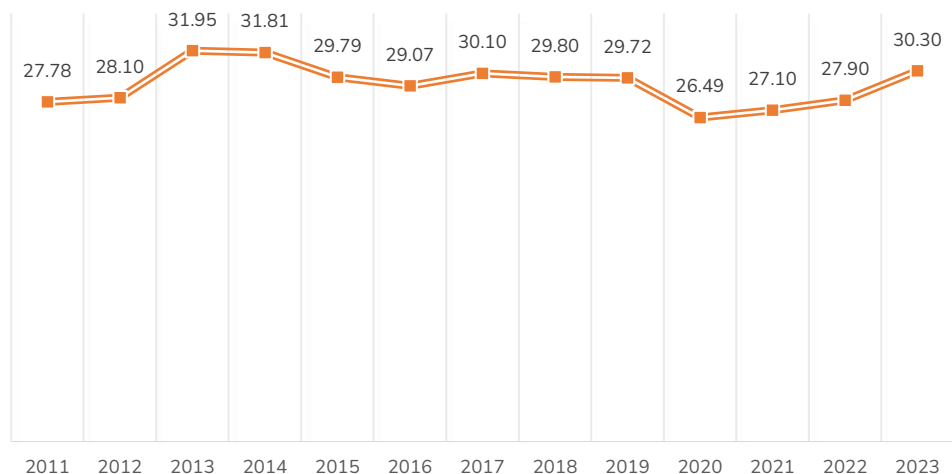


Figure 1. Indonesia's GII 2011-2023 (Source: World Intellectual Property Organization [10]).
Note: The GII score ranges from 0 (lowest) to 100 (highest).

The continuing gap suggests that structural constraints remain unaddressed. One central issue repeatedly observed in policy debates is that weak governance quality may hinder innovation capability [11,12]. Governance affects how effectively public resources are allocated, how regulations support or impede innovation, how transparent institutions are, and how conducive the broader environment is for risk taking and knowledge creation [13,14]. The allegation that governance performance plays a significant role in shaping innovation outcomes is therefore reasonable, especially in a developing economy where institutional capacity varies across sectors and regions [15,16].

In the Indonesian context, governance challenges remain a persistent real-world impediment to innovation-oriented development. Despite ongoing reform initiatives, issues such as regulatory inconsistency, bureaucratic inefficiency, weak legal enforcement, and recurring corruption continue to undermine institutional credibility and discourage long-term investment in innovation [17,18]. Frequent policy reversals and overlapping authority between central and regional governments create uncertainty for firms and innovators, while delays in judiciary processes and gaps in contract enforcement weaken investor protection and entrepreneurial risk-taking [19,20]. High-profile corruption cases within public procurement and strategic development programs further illustrate systemic weaknesses that erode public trust and reduce incentives for technological upgrading and research-based industrial growth [21]. These conditions reinforce the argument that strengthening governance is essential for improving Indonesia's innovation ecosystem and reducing the institutional frictions that hinder knowledge creation and diffusion.

To empirically examine this relationship, governance quality must be measured through a credible and comprehensive indicator. While several global governance or institutional quality indices exist, such as the Global Competitiveness Index (GCI), the Economic Freedom Index (EFI), and the Corruption Perceptions Index (CPI), many of them capture governance only indirectly or through narrower dimensions. In contrast, the Worldwide Governance Indicators [22] offer an appropriate proxy because they capture six key dimensions of governance including control of corruption, government effectiveness, political stability, rule of law, regulatory quality, and voice and accountability. The WGI's methodological consistency, cross-country comparability, and adequately long historical coverage make it especially suitable for empirical research. These dimensions collectively reflect the institutional conditions most relevant to innovation activity, providing a stronger conceptual and empirical basis than alternative single-dimension or composite indices that do not disaggregate governance into its underlying institutional mechanisms [23].

The theoretical foundation for this nexus is supported by institutional economics, which argues that institutions shape incentives, transaction costs, and the functioning of markets, all of which influence the capacity of an economy to generate and sustain innovation [24]. Strong institutions reduce uncertainty, enhance the efficiency of resource allocation, and promote long term investment in knowledge creation [25]. Schumpeterian innovation theory similarly emphasises that well functioning institutions foster an environment where entrepreneurial activity, technological advancement, and creative destruction can occur [26]. In such settings, innovators are more likely to take risks, firms are better able to accumulate capabilities, and the overall system becomes more conducive to continuous technological upgrading [27]. Collectively, these perspectives underscore that institutional quality is a foundational precondition for the emergence and diffusion of innovation.

Empirical evidence over the past decade corroborates the theoretical link between institutional quality and innovation. Cross-country analyses by Boudreaux [28] find that stronger institutions and market-supporting frameworks are associated with higher national innovation performance, with Boudreaux showing that institutional quality helps explain international variation in Global Innovation Index scores and related innovation measures. Review articles by He & Tian [24] synthesize micro and macro evidence and conclude that institutions matter for innovation through channels such as reduced uncertainty, stronger property rights, and better incentives for investment in research and development. Firm-level studies by Ellis et al. [29] further document that political corruption and weak governance reduce both the quantity and quality of innovation outputs, with evidence from US firms showing substantial negative effects of corruption on corporate innovation. Similar firm-level findings by Quan et al. [30] appear in sectoral and country studies; for example, research on Chinese firms reports that higher political corruption is associated with fewer green patents and citations, after accounting for endogeneity. Complementing these results, studies by Aldieri et al. [31] that examine governance more broadly find that dimensions of institutional quality such as regulatory performance and judicial credibility are important for firm efficiency and innovation diffusion, even when effects vary across contexts and sectors. Taken together, this body of recent, peer-reviewed work provides both cross-country and firm-level support for the contention that improvements in governance.

Indonesian scholarship offers emerging but still limited empirical work on the governance–innovation nexus, often focusing on regional or policy dimensions rather than on a national, WGI-based assessment of the Global Innovation Index. For example, studies by Hilmawan et al. [32] in local public sector innovation document how government initiatives and institutional capacity at the district or regional level affect innovation outcomes and service performance, highlighting the practical importance of governance for regional innovation ecosystems. Policy-oriented analyses by Simatupang et al. [33] trace the evolution of Indonesia’s innovation policy and institutional reforms, underscoring the salience of governance arrangements for national innovation strategy. Recent Indonesian work by Fadila [34] explicitly using the WGI has tended to analyse single WGI dimensions, such as regulatory quality, in comparative or case study settings rather than to assess their joint and disaggregated effects on national innovation performance. Taken together, these studies substantiate the relevance of governance for innovation in the Indonesian context but also reveal a clear gap, which to our knowledge, no previous study has systematically used the WGI as the primary proxy for governance quality to evaluate its effect on Indonesia’s GII. This lacuna motivates the present study, which fills the gap by applying both the aggregate WGI and its six constituent dimensions to examine their isolated and combined influence on Indonesia’s GII.

Building on the above discussion, the primary focus of this study is to examine the impact of governance quality on national innovation capability in Indonesia. The analysis employs the WGI as the main explanatory variable and uses a decomposition approach in which each of the six

governance dimensions is evaluated in separate regression models. This design enables the study to isolate the individual effects of the six WGI dimensions (control of corruption, government effectiveness, political stability, rule of law, regulatory quality, and voice and accountability) on the GII while maintaining a consistent set of control variables, including economic growth, foreign direct investment, and the labor force. By modelling each WGI dimension separately with an identical set of controls, the study provides a more robust identification of which institutional aspects matter most for Indonesia's innovation performance. This approach contributes to the Indonesian empirical literature by clarifying the institutional drivers of innovation and offering evidence based insights that can inform governance reforms intended to strengthen Indonesia's long term innovation capacity.

Materials and Methods

Data and Variables

This study uses data from 2011 to 2023, a period determined by the availability of the variables. The earliest data for the dependent variable, the Global Innovation Index (GII), begin in 2011, while the most recent data for the main independent variable, the Worldwide Governance Indicators (WGI), extend to 2023. Because the time span is relatively short, the data were converted from annual to semi-annual frequency using a linear interpolation approach commonly applied in economic data transformation. This conversion increases the number of observations, thereby improving the statistical power and stability of the econometric estimations.

As shown in Table 1, this study employs a total of 11 variables. The GII serves as the sole dependent variable. The WGI and its six dimensions constitute the main independent variables. GDP growth (GDPG), FDI inflows (FDI), and the labor force (LF) function as control variables. GII data are obtained from the World Intellectual Property Organization [10], while the WGI and all control variables are sourced from the World Bank [22,36].

Table 1. Variable synopsis.

Variable Status	Variable Name	Variable Symbol	Variable Units
Dependent	Global Innovation Index	GII	Score (0 to 100)
Main Independent	Worldwide Governance Indicators	WGI	Score (-2.5 to +2.5)
	WGI Control of Corruption	WGL_CC	Score (-2.5 to +2.5)
	WGI Government Effectiveness	WGL_GE	Score (-2.5 to +2.5)
	WGI Political Stability and Absence of Violence/Terrorism	WGL_PV	Score (-2.5 to +2.5)
	WGI Rule of Law	WGL_RL	Score (-2.5 to +2.5)
	WGI Regulatory Quality	WGL_RQ	Score (-2.5 to +2.5)
	WGI Voice and Accountability	WGL_VA	Score (-2.5 to +2.5)
Control Independent	GDP Growth	GDPG	Percent
	Foreign Direct Investment Inflow	FDI	Percent of GDP
	Labor Force	LF	Person

Conceptual Framework

This study's conceptual framework, illustrated in Figure 2, is grounded in the proposition that the quality of national governance plays a central role in shaping innovation outcomes. The GII, which captures a country's overall innovation performance, is expected to respond to improvements in institutional functions that facilitate information flows, reduce uncertainty, and strengthen the incentives for knowledge creation [24]. The WGI serve as the primary explanatory dimension in this framework because they reflect the effectiveness of a country's political and administrative systems [23]. The overall WGI score provides an aggregate measure

of governance quality, while the six underlying dimensions offer more granular channels through which authority structures influence innovation performance. Consistent with this reasoning, the study hypothesizes that improvements in the overall WGI score will exert a positive effect on the GII.

Building on this aggregate perspective, each of the six WGI dimensions captures a distinct mechanism through which governance quality can shape the national innovation environment. (1) Control of Corruption captures the extent to which public power is exercised for private benefit, encompassing both petty and grand corruption as well as broader forms of state capture. (2) Government Effectiveness reflects the quality of public services, the professionalism and independence of the civil service, and the credibility and coherence of government policy formulation and implementation. (3) Political Stability and the Absence of Violence or Terrorism represents the likelihood that politically motivated instability or violence will disrupt economic activities and constrain the conditions necessary for innovation. (4) Rule of Law measures the degree of confidence that individuals and firms have in the legal system, including the reliability of contract enforcement, the security of property rights, and the overall functioning of police and judicial institutions. (5) Regulatory Quality captures the government’s capacity to design and implement policy frameworks that support private sector development and enable efficient market operations. (6) Voice and Accountability reflects the extent to which citizens are able to participate in the selection of their government and enjoy freedoms of expression, association, and media. Together, these six governance dimensions shape incentives, risks, and transactional conditions faced by innovators, firms, and investors, thereby influencing national innovation performance [37]. Consistent with this conceptual foundation, the study hypothesizes that improvements in each governance dimension will exert a positive impact on the GII.

In addition to institutional quality, the model incorporates macroeconomic and demographic conditions that are commonly associated with innovation performance. GDP growth represents the economy’s ability to generate additional resources that may be allocated to innovation investment [1]. Foreign direct investment provides access to international capital and knowledge spillovers that can stimulate innovative activity [38]. The labor force reflects the availability of human resources that form the basis for research, development, and production [39]. These control variables ensure that the estimated effect of governance on innovation is not confounded by broader economic conditions. Taken together, the expected empirical relationship is therefore that improvements in governance quality, whether measured through the overall index or its six constituent dimensions, contribute positively to a country’s innovation capability after accounting for economic growth, foreign investment, and labor force dynamics.

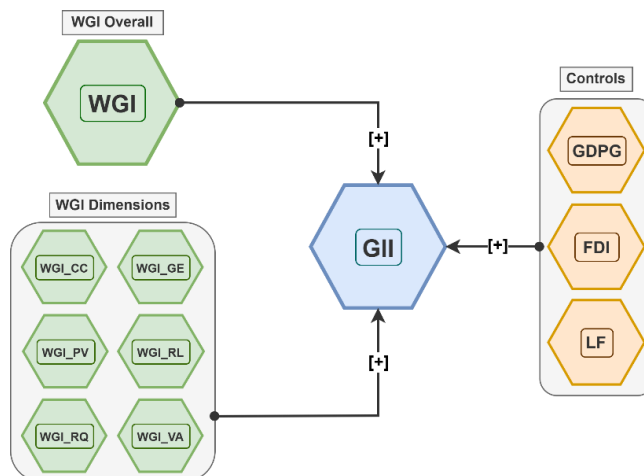


Figure 2. Study’s conceptual framework.

Model Specification

The primary focus of this study is to examine the impact of the WGI and its six dimensions on the GII using separate model specifications, each estimated with a consistent set of control variables (GDPG, FDI, and LF). The baseline function employed in this study is mathematically presented in Equation 1.

$$GII = f(WGID, GDPG, FDI, LF) \tag{1}$$

Where *GII* represents Global Innovation Index, *WGID* represents World Governance Indicators and its six dimensions, *GDPG* represents gross domestic product growth, *FDI* represents foreign direct investment inflow, and *LF* represents labor force.

Based on the functional form in Equation 1, the study’s decomposed econometric specifications are outlined in Equations 2-8.

$$GII_t = \beta_{01} + \beta_{11}WGI_t + \beta_{21}GDPG_t + \beta_{31}FDI_t + \beta_{41}LF_t + \varepsilon_t \tag{2}$$

$$GII_t = \beta_{02} + \beta_{12}WGI_CC_t + \beta_{22}GDPG_t + \beta_{32}FDI_t + \beta_{42}LF_t + \varepsilon_t \tag{3}$$

$$GII_t = \beta_{03} + \beta_{13}WGI_GE_t + \beta_{23}GDPG_t + \beta_{33}FDI_t + \beta_{43}LF_t + \varepsilon_t \tag{4}$$

$$GII_t = \beta_{04} + \beta_{14}WGI_PV_t + \beta_{24}GDPG_t + \beta_{34}FDI_t + \beta_{44}LF_t + \varepsilon_t \tag{5}$$

$$GII_t = \beta_{05} + \beta_{15}WGI_RL_t + \beta_{25}GDPG_t + \beta_{35}FDI_t + \beta_{45}LF_t + \varepsilon_t \tag{6}$$

$$GII_t = \beta_{06} + \beta_{16}WGI_RQ_t + \beta_{26}GDPG_t + \beta_{36}FDI_t + \beta_{46}LF_t + \varepsilon_t \tag{7}$$

$$GII_t = \beta_{07} + \beta_{17}WGI_VA_t + \beta_{27}GDPG_t + \beta_{37}FDI_t + \beta_{47}LF_t + \varepsilon_t \tag{8}$$

Here, *WGI* represents overall governance quality, *WGI_CC* represents WGI control of corruption, *WGI_GE* represents WGI government effectiveness, *WGI_PV* represents WGI political stability and absence of violence/terrorism, *WGI_RL* represents WGI rule of law, *WGI_RQ* represents WGI regulatory quality, *WGI_VA* represents WGI voice and accountability, *t* represents period of the study, $\beta_{01} - \beta_{07}$ represent the intercepts, $\beta_{11} - \beta_{47}$ represent the coefficients, and ε is the error term.

Lastly, the variables that contain no negative values in their raw data and are not expressed in percentage form, namely GII and LF, are transformed using the natural logarithm (ln) to account for scale normalization and improve the interpretability of the estimated coefficients. The final model specifications employed in this study are presented in Equations 9-15.

$$\ln GII_t = \beta_{01} + \beta_{11}WGI_t + \beta_{21}GDPG_t + \beta_{31}FDI_t + \beta_{41}\ln LF_t + \varepsilon_t \tag{9}$$

$$\ln GII_t = \beta_{02} + \beta_{12}WGI_CC_t + \beta_{22}GDPG_t + \beta_{32}FDI_t + \beta_{42}\ln LF_t + \varepsilon_t \tag{10}$$

$$\ln GII_t = \beta_{03} + \beta_{13}WGI_GE_t + \beta_{23}GDPG_t + \beta_{33}FDI_t + \beta_{43}\ln LF_t + \varepsilon_t \tag{11}$$

$$\ln GII_t = \beta_{04} + \beta_{14}WGI_PV_t + \beta_{24}GDPG_t + \beta_{34}FDI_t + \beta_{44}\ln LF_t + \varepsilon_t \tag{12}$$

$$\ln GII_t = \beta_{05} + \beta_{15}WGI_RL_t + \beta_{25}GDPG_t + \beta_{35}FDI_t + \beta_{45}\ln LF_t + \varepsilon_t \tag{13}$$

$$\ln GII_t = \beta_{06} + \beta_{16}WGI_RQ_t + \beta_{26}GDPG_t + \beta_{36}FDI_t + \beta_{46}\ln LF_t + \varepsilon_t \tag{14}$$

$$\ln GII_t = \beta_{07} + \beta_{17}WGI_VA_t + \beta_{27}GDPG_t + \beta_{37}FDI_t + \beta_{47}\ln LF_t + \varepsilon_t \tag{15}$$

Methods

Gaussian Identity-link Generalized Linear Models (GI-GLMs)

Gaussian identity-link generalized linear models represent a subset of GLMs designed for continuous outcomes that reasonably follow a normal distribution. Under the identity link, the expected value of the dependent variable is expressed as a linear function of the explanatory variables [40–42]. This specification is appropriate for the present analysis because the variables employed are continuous and exhibit an approximately normal distribution over time.

Beyond their compatibility with the data structure, GI-GLMs provide greater flexibility than ordinary least squares (OLS), particularly when dealing with heteroskedasticity, an issue commonly encountered in macroeconomic time-series research. Although GI-GLMs share the

linear functional form of traditional regression models, they are estimated using maximum likelihood rather than least squares, yielding more efficient and reliable parameter estimates when classical OLS assumptions are not fully met [43]. In this sense, GI-GLMs offer a more robust and adaptable estimation framework, making them well suited for analyzing the complex linkages between institutional quality and innovation capability.

Robust Least Squares (RLS)

Robust Least Squares (RLS) is designed to produce reliable parameter estimates when datasets contain outliers or violate the classical assumptions of OLS regression. Because OLS is highly sensitive to extreme observations, which can distort coefficient estimates, RLS employs estimation procedures that limit the impact of such values, offering a clearer and more accurate representation of the underlying relationships in the data [41,42,44]. This makes RLS particularly useful in empirical settings where deviations from normality or irregular error structures are likely.

RLS achieves this robustness through methods such as M-estimators, which minimize an alternative loss function rather than the standard sum of squared residuals used in OLS. By reducing the weight assigned to outliers, these techniques enhance both the stability of parameter estimates and the overall reliability of the model [45]. For this reason, RLS serves as an important complementary approach for validating the GI-GLM results, ensuring that the study’s conclusions are not unduly influenced by extreme values or assumption violations.

Flow Analysis

Figure 3 illustrates the sequential methodological framework employed in the study. The process begins with variable identification (Step 1) to define the dependent and independent variables. This is followed by the collection of relevant secondary data (Step 2) and the generation of descriptive statistics (Step 3) to provide an initial overview of the dataset. A normality test (Step 4) is conducted to assess whether the data distribution meets the assumptions required for econometric estimation, followed by a RESET test (Step 5) to check model specification validity. Subsequently, Gaussian Identity-link Generalized Linear Models (GI-GLMs) estimation (Step 6) is performed to obtain empirical results and interpret the findings, complemented by Robust Least Squares (RLS) estimation (Step 7) to ensure robustness. Finally, the research process concludes with detailed discussions and policy recommendations (Step 8).

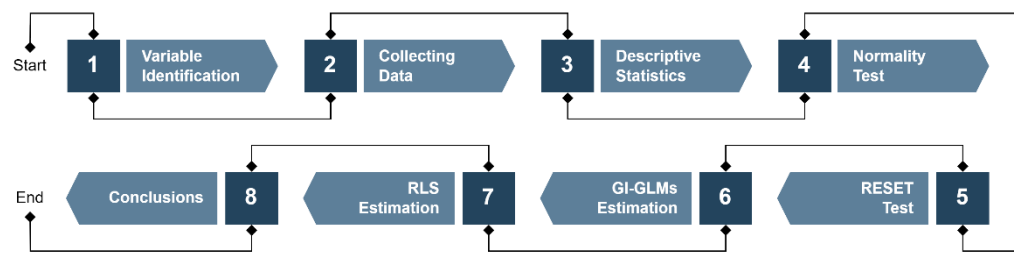


Figure 3. Study’s flow analysis.

Results and Discussion

Descriptive Statistics

The descriptive statistics in Table 2 provide an overview of the central tendencies, dispersion, and distributional characteristics of all variables used in the analysis, with attention to the measurement scales noted below the table. The Global Innovation Index (GII), measured on a 0-100 scale, exhibits a mean of 29.22 and a narrow range between 26.49 and 31.95, indicating modest cross-country variation in innovation performance within the sample. Its skewness

(0.06) and kurtosis (2.10) suggest an approximately symmetric and near-normal distribution. The World Governance Indicators (WGI), measured on a -2.5 to +2.5 scale, show consistently negative mean values for most dimensions, such as WGI, WGI_CC, WGI_PV, and WGI_RL, indicating that Indonesia generally performs below the global governance benchmark during the study period. WGI_GE and WGI_VA have slightly positive means (0.05 and 0.12), though both remain close to zero, indicating moderate but not strong governance performance. The distributional properties of these indicators are all near-normal, with skewness values from -0.79 to 0.23 and kurtosis from 1.82 to 3.65, suggesting no extreme deviations from normality.

Regarding the control variables, GDP Growth (GDPG), expressed as a percentage, has a mean of 4.61 percent with considerable variability (std. dev. 2.09), and displays strong negative skewness (-2.75) and high kurtosis (9.42), indicating occasional large contractions that pull the distribution leftward. FDI inflows, also expressed as a percentage of GDP, average 1.99 percent and show similarly left-skewed and peaked distributions (skewness -1.23, kurtosis 4.89), reflecting occasional low-FDI years. The labor force (LF), measured in millions of persons, exhibits a mean of 131.28 million with a relatively narrow distribution (std. dev. 6.82) and near-zero skewness, suggesting a stable population size across the sample. Taken together, the descriptive statistics suggest that while governance quality varies modestly around generally negative baseline scores, macroeconomic conditions such as growth and FDI show higher volatility. These distributional characteristics underscore the need for robust estimation techniques, such as Gaussian Identity-link Generalized Linear Models and Robust Least Squares, to ensure stable and reliable inference in the empirical analysis.

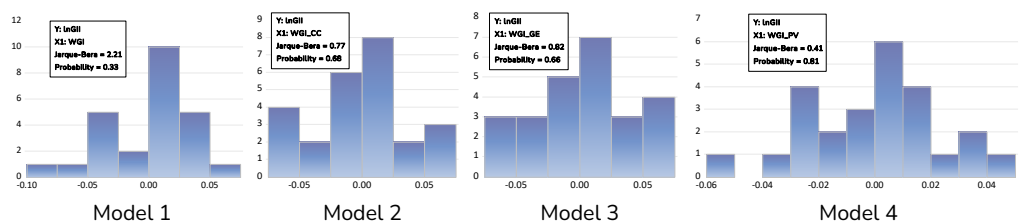
Table 2. Descriptive statistics of raw data.

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
GII	29.22	29.72	31.95	26.49	1.68	0.06	2.10
WGI	-0.20	-0.17	-0.01	-0.46	0.14	-0.49	2.24
WGI_CC	-0.51	-0.47	-0.30	-0.76	0.14	-0.27	2.33
WGI_GE	0.05	-0.02	0.58	-0.33	0.31	0.23	1.82
WGI_PV	-0.52	-0.52	-0.40	-0.77	0.10	-0.79	3.65
WGI_RL	-0.37	-0.35	-0.15	-0.60	0.14	-0.35	2.27
WGI_RQ	0.01	-0.01	0.30	-0.31	0.19	0.04	1.99
WGI_VA	0.12	0.14	0.18	-0.01	0.06	-1.11	3.18
GDPG	4.61	5.05	6.17	-2.07	2.09	-2.75	9.42
FDI	1.99	2.02	2.82	0.49	0.57	-1.23	4.89
LF	131.28	130.94	141.35	120.65	6.82	-0.03	1.63

Note: GII is measured on a 0–100 scale; WGI on a -2.5 to +2.5 scale; GDPG and FDI are expressed as percentages; and LF is measured in millions of persons.

Normality Test

The normality test evaluates whether the residuals of a regression model follow a normal distribution, an essential condition for ensuring valid statistical inference. In this study, the Jarque-Bera test [46] was applied to assess residual normality across the seven estimated models. As presented in Figure 4, the results show that all models satisfy the normality assumption, with the probability values of the Jarque-Bera statistics exceeding the 0.05 significance threshold. This indicates that the residuals are normally distributed and that the models are statistically sound with respect to this diagnostic.



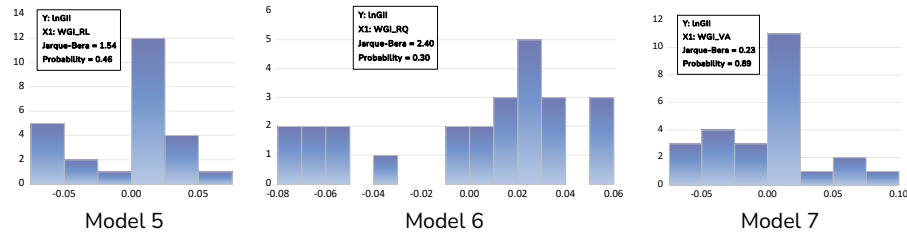


Figure 4. Results of Jarque-Bera normality test.

Regression Equation Specification Error Test (RESET)

The RESET, proposed by Ramsey [47], is used to detect whether a regression model suffers from functional-form misspecification, such as omitted nonlinear terms or incorrect structural specification. As shown in Table 3, all seven models yield probability values above the 0.05 threshold, meaning the null hypothesis of correct specification cannot be rejected. This indicates that none of the models show statistical evidence of misspecification and that the functional forms employed are appropriate.

Table 3. Results of Ramsey RESET.

Model	F-stat.	Prob.
Model 1: $\ln GII = f(WGI, GDPG, FDI, LF)$	1.7266	0.2045
Model 2: $\ln GII = f(WGI_{CC}, GDPG, FDI, LF)$	0.8543	0.3669
Model 3: $\ln GII = f(WGI_{GE}, GDPG, FDI, LF)$	0.2679	0.6107
Model 4: $\ln GII = f(WGI_{PV}, GDPG, FDI, LF)$	0.4430	0.5137
Model 5: $\ln GII = f(WGI_{RL}, GDPG, FDI, LF)$	0.9643	0.3384
Model 6: $\ln GII = f(WGI_{RQ}, GDPG, FDI, LF)$	0.0170	0.8975
Model 7: $\ln GII = f(WGI_{VA}, GDPG, FDI, LF)$	0.4169	0.5262

Note: A probability value above 0.05 indicates that the model is correctly specified.

GI-GLMs Estimation

The GI-GLMs results in Table 4 show that overall governance quality (WGI) has a positive and statistically significant effect on lnGII, indicating that stronger governance enhances innovation capability. For WGI, a 0.1-score improvement increases GII by approximately 5.18 percent. Delving into each WGI dimension separately, control of corruption (WGI_CC) also exhibits a positive and statistically significant effect, implying that better corruption control supports innovation, with a 0.1-score improvement raising GII by about 1.98 percent. Government effectiveness (WGI_GE) shows a negative and statistically insignificant effect, meaning it does not exhibit a meaningful association with innovation capability. Political stability and absence of violence/terrorism (WGI_PV) demonstrates a positive and highly significant influence, suggesting that more stable political conditions facilitate innovation, where a 0.1-score improvement increases GII by around 4.87 percent. Rule of law (WGI_RL) likewise shows a positive and statistically significant impact, indicating that stronger legal institutions promote innovation, with a 0.1-score increase raising GII by approximately 3.11 percent. Regulatory quality (WGI_RQ) has a positive but statistically insignificant coefficient, showing no reliable effect on innovation. Voice and accountability (WGI_VA) displays a positive and statistically significant effect, meaning that more participatory and transparent governance environments enhance innovation capability, with a 0.1-score improvement leading to about a 4.95 percent increase in GII.

Across all seven models, the control variables exhibit consistent and economically meaningful patterns. GDP growth (GDPG) shows a positive and statistically significant association with lnGII in every specification, indicating that stronger economic expansion supports innovation performance. With coefficients ranging from 0.0097 to 0.0172, a 1 percent increase in GDP growth raises GII by approximately 0.97 to 1.72 percent, reflecting the role of expanding economic activity in facilitating greater investment in innovation inputs and outputs. Foreign

direct investment (FDI) inflows also display positive and statistically significant effects across all models, suggesting that higher FDI inflows enhance innovation through technology transfer and knowledge spillovers. With coefficient values between 0.0291 and 0.0509, a 1 percent increase in FDI inflows (as a share of GDP) increases GII by about 2.91 to 5.09 percent. Meanwhile, the labor force (LnLF) generally shows negative and mostly insignificant coefficients. The insignificance of LnLF in most models indicates that the size of the labor force alone does not strengthen innovation capacity, underscoring the greater importance of workforce quality rather than quantity.

Lastly, the LR statistics across all seven models, which range from 11.410 to 77.298 with p-values below 0.05, indicate that the independent variables are jointly significant, meaning the full models provide a significantly better fit than their respective restricted models in explaining the variation in GII. This result suggests that the selected independent variables are appropriate and contribute meaningfully to the model specification.

Table 4. Results of the GI-GLMs estimation.

<i>Dependent Variable: lnGII</i>							
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
WGI	0.5181 (2.67)***						
WGI_CC		0.1979 (1.90)*					
WGI_GE			-0.0795 (-0.75)				
WGI_PV				0.4866 (6.51)***			
WGI_RL					0.3113 (2.16)**		
WGI_RQ						0.0504 (0.38)	
WGI_VA							0.4945 (2.43)**
GDPG	0.0141 (2.85)***	0.0132 (2.48)**	0.0139 (2.43)**	0.0172 (5.19)***	0.0097 (1.76)*	0.0147 (2.42)**	0.0120 (2.34)**
FDI	0.0435 (2.33)**	0.0432 (2.11)**	0.0291 (1.42)	0.0509 (4.16)***	0.0362 (1.91)*	0.0292 (1.41)	0.0416 (2.20)**
lnLF	-1.1659 (-2.41)**	-0.3180 (-1.15)	0.4525 (0.71)	-0.2096 (-1.52)	-0.7299 (-1.82)*	-0.1458 (-0.32)	-0.2363 (-1.03)
C	25.112 (2.77)***	9.2705 (1.78)*	-5.2018 (-0.43)	7.3646 (2.84)***	17.013 (2.25)**	5.9720 (0.69)	7.5916 (1.76)*
LR Stat.	22.296***	16.804***	12.049**	77.298***	18.484***	11.410**	20.377***
LR Prob.	0.0002	0.0021	0.0170	0.0000	0.0010	0.0223	0.0004

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; Values outside parentheses are coefficients, and values in parentheses are z-statistics.

RLS Estimation

The RLS estimation in Table 5 largely confirms the robustness of the GI-GLMs findings, with several governance dimensions maintaining consistent effects on innovation capability. The composite WGI again shows a positive and statistically significant relationship with lnGII, reinforcing that stronger overall governance reliably enhances innovation outcomes even under robust estimation. Political stability and absence of violence/terrorism (WGI_PV), rule of law (WGI_RL), and voice and accountability (WGI_VA) also remain positive and significant, confirming that their effects are stable and aligned with the GI-GLMs results. In contrast, Control of corruption (WGI_CC), which was significant in the GI-GLMs, becomes statistically insignificant in the RLS framework, indicating that its previously observed effect is not robust to alternative estimation and therefore sensitive to model assumptions or outliers. Government

effectiveness (WGI_GE) and regulatory quality (WGI_RQ) continue to display insignificant effects, confirming the original conclusion that these dimensions do not exert measurable influence on innovation in this context.

Regarding the controls, GDP growth (GDPG) remains positive and significant, with coefficients in RLS estimation ranging from 0.0114 to 0.0172, confirming a robust but modest contribution to innovation performance. FDI also maintains its positive and significant effect, with coefficients in RLS estimation between 0.0282 and 0.0510, showing that inflows in foreign investment consistently supports innovation across methods. Labor force (LnLF) remains insignificant across most RLS specifications, reinforcing the earlier conclusion that labor size does not robustly affect innovation outcomes.

Lastly, the Rn-squared statistics across all seven models, which range from 10.140 to 1171.6 with p-values below 0.05, indicate that the independent variables are jointly significant, meaning they collectively explain a statistically meaningful portion of the variation in the GI under the robust estimation framework.

Table 5. Results of the RLS estimation.

<i>Dependent Variable: GI</i>							
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
WGI	0.5765 (2.53)**						
WGI_CC		0.1950 (1.42)					
WGI_GE			-0.0281 (-0.24)				
WGI_PV				0.4850 (6.14)***			
WGI_RL					0.2659 (15.3)***		
WGI_RQ						-0.0412 (-0.31)	
WGI_VA							0.6194 (2.63)***
GDPG	0.0145 (2.49)**	0.0125 (1.79)*	0.0147 (2.30)**	0.0172 (4.92)***	0.0135 (20.2)***	0.0142 (2.32)**	0.0114 (1.91)*
FDI	0.0433 (1.98)**	0.0401 (1.49)	0.0282 (1.23)	0.0510 (3.94)***	0.0307 (13.3)***	0.0289 (1.38)	0.0365 (1.66)*
LF	-1.2109 (-2.13)**	-0.4130 (-1.14)	-0.0949 (-0.13)	-0.2278 (-1.56)	-0.4258 (-8.76)***	-0.2194 (-0.47)	-0.2090 (-0.78)
C	25.975 (2.44)**	11.054 (1.61)	5.0338 (0.37)	7.7050 (2.81)***	11.326 (12.4)***	7.3650 (0.84)	7.0767 (1.42)
Rn ² Stat.	16.008	10.140	15.547	70.125	1171.6	22.579	14.683
Rn ² Prob.	0.0030	0.0381	0.0037	0.0000	0.0000	0.0002	0.0054

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; Values outside parentheses are coefficients, and values in parentheses are z-statistics.

Discussion

The empirical findings of this study provide compelling evidence that governance quality plays a pivotal role in shaping Indonesia's national innovation capability. Across both estimation of GI-GLMs and RLS methods, governance quality, whether measured in aggregate or through several of its disaggregated dimensions, emerges as a meaningful determinant of innovation performance. These results reinforce the central proposition of institutional economics that strong and credible institutions lower uncertainty, reduce transaction costs, and create an enabling environment for the accumulation and diffusion of knowledge.

The positive and statistically significant effect of the overall WGI on Indonesia's GII score is consistent with the broader cross-country evidence reported by Boudreaux [28], He & Tian [24], and Donges et al. [27], who all emphasize the centrality of institutional conditions in fostering innovative activity. In the Indonesian context, this result aligns with longstanding concerns regarding institutional weaknesses that inhibit the effectiveness of policy instruments designed to stimulate innovation [33]. The present study quantitatively confirms that improvements in Indonesia's overall governance performance translate into measurable gains in national innovation capability.

Decomposing the WGI into its six constituent dimensions yields several important insights. WGI political stability and absence of violence show the most consistent and robust relationship with innovation performance. This finding underscores that innovation thrives in predictable environments where political risks are minimized [48]. For Indonesia, periodic episodes of political uncertainty, policy inconsistency, and security concerns may have imposed constraints on long-term investment in research, technological upgrading, and private-sector innovation initiatives [49]. The strong significance of political stability reinforces the argument that it serves as a foundational precondition for sustained innovation.

WGI rule of law similarly demonstrates a positive and robust effect. This dimension captures the protection of property rights, contract enforcement, and the reliability of judicial institutions, all of which are critical for reducing the risks associated with innovation investment [50]. The Indonesian literature has long highlighted weaknesses in legal enforcement and regulatory predictability as barriers to knowledge production and technology adoption [7]. The present findings indicate that improvements in legal institutional quality could yield substantial benefits for innovation-led development. These results are also consistent with firm-level evidence from international studies showing that strong legal institutions support higher innovation productivity and diffusion [31].

WGI voice and accountability also produce significant coefficients in both estimation approaches, suggesting that participatory governance, freedom of expression, and transparency contribute to innovation capability [51]. This finding is noteworthy because it highlights the role of democratic freedoms in facilitating knowledge creation. Environments that allow open information exchange, critical inquiry, and public scrutiny of policymaking are more conducive to innovation [52]. In Indonesia, where civil liberties and public discourse have faced periodic constraints [42], the positive association between voice and accountability and GII reinforces the argument that innovation ecosystems benefit from transparent and participatory governance structures.

WGI control of corruption is significant under GI-GLM but loses significance under RLS, indicating that its effect is not fully robust. This suggests that corruption may influence innovation performance in Indonesia, but the relationship is sensitive to model assumptions and the presence of outliers. The mixed result may stem from corruption may indirectly affect innovation through channels already captured by political stability or rule of law [53], reducing its independent explanatory power. Furthermore, WGI government effectiveness and WGI regulatory quality display insignificant effects across both models. These findings may reflect the disconnect between policy formulation and implementation in Indonesia's bureaucratic system. Although many innovation-related policies exist, their execution may be hindered by fragmented coordination, bureaucratic inertia, or insufficient capacity, reducing the measurable impact of these dimensions on innovation outcomes [54]. The lack of significance may also indicate that improvements in these dimensions are either too gradual or too recent to produce a measurable effect during the study period.

The control variables behave largely as expected. GDP growth consistently shows a positive effect, suggesting that innovation capability strengthens in tandem with broader

macroeconomic expansion, supporting theories that link resource availability to innovation investment [1]. FDI inflows also exhibit stable positive effects across models, reinforcing international evidence that foreign capital contributes to innovation through knowledge spillovers, managerial expertise, and technology transfer [38]. In contrast, the labor force variable displays negative and mostly insignificant coefficients, indicating that the sheer size of the workforce does not contribute to innovation capability. This result emphasizes that Indonesia's challenge lies in labor quality, such as skills, education, and human capital intensity, rather than labor quantity alone [55].

Overall, the findings demonstrate that Indonesia's innovation performance is highly sensitive to institutional structures, particularly political stability, legal integrity, and participatory governance. These results align with both theoretical expectations and empirical findings from previous studies but also provide new insights by systematically evaluating each WGI dimension. Strengthening these specific institutional areas may therefore be more effective than broad, undifferentiated governance reforms in improving Indonesia's innovation capacity. The results underscore the importance of building a governance environment that reduces uncertainty, enforces legal protections, promotes transparency, and encourages open participation, which are essential conditions for the emergence and sustainability of an innovative economy.

Conclusions

This study concludes that governance quality is a critical driver of Indonesia's national innovation capability, with empirical evidence showing that stronger political stability, more credible legal institutions, and greater voice and accountability consistently enhance the country's GII performance. Although the WGI in its entirety exerts a significant positive effect, only select governance dimensions produce robust impacts, indicating that institutional reforms must prioritize stability, legal certainty, and participatory governance rather than relying solely on broad governance improvements. The positive roles of GDP growth and foreign direct investment highlight the complementary importance of macroeconomic strength and international knowledge spillovers, while the limited relevance of labor force size underscores the need for improving human capital quality. Taken together, the findings highlight that meaningful progress in Indonesia's innovation capability depends on targeted institutional strengthening supported by sustained economic and human capital development.

As the findings indicate that Indonesia's innovation capability is most strongly enhanced by improvements in political stability, rule of law, and voice and accountability, policymakers should therefore prioritize institutional reforms that strengthen credibility, predictability, and transparency in governance. First, to reinforce political stability, the government should institutionalize long-term innovation policies insulated from electoral cycles, strengthen coordination between central and regional authorities, and reduce regulatory volatility by implementing mandatory multi-year regulatory impact assessments before major policy changes. Second, improving the rule of law requires accelerating judicial reforms that focus on enforcing property rights, reducing case-processing delays, and strengthening contract enforcement mechanisms through specialized commercial courts. Third, enhancing voice and accountability demands reforms that expand public access to government data, strengthen whistleblower protections, and widen civic participation in policy formulation through formal consultation platforms, particularly in sectors involving technology, research, and digital innovation. These targeted reforms directly address the institutional dimensions shown to exert the strongest and most robust effects on innovation performance.

In addition to institutional reforms, the results highlight the importance of macroeconomic and structural policies that complement governance improvements. The robust positive impact of GDP growth and FDI suggests that policymakers should enhance innovation-related investment

incentives, such as offering targeted tax credits for R&D activities, strengthening fiscal support for technology-based SMEs, and expanding FDI facilitation measures in high-technology sectors. To ensure that FDI inflows translate into meaningful knowledge spillovers, the government should require foreign investors to engage in local research collaborations, technology transfer agreements, and structured training programs for Indonesian workers. Given the insignificant role of labor force size, policy efforts must shift toward improving human capital quality through investments in STEM education, vocational upskilling, and university–industry innovation partnerships designed to align graduate competencies with technological needs. Collectively, these policies ensure that Indonesia not only strengthens the institutional conditions needed for innovation but also builds the economic, technological, and human resource base required for sustained innovation-driven development.

This study has several limitations that offer opportunities for future research. First, the analysis relies on a relatively short time span of data from 2011 to 2023, constrained by the availability of the GII and WGI. Therefore, future studies should incorporate longer time periods as additional data become available to enhance statistical power and long-term inference. Second, this study examines Indonesia solely as a national time-series unit of analysis, and future research could employ provincial-level panel data to capture spatial heterogeneity in governance and innovation patterns across regions. Third, the empirical approach is limited to static estimations, and subsequent studies should apply dynamic models such as ARDL, VECM, or other cointegration techniques to capture both short-run adjustments and long-run relationships. Finally, the study uses three macroeconomic control variables, namely GDP growth, FDI inflows, and labor force size, while future research should examine additional theoretically relevant determinants, such as human capital quality, R&D expenditure, digital infrastructure, and institutional decentralization, to provide a more comprehensive understanding of the drivers of innovation capability.

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