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Freedom and Prosperity: The Impact of Political Rights and Civil Liberties on Economic Complexity

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Abstract

As governance and economic sophistication become increasingly interconnected, understanding their relationship is crucial for shaping national growth strategies. This study investigates the impact of political rights and civil liberties on Indonesia's economic complexity from 2006 to 2021 by disaggregating the Economic Complexity Index (ECI) into trade, technology, and research components. Indonesia serves as an ideal case study due to its dynamic political landscape, evolving civil liberties, and its strategic role as an emerging economy with untapped potential for economic diversification. While a growing body of literature explores the intersection of political and economic development in Indonesia, no prior study has specifically examined the relationship between the Freedom in the World ratings (as an indicator of political rights and civil liberties) and the distinct dimensions of ECI. The analysis employs Gaussian identity-link Generalized Linear Models (GLMs), with robustness checks using Robust Least Squares, and adopts a decomposition approach that includes a set of control variables such as GDP per capita and FDI inflow. The results across both the main and robustness check methods consistently show that political rights and civil liberties contribute positively to ECI-technology, but negatively affect ECI-trade and have no significant effect on ECI-research. These findings underscore the sector-specific nature of political and democratization influences on economic complexity in Indonesia and imply that they facilitate technological advancement but do not uniformly promote trade or research sophistication.

1. Introduction

Indonesia's economic development trajectory has undergone significant transformation, marked by a gradual shift from a resource-dependent economy to one increasingly oriented toward value-added production and innovation [1]. Since the early 2000s, structural reforms and expanding domestic demand have supported growth in manufacturing, services, and digital sectors, allowing Indonesia to reposition itself within regional and global supply chains [2]. These shifts reflect an evolving policy emphasis on industrial upgrading, technological capacity, and human capital development, intended to move the economy beyond its traditional reliance on extractive and low-complexity industries [3].

However, despite these efforts, the country continues to exhibit relatively low scores on global measures of economic complexity. The Economic Complexity Index (ECI), which assesses a nation's productive capabilities based on the diversity and sophistication of its exports, technological outputs, and research systems [4], consistently ranks Indonesia below its potential, particularly when compared with peer economies in Southeast Asia. According to the latest ECI report [5], Indonesia ranks 65th out of 132 countries in ECI-trade, 61st out of 89 in ECI-technology, and 41st out of 123 in ECI-research. Notably, Indonesia records negative index values in both ECI-trade and ECI-technology, while only ECI-research registers a positive score. This limited progress in economic complexity raises concerns about the sustainability of Indonesia's long-term growth and its ability to transition into a more knowledge-based and innovation-driven economy.

This underperformance is not merely a reflection of market inefficiencies but is also rooted in structural and institutional constraints of the country [6, 7]. A major limitation stems from the persistent dominance of low-technology, extractive, and resource-based sectors, which, while contributing significantly to export revenues, offer few linkages to broader innovation systems or human capital development [8, 9]. These sectors tend to generate limited demand for skilled labor, advanced inputs, or R&D investment, thereby reinforcing a path-dependent growth model centered on primary commodities [10, 11]. In this context, industrial upgrading requires more than sectoral reorientation. It also necessitates a conducive institutional framework that supports knowledge generation, coordination among actors, and long-term investment in complex capabilities [12].

As the Indonesian government intensifies efforts to enhance competitiveness, through education reform, infrastructure investment, and digital transformation [13, 14], greater attention must be given to the political and civil institutional foundations that underpin these initiatives. Political rights and civil liberties, such as electoral participation, transparency, freedom of expression, and access to information [15, 16], may hold a decisive role in shaping the incentives and constraints that guide economic decision-making and innovation. These institutional freedoms are believed to reduce uncertainty, enhance accountability, and foster environments conducive to investment in complex sectors [17, 18]. Yet, despite growing interest in the political determinants of development, the extent to which political rights and civil liberties influence Indonesia's economic complexity has received limited empirical scrutiny.

The theoretical foundation for linking political institutions and economic complexity draws from institutional economics, which posits that well-functioning democratic institutions provide policy stability, reduce transaction costs, and support long-term investment in innovation [19, 20]. Political rights, such as electoral participation, pluralism, and executive constraints, create conditions of accountability and transparency that enhance investor confidence and institutional coordination [21]. Similarly, civil liberties, such as freedom of speech, academic independence, and association, are critical for knowledge diffusion, creativity, and research collaboration, all of which underpin the production of complex goods and services [22, 23]. These institutional factors not only influence economic outcomes in general but may also exert differential effects across dimensions of complexity, such as trade structure, technological capability, and research output.

Building on this theoretical foundation, recent empirical studies provide robust evidence that political rights and civil liberties influence economic performance. Kabir & Alam [24], examining 115 countries, find that improvements in democracy, measured by indices of political rights and civil liberties, lead to increases in GDP per capita, highlighting the economic returns to institutional openness. Similarly, Ahmed & Ahmad [25], using panel data from 34 Asian countries, demonstrate that both political rights and civil liberties have statistically significant positive effects on economic growth, confirming the role of democratic governance in development. Complementing these findings, Nisticò [26] analyzes cross-country data from 1870 to 2010 and shows that democracy has a significant positive impact on income per capita, particularly in the post-1990 period. Mousseau & Mousseau [27], analyzing most countries from 1961 to 2019, reveal that stronger civil liberties emerge from economic norms favoring contracts and exchange, suggesting a reinforcing relationship between economic systems and democratic freedoms. Lastly, Chen et al. [28], using advanced panel estimators to re-evaluate the democracy–growth link, find that the long-term economic benefits of democracy are even greater than previously estimated. Together, some of these studies substantiate the claim that democratic institutions, through the protection of political rights and civil liberties, are integral to sustained economic development.

Specific studies have examined the relationships between political freedom and civil liberties and the economic dimensions of trade, technology, and research. For example, Boungou et al. [29] found that higher democracy scores promote intra-African goods trade. Tabellini & Magistretti [30] reported that economic openness, particularly toward democratic partners, correlates with the spread of democratic governance, suggesting that democratic integration fosters both trade and democratization. Wang et al. [31] found that democracy has a positive and significant association with innovation performance. Yang & Liu [32] observed that countries with higher levels of democracy demonstrate greater scholarly productivity and impact, evidenced by larger research outputs with higher citation rates and H-indices. Whetsell et al. [33] showed that democratic governance positively correlates with higher scientific performance, especially when interacting with economic complexity, globalization, and international collaboration. Collectively, these studies provide empirical evidence that political freedom and civil liberties influence a country's complexity in terms of trade, technology, and research.

Despite this growing global evidence, the Indonesian literature has yet to fully explore the specific institutional drivers of economic complexity. While several studies have examined the nexus between political development and macroeconomic outcomes, they predominantly focus on general indicators such as democratic indices [34, 35] and corruption perception [36–39]. Few have attempted to disaggregate economic outcomes into complexity dimensions, and to date, no empirical study has explicitly employed the Freedom in the World (FIW) rating [40], a globally recognized index of political rights and civil liberties, to examine their distinct effects on economic complexity. Compared to other measures such as the Human Rights Index or governance-based indicators, the FIW offers broader coverage, annual updates, and consistent cross-country comparability, making it particularly suitable for assessing institutional freedoms over time. This leaves a critical gap in the empirical understanding of how institutional freedoms shape the specific pathways of economic upgrading in Indonesia, particularly in trade, technology, and research.

This study aims to fill that gap by empirically analyzing the impact of political rights and civil liberties, as measured by the Freedom in the World rating, on Indonesia's economic complexity from 2006 to 2021. By disaggregating the ECI into trade, technology, and research components, and employing both Gaussian identity-link generalized linear models and robust least squares estimations, this paper offers a comprehensive and statistically rigorous assessment of the institutional determinants of complexity. The contribution of this study lies in its sector-specific approach to economic complexity, its integration of internationally standardized freedom indicators, and its policy relevance for emerging democracies navigating the trade-offs between institutional openness and structural transformation.

2. Methodology

2.1. Data and Variable

The time-series data used in this study begins in 2006, as this is the earliest year for which Freedom in the World (FIW) data is available, and extends to 2021, the latest year for which Economic Complexity Index (ECI) of Technology data is available. As can be seen in Table 1, a total of seven variables are employed: three indicators from ECI serve as the dependent variable, two indicators from FIW serve as the main independent variable, and two additional macroeconomic factors serve as control variables. The ECI data is sourced from the Observatory of Economic Complexity [5], the FIW data from Freedom House [40], and GDP per capita and FDI inflow from the World Bank's World Development Indicators [41].

2.2. Conceptual Framework

The conceptual framework guiding this study illustrates the hypothesized relationships between institutional quality, measured through political rights and civil liberties, and economic complexity in Indonesia. Drawing on institutional economics and the literature on democratic governance and development, the model posits that improvements in political and civil freedoms shape the environment in which economic activities evolve, particularly in sectors requiring coordination, innovation, and knowledge generation.

At the core of the framework are two key dimensions of institutional quality, proxied by the Freedom in the World (FIW) rating: political rights (FIW1) and civil liberties (FIW2). Political rights refer to the degree of electoral participation, pluralism, and checks on executive power, while civil liberties encompass freedom of expression, association, and the rule of law [42]. These two elements are posited to influence economic complexity through mechanisms such as policy stability, transparency, accountability, and the facilitation of research collaboration and technological diffusion.

The dependent variables are represented by three disaggregated components of the Economic Complexity Index (ECI): ECI-trade, ECI-technology, and ECI-research.

Table 1. Variable synopsis.

Status	Description	Symbol	Units	Definition
Dependent	Economic Complexity Index (ECI) of Trade	ECI1	Index scale approximately from -2.5 to +2.5	Measures the complexity of a country's exported products, based on their diversity and ubiquity in global trade.
	Economic Complexity Index (ECI) of Technology	ECI2	Index scale approximately from -2.5 to +2.5	Reflects the complexity of a country's technological outputs, typically based on the diversity and ubiquity of patent categories.
	Economic Complexity Index (ECI) of Research	ECI3	Index scale approximately from -2.5 to +2.5	Captures the complexity of a country's scientific research output by assessing the diversity and specialization of published academic fields.
Main Independent	Freedom in the World (FIW) rating of Political Rights	FIW1	Score scale from 0 to 40	The extent of a country's political freedoms, including electoral processes, political pluralism, and participation.
	Freedom in the World (FWI) rating of Civil Liberties	FIW2	Score scale from 0 to 60	The degree of a country's protection of civil freedoms, such as freedom of expression, assembly, religion, and rule of law.
Control Independent	GDP per Capita	GDPC	Constant Rupiah	The average economic output per person, calculated by dividing a country's gross domestic product by its population.
	Foreign Direct Investment Inflow	FDI	Percent of GDP	The value of foreign direct investment entering a country, reflecting external investment in domestic business assets and operations.

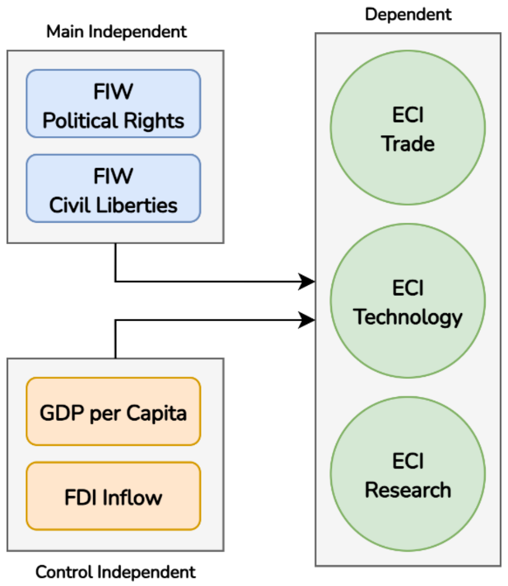

Figure 1. Conceptual framework of the study.

These dimensions capture the diversity and sophistication of a country's productive and innovative capabilities across tradeable goods, patented technologies, and scientific outputs [4]. Disaggregating ECI enables a sector-specific analysis of how institutional variables influence different pathways of structural transformation.

Additionally, two macroeconomic factors are included as control variables to isolate the institutional effects: GDP per capita, which reflects the general level of economic development [43–45], and foreign direct investment (FDI) inflow, which serves as a proxy for international capital integration and sectoral modernization [46–48]. These variables are expected to influence economic complexity independently, by expanding the resources and knowledge available for industrial upgrading.

The framework, as visualized in Figure 1, thus captures the direct institutional effects of political rights and civil liberties, and the background macroeconomic influences that shape Indonesia's structural economic transformation. This configuration allows for a rigorous empirical investigation of how democratic institutions intersect with developmental outcomes, particularly within an emerging economy navigating the transition toward innovation-driven growth. Based on this framework, the study hypothesizes that the FIW measures of political rights and civil liberties, along with GDP per capita and FDI inflows, have a positive and significant impact on all three ECI dimensions, namely trade, technology, and research.

2.3. Model Specification

The focus of the econometric analysis in this study is to examine how the two components of the FWI influence the three dimensions of the ECI by estimating separate models for each relationship. A consistent set of control variables, namely GDP per capita and FDI inflows, is included across models. The estimation uses annual data converted into semi-annual frequency to comply with the rule of thumb sample size for regression models with three independent variables. This rule of thumb suggests

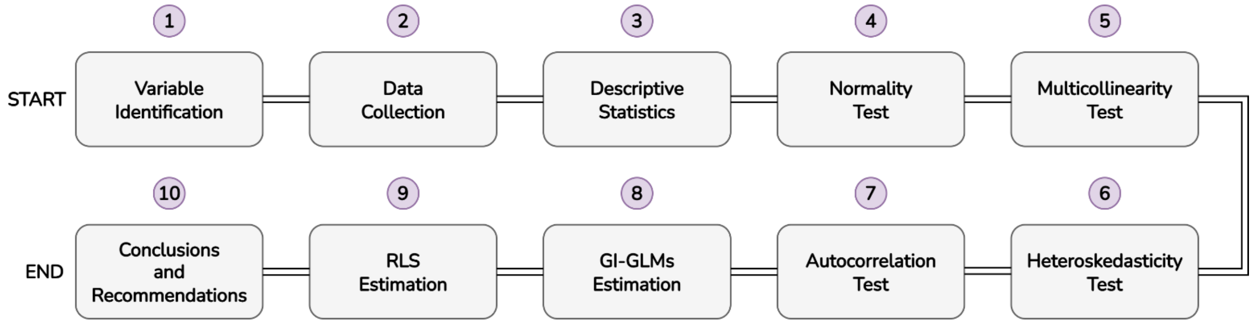

Figure 2. Flow analysis of the study.

that, to obtain reliable estimates and avoid overfitting, the sample should include about 10 observations for each independent variable in the model [49]. Given the relatively short time span of available data for this study, increasing the number of observations by converting to semi-annual frequency helps to satisfy this criterion and enhance the robustness of the regression results. The mathematical representation of this relationship is provided in Equation 1.

$$ECI = f(FWI, GDPC, FDI) \quad (1)$$

Where ECI represents economic complexity index of trade, technology, and research, FWI represents freedom in the world index of political rights and civil liberties, $GDPC$ represents gross domestic product per capita, and FDI represents foreign direct investment inflow.

Based on the function shown in Equation 1, the econometric models of the study are presented in Equations 2-7.

$$ECI1_t = \beta_{01} + \beta_{11}PR_t + \beta_{21}lnGDPC_t + \beta_{31}FDI_t + \varepsilon_t \quad (2)$$
$$ECI2_t = \beta_{02} + \beta_{12}PR_t + \beta_{22}lnGDPC_t + \beta_{32}FDI_t + \varepsilon_t \quad (3)$$
$$ECI3_t = \beta_{03} + \beta_{13}PR_t + \beta_{23}lnGDPC_t + \beta_{33}FDI_t + \varepsilon_t \quad (4)$$
$$ECI1_t = \beta_{04} + \beta_{14}CL_t + \beta_{24}lnGDPC_t + \beta_{34}FDI_t + \varepsilon_t \quad (5)$$
$$ECI2_t = \beta_{05} + \beta_{15}CL_t + \beta_{25}lnGDPC_t + \beta_{35}FDI_t + \varepsilon_t \quad (6)$$
$$ECI3_t = \beta_{06} + \beta_{16}CL_t + \beta_{26}lnGDPC_t + \beta_{36}FDI_t + \varepsilon_t \quad (7)$$

Here, $ECI1$ represents economic complexity index of trade, $ECI2$ represents economic complexity index of technology, $ECI3$ represents economic complexity index of research, $FWI1$ represents freedom of the world index of political rights, $FWI2$ represents freedom of the world index of civil liberties, $lnGDPC$ represents GDP per capita in natural logarithmic form, FDI represents foreign direct investment inflow, t represents the study period, $\beta_{01} - \beta_{06}$ represent the intercepts, $\beta_{11} - \beta_{36}$ represent the coefficients, and ε is the error term.

GDPC is transformed using the natural logarithm (ln) to account for its large scale in constant local currency units (Indonesian Rupiah), which differs significantly in magnitude from the other variables. This transformation helps normalize the scale across variables and improves interpretability.

2.4. Methods

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

GI-GLMs are a subclass of Generalized Linear Models appropriate for continuous dependent variables that follow a normal distribution. The identity link function implies that the expected value of the dependent variable is modeled as a linear combination of the predictors [50, 51]. This makes GI-GLMs particularly suitable for this study, as the ECI indicators are continuous and approximately normally distributed across period. Moreover, GI-GLMs allow for greater modeling flexibility compared to ordinary least squares (OLS), particularly in the presence of non-constant error variance, which is often a concern in macroeconomic time series data. While the structure of GI-GLMs is similar to linear regression, they are estimated through maximum likelihood rather than least squares, providing more efficient and statistically robust inference when standard OLS assumptions are not fully satisfied [52]. Thus, GI-GLMs offer a more general and resilient estimation framework, making them well-suited for examining the nuanced relationships between institutional variables and economic complexity.

2.4.2. Robust Least Squares (RLS)

Robust Least Squares (RLS) is a statistical method developed to produce dependable estimates in datasets that include outliers or deviate from the classical assumptions of OLS regression. Unlike OLS, which can be highly sensitive to extreme values and potentially distort coefficient estimates, RLS mitigates this issue by using estimation techniques that reduce the influence of outliers, resulting in a more accurate representation of the relationships within the data [53]. A key benefit of RLS is its capacity to generate stable and reliable estimates even when the data does not follow a normal distribution. By applying methods such as M-estimators,

Table 2. Descriptive statistics.

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
ECI1	-0.2413	-0.2700	0.0371	-0.4148	0.1258	0.6318	2.6260
ECI2	-0.1894	-0.1712	-0.0045	-0.5111	0.1476	-0.4575	2.3789
ECI3	-0.2298	-0.2154	0.0098	-0.6531	0.1742	-0.8499	3.2709
PR	30.125	30	31	30	0.3416	2.2678	6.1429
CL	34.063	34.5	37	29	1.9483	-1.2074	4.2251
lnGDPC	17.278	17.296	17.509	16.969	0.1820	-0.2381	1.7351
FDI	1.8838	1.9229	2.8200	0.4874	0.5950	-0.8023	3.3418

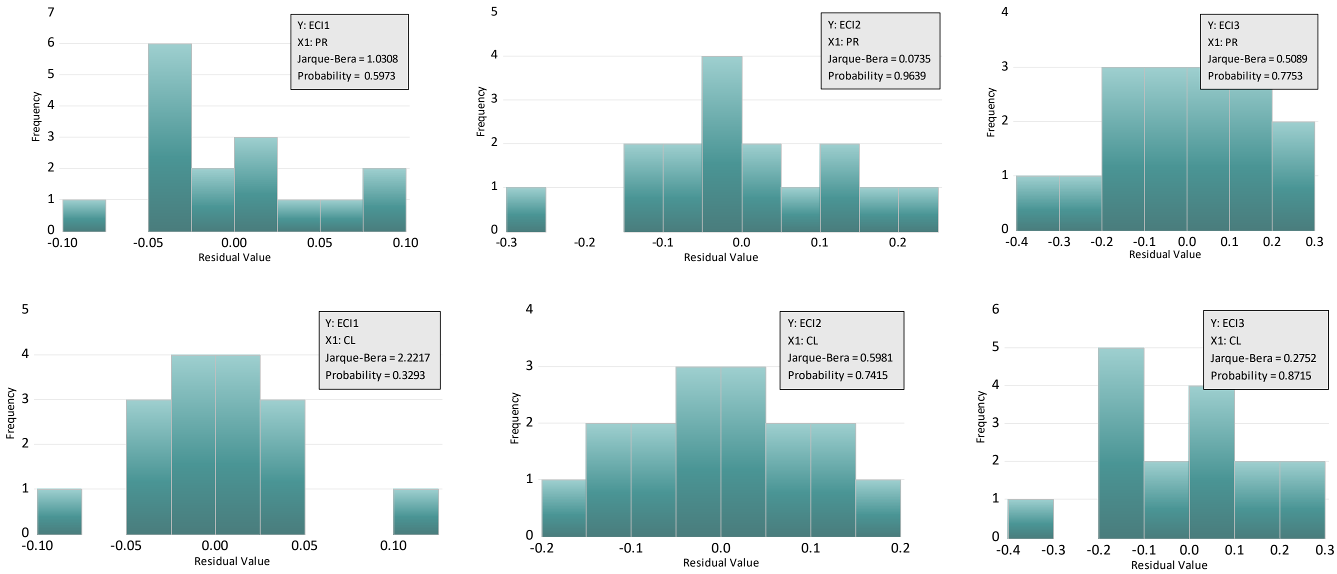

Figure 3. Results of normality test.

Note: A probability value above 0.05 indicates that the residuals are normally distributed.

RLS minimizes an alternative loss function rather than the traditional sum of squared residuals used in OLS. This approach lessens the weight of outliers, enhancing the robustness of the parameter estimates and overall model accuracy [54, 55]. As a result, RLS is well-suited for robustness checks in GI-GLMs, serving as a valuable supplementary method to ensure that the results are not distorted by outliers or assumption violations.

2.5. Flow Analysis

The flow analysis of the study, as depicted in Figure 2, begins with identifying the relevant variables (Step 1) and proceeds with data collection (Step 2). Descriptive statistics are then performed to understand the basic features of the data (Step 3), followed by diagnostic tests, including the normality test (Step 4), multicollinearity test (Step 5), heteroskedasticity test (Step 6), and autocorrelation test (Step 7), to ensure the validity of the regression assumptions. After confirming data adequacy and model assumptions, the core estimation using Gaussian Identity-Link Generalized Linear Models (GI-GLMs) is conducted (Step 8). To verify the robustness of the findings, a Robust Least Squares (RLS) estimation is then employed (Step 9). The study concludes with interpretations, discussion, and policy implications based on the empirical results (Step 10). This structured flow ensures methodological rigor and robustness in deriving conclusions.

3. Results

3.1. Descriptive Statistics

The descriptive statistics in Table 2 provide an overview of the central tendency and distributional characteristics of the variables used in the time-series dataset for Indonesia. For the three dependent variables representing economic complexity, ECI1 (trade), ECI2 (technology), and ECI3 (research), the mean values are all negative. This indicates that Indonesia's complexity scores generally fall below the global average (centered at zero) across the observed time period. Among these, ECI3 (research) records both the lowest minimum value (−0.6531) and the highest skewness (−0.8499), suggesting a left-skewed distribution with several observations concentrated near the higher end of the scale. The standard deviations for all ECI variables are relatively low, indicating limited variability over time, with ECI3 being the most volatile (Std. Dev. = 0.1742). Skewness and kurtosis

Table 3. Results of correlation matrix and VIF test.

Independent Variable	Pairwise Correlation				Centered VIF
	PR	CL	lnGDPC	FDI	
PR	1				1.8102
CL	-0.0125	1			3.0635
lnGDPC	0.2819	-0.7649	1		3.7820
FDI	-0.4136	-0.0744	0.1946	1	1.5665

Note: A correlation value below 0.8 and a centered VIF value below 10 indicate no high multicollinearity.

Table 4. Results of Breusch-Pagan-Godfrey heteroskedasticity test.

Model	**F-stat.** (Prob.)	**Obs. × R^2** (Prob. Chi^2)	**Scaled Explained Sum of Squares** (Prob. Chi^2)
$ECI1 = f(PR, GDPC, FDI)$	0.9674	0.9544	0.9887
$ECI2 = f(PR, GDPC, FDI)$	0.0869	0.0875	0.3338
$ECI3 = f(PR, GDPC, FDI)$	0.3375	0.2848	0.6565
$ECI1 = f(CL, GDPC, FDI)$	0.5398	0.4674	0.5234
$ECI2 = f(CL, GDPC, FDI)$	0.8259	0.7745	0.9535
$ECI3 = f(CL, GDPC, FDI)$	0.0313	0.0432	0.3252

Note: A probability value above 0.05 indicates no evidence of heteroskedasticity, suggesting homoskedasticity.

Table 5. Results of Breusch-Godfrey serial correlation LM test.

Model	**F-stat.** (Prob.)	**Obs. × R^2** (Prob. Chi^2)
$ECI1 = f(PR, GDPC, FDI)$	0.4659	0.3744
$ECI2 = f(PR, GDPC, FDI)$	0.7282	0.6689
$ECI3 = f(PR, GDPC, FDI)$	0.0602	0.0327
$ECI1 = f(CL, GDPC, FDI)$	0.4796	0.3887
$ECI2 = f(CL, GDPC, FDI)$	0.8438	0.8081
$ECI3 = f(CL, GDPC, FDI)$	0.1323	0.0783

Note: A probability value above 0.05 indicates no evidence of autocorrelation.

values point to moderate asymmetry and deviations from normality, although not to an extreme degree.

For the main independent variables, political rights (PR) and civil liberties (CL), the mean values are 30.125 and 34.063, respectively, based on a scale likely ranging from 0 to 40. PR exhibits very low variation (Std. Dev. = 0.3416), reflecting consistency in Indonesia's political rights scores over time. It is positively skewed (2.2678), indicating a clustering of values at the lower end of the range. In contrast, CL is negatively skewed (−1.2074), implying more frequent observations at the higher end of the distribution. Both variables exhibit high kurtosis, especially PR (6.1429), indicating distributions that are sharply peaked with heavier tails.

The control variables, lnGDPC and FDI, show moderate dispersion and mild asymmetry. lnGDPC exhibits the lowest kurtosis (1.7351), implying a relatively flat distribution over time. FDI, on the other hand, displays notable left skewness (−0.8023) and moderate kurtosis (3.3418), indicating a concentration of years with lower FDI inflows and a few instances of exceptionally high values. Overall, the data displays sufficient temporal variation and distributional asymmetry to support the use of further econometric modeling.

3.2. Diagnostic Tests

3.2.1. Normality Test

The normality test is conducted to assess whether the residuals of a regression model follow a normal distribution, which is an important assumption for ensuring valid statistical inference. In this study, the Jarque-Bera test [56] was used to evaluate the normality of residuals across the six estimated models. As shown in Figure 3, the results confirm that all six models have normally distributed residuals, as indicated by the probability values of the Jarque-Bera statistics being above the 0.05 significance level. This suggests that the assumption of normality is not violated and the models are statistically reliable in this regard.

3.2.2. Multicollinearity Test

The multicollinearity test is performed to determine whether there is a high correlation among independent variables, which can distort the estimation of regression coefficients and weaken the statistical power of the model. In this analysis, the Pearson correlation matrix [57] and the centered Variance Inflation Factor (VIF) [58] were used as diagnostic tools. The results in Table 3 show that all Pearson correlation values are below the threshold of 0.8, and all centered VIF values are below 10.

Table 6. Results of GI-GLMs estimation for the main independent variable PR.

Variable	Coef.	Std. Er.	z-stat.	Prob.
Dependent: ECI1				
PR	-0.1101***	0.0327	-3.3678	0.0008
lnGDPC	0.6977***	0.0543	12.852	0.0000
FDI	-0.0787***	0.0189	-4.1471	0.0000
Constant	-8.8337***	1.0111	-8.7368	0.0000
Dependent: ECI2				
PR	0.2563***	0.0758	3.3821	0.0007
lnGDPC	-0.0559	0.1260	-0.4437	0.6573
FDI	0.1582***	0.0440	3.5940	0.0003
Constant	-7.2408***	2.3446	-3.0883	0.0020
Dependent: ECI3				
PR	0.0458	0.1146	0.3997	0.6894
lnGDPC	-0.3620*	0.1902	-1.9032	0.0570
FDI	0.0510	0.0665	0.7664	0.4434
Constant	4.5472	3.5423	1.2837	0.1992

Note: *** and * denote significance levels at 1% and 10%, respectively.

These findings indicate that there is no serious multicollinearity present among the independent variables, ensuring the robustness and reliability of the regression estimates.

3.2.3. Heteroscedasticity Test

The heteroskedasticity test aims to detect whether the residuals of a regression model have constant variance, which is essential for ensuring the efficiency and consistency of the estimators. The Breusch-Pagan-Godfrey test [59, 60] was employed to evaluate the presence of heteroskedasticity across the six models. The results in Table 4 show that all models yield probability values above 0.05 for the F-statistic, the Obs. × R^2 (Chi-squared), and the Scaled Explained Sum of Squares (Chi-squared). These outcomes consistently indicate no evidence of heteroskedasticity, suggesting that the residuals are homoscedastic and that the models meet this key classical assumption.

3.2.4. Autocorrelation Test

The autocorrelation test is conducted to check whether residuals from a regression model are serially correlated, which can undermine the efficiency of estimators and the validity of statistical inference. In this study, the Breusch-Godfrey Serial Correlation LM test [60, 61] was applied to all six models. The results in Table 5 generally show no evidence of autocorrelation, as indicated by probability values above 0.05 for both the F-statistic and the Obs. × R^2 (Chi-squared) in most models. Although Model 3 reports a probability value below 0.05 for the Obs. × R^2 statistic, the F-statistic probability remains above 0.05. Given that the F-statistic is more robust in small samples, as in this study, the result suggests that autocorrelation is unlikely to be a significant issue in Model 3. Overall, the assumption of error independence is reasonably upheld across all models.

3.3. GI-GLMs Estimation

3.3.1. GI-GLMs Results of PR's Impact on ECI

Table 6 presents the results of the first three models, estimated using GI-GLMs, to examine the effect of Political Rights (PR) on ECI indicators. The main independent variable of PR shows statistically significant effects on trade and technological complexity, but not on research complexity. For trade complexity (ECI1), the coefficient of -0.1101 suggests that a one-point increase in PR, indicating greater political freedom, is associated with a 0.11-point decrease in trade complexity. This implies that, in Indonesia, with more restricted political rights may achieve higher trade complexity. In contrast, PR has a positive and significant effect on technological complexity (ECI2), with a coefficient of 0.2563, meaning that a one-point improvement in political rights is associated with a 0.26-point increase in technological complexity. This underscores the role of democratic governance in supporting innovation systems and knowledge transfer in Indonesia's technological development.

Among the control variables, GDP per capita (lnGDPC) is positively associated with ECI1, with a coefficient of 0.6977. This means that a one-unit increase in the log of GDP per capita corresponds to a 0.70-point rise in trade complexity, indicating that higher income levels in Indonesia are linked to more diversified and sophisticated export structures. For research complexity (ECI3), lnGDPC is weakly significant at the 10% level, suggesting that its impact is not convincingly significant. Foreign Direct Investment (FDI) inflow shows contrasting effects: a one-percentage-point increase in FDI as a share of GDP is associated with a 0.08-point decline in trade complexity (coefficient = -0.0787), possibly due to the dominance of FDI in low-complexity sectors. Conversely,

Table 7. Results of GI-GLMs estimation for the main independent variable CL.

Variable	Coef.	Std. Er.	z-stat.	Prob.
Dependent: ECI1				
CL	-0.0295***	0.0069	-4.2728	0.0000
lnGDPC	0.3722***	0.0721	5.1625	0.0000
FDI	-0.0376**	0.0148	-2.5320	0.0113
Constant	-5.5967***	1.4333	-3.9049	0.0001
Dependent: ECI2				
CL	0.0807***	0.0138	5.8634	0.0000
lnGDPC	0.8009***	0.1437	5.5716	0.0000
FDI	0.0597**	0.0296	2.0141	0.0440
Constant	-16.888***	2.8574	-5.9103	0.0000
Dependent: ECI3				
CL	-0.0375	0.0253	-1.4817	0.1384
lnGDPC	-0.6359**	0.2647	-2.4027	0.0163
FDI	0.0456	0.0545	0.8362	0.4031
Constant	11.952**	5.2617	2.2715	0.0231

Note: *** and ** denote significance levels at 1% and 5%, respectively.

the same FDI increase is linked to a 0.16-point rise in technological complexity (coefficient = 0.1582), suggesting that foreign capital contributes positively to technological upgrading and sectoral modernization in Indonesia.

3.3.2. GI-GLMs Results of CL's Impact on ECI

The impact of Civil Liberties (CL) on economic complexity, as estimated in three decomposed models using GI-GLMs in Table 7, follows a similar pattern to that of Political Rights (PR), showing statistically significant effects on trade and technological complexity but not on research complexity. For ECI1 (Trade Complexity), CL has a negative and significant coefficient of -0.0295, indicating that a one-point increase in civil liberties is associated with a 0.0295-point decline in trade complexity. This suggests that more restricted civil environments may coincide with more complex trade structures, potentially due to centralized policy coordination or reduced policy fragmentation. In contrast, CL positively influences ECI2 (Technological Complexity), with a coefficient of 0.0807, meaning that a one-point increase in civil liberties contributes to a 0.0807-point rise in technological complexity. This highlights the role of civic freedoms, such as expression, association, and access to information, in supporting innovation ecosystems.

The control variables exhibit consistent and significant effects across the three models, particularly for GDP per capita (lnGDPC). A one-unit increase in lnGDPC is associated with a 0.3722-point rise in ECI1 (Trade Complexity), a 0.8009-point rise in ECI2 (Technological Complexity), and a -0.6359-point change in ECI3 (Research Complexity), all statistically significant. These findings suggest that each one-unit increase in the log of GDP per capita contributes substantially to trade and technological complexity, but corresponds to a considerable decline in research complexity. This inverse relationship may reflect concentration of R&D in limited sectors, or weak linkages between growth and research institutions in Indonesia. Foreign Direct Investment (FDI) shows a positive and statistically significant effect only on ECI2, with a coefficient of 0.0597, meaning that a one-percentage-point increase in FDI inflow is associated with a 0.0597-point rise in technological complexity. FDI has no statistically significant effect on either ECI1 or ECI3, suggesting that while foreign investment contributes to technological upgrading, it does not systematically influence trade or research complexity in the Indonesian context.

3.4. Robustness Check with RLS Estimation

3.4.1. RLS Results of PR's Impact on ECI

The results from the Robust Least Squares (RLS) estimation in Table 8 confirm the core findings of the GI-GLMs with regard to the role of Political Rights (PR) in shaping economic complexity, particularly in trade and technology dimensions. PR exhibits a statistically significant and negative relationship with ECI1 (Trade Complexity), with a coefficient of -0.1014, indicating that a one-point increase in PR (i.e., less political rights) is associated with a 0.1014-point reduction in trade complexity. Conversely, PR has a statistically significant and positive association with ECI2 (Technological Complexity), with a coefficient of 0.1914, meaning that an increase in political rights improves technological complexity. These results are robust and align with the GI-GLM findings, reinforcing the conclusion that political rights play a differentiated role, negatively affecting trade complexity while promoting technological upgrading. The effect of PR on ECI3 (Research Complexity), however, remains statistically insignificant, suggesting that

Table 8. Results of RLS estimation for the main independent variable PR.

Variable	Coef.	Std. Er.	z-stat.	Prob.
Dependent: ECI1				
PR	-0.1014***	0.0348	-2.9132	0.0036
lnGDPC	0.6837***	0.0578	11.821	0.0000
FDI	-0.0741***	0.0202	-3.6639	0.0002
Constant	-8.8623***	1.0772	-8.2274	0.0000
Dependent: ECI2				
PR	0.1914***	0.0739	2.5916	0.0096
lnGDPC	0.0928	0.1227	0.7563	0.4495
FDI	0.1264***	0.0429	2.9472	0.0032
Constant	-7.7789***	2.2841	-3.4056	0.0007
Dependent: ECI3				
PR	0.0274	0.1227	0.2233	0.8233
lnGDPC	-0.2727	0.2041	-1.3360	0.1816
FDI	0.0489	0.0713	0.6858	0.4929
Constant	3.5685	3.8007	0.9389	0.3478

Note: *** denotes significance level at 1%.

Table 9. Results of RLS estimation for the main independent variable CL.

Variable	Coef.	Std. Er.	z-stat.	Prob.
Dependent: ECI1				
CL	-0.0352***	0.0058	-6.0804	0.0000
lnGDPC	0.3864***	0.0605	6.3909	0.0000
FDI	-0.0337***	0.0125	-2.7058	0.0068
Constant	-5.6617***	1.2018	-4.7111	0.0000
Dependent: ECI2				
CL	0.0825***	0.0146	5.6567	0.0000
lnGDPC	0.8259***	0.1523	5.4228	0.0000
FDI	0.0588*	0.0314	1.8736	0.0610
Constant	-17.381***	3.0278	-5.7404	0.0000
Dependent: ECI3				
CL	-0.0492*	0.0252	-1.9500	0.0512
lnGDPC	-0.8187***	0.2633	-3.1094	0.0019
FDI	0.1182**	0.0543	2.1778	0.0294
Constant	15.351***	5.2341	2.9329	0.0034

Note: ***, ** and * denote significance levels at 1%, 5% and 10%, respectively.

research-related complexity is less sensitive to political rights in the Indonesian context.

The control variables also behave consistently with the GI-GLM specification. GDP per capita (lnGDPC) remains positively and significantly associated with ECI1, with a coefficient of 0.6837, indicating that a one-unit increase in the log of income per capita leads to a 0.6837-point increase in trade complexity. This supports the interpretation that economic development continues to be a driver of export sophistication. However, lnGDPC does not significantly influence ECI2 or ECI3 in the RLS model, weakening the robustness of its effects on technological and research complexity. As for FDI, the results mirror earlier patterns: it is significantly negative for ECI1 (coefficient = -0.0741) and significantly positive for ECI2 (coefficient = 0.1264), implying that FDI may constrain trade complexity while contributing positively to technological complexity. Its effect on ECI3 remains insignificant. Overall, the RLS estimation provides further evidence that the relationships found in the GI-GLMs are stable, strengthening the validity of the main conclusions.

3.4.2. RLS Results of CL's Impact on ECI

The RLS estimation results in Table 9 support and reinforce the main findings obtained from the GI-GLMs regarding the role of Civil Liberties (CL) in shaping economic complexity in Indonesia. CL exhibits statistically significant and differentiated effects across the three dimensions of economic complexity. For ECI1 (Trade Complexity), the coefficient for CL is -0.0352 and significant at the 1% level, indicating that better civil liberties (lower CL score) are associated with higher trade complexity, consistent with the GI-GLM findings. For ECI2 (Technological Complexity), CL is also positive and highly significant (coefficient = 0.0825), reaffirming the strong association between civil liberties and technological sophistication. Notably, the negative association between CL and ECI3 (Research Complexity) becomes statistically significant in the RLS model, but only at the 10% level, making it less convincing to conclude a meaningful impact. Nevertheless, this finding suggests that greater civil liberties may, in the Indonesian context, be associated with reduced research complexity, possibly reflecting limited absorptive capacity or a disconnect between democratic openness and the national innovation system.

The control variables in the RLS estimation show robust and consistent effects across the three complexity dimensions, generally confirming the GI-GLM findings. GDP per capita (lnGDPC) remains a strong and statistically significant driver for both ECI1 and ECI2, with coefficients of 0.3864 and 0.8259, respectively, indicating that income growth in Indonesia is associated with increases in trade and technological complexity. In ECI3, lnGDPC has a negative and significant effect (-0.8187), again confirming the inverse relationship between income level and research complexity found previously. FDI also demonstrates consistent patterns which shows a negative and significant effect on ECI1 (-0.0337), a positive effect on ECI2 (0.0588, significant at 10%), and a positive and significant association with ECI3 (0.1182), which was not significant in the GI-GLM. This suggests that foreign investment may contribute to advancing both technological and research complexity, although it might constrain trade complexity due to enclave effects or sectoral concentration.

4. Discussion

4.1. Political Rights Impact on Economic Complexity

The results reveal a differentiated influence of political rights across the three components of economic complexity. In the trade dimension, political rights shows a negative and statistically significant effect. This implies that where political rights are stronger, such as greater electoral freedom and political participation, there tends to be a reduction in trade-related economic complexity. This finding may seem counterintuitive at first but becomes plausible when considering the structural composition of Indonesia's exports, which are still heavily reliant on primary commodities, low-complexity manufactured goods, and resource-based sectors [8, 9]. Previous studies, such as Khodaverdian [62] and Gerring et al. [63], have reported similar evidence, suggesting that in more politically open environments, regulatory frameworks and public oversight may become more stringent, discouraging extractive or low-complexity industries due to increasing transparency demands and accountability pressures.

In contrast, political rights have a positive and significant impact on technological complexity, aligning with previous studies such as Wang et al. [31] and Okada & Samreth [64]. This reinforces the idea that democratic political institutions provide a favorable environment for the development of more sophisticated and innovation-driven economic activities [65]. Political rights contribute to the predictability of policies, institutional trust, and protection of investor and intellectual property rights, all of which are essential for stimulating technological progress [66]. In the Indonesian context, stronger political rights may attract more private investment in high-tech sectors, foster collaboration between government and industry, and provide a more enabling environment for the growth of technological clusters [67]. This effect remains robust even when controlling for GDP per capita and FDI, suggesting that political institutions themselves hold an independent role in advancing technological sophistication.

However, for the research dimension, political rights does not exhibit a statistically significant effect. This may indicate that while political rights are necessary for creating an open and participatory policy environment, they are not sufficient on their own to drive advancements in research-related complexity [68]. The development of research capacity often depends on long-term investments in education, research infrastructure, funding mechanisms, and institutional coordination, areas where Indonesia still faces considerable challenges [64]. In this case, the absence of a political rights effect might reflect the limited responsiveness of research systems to political conditions, or a lagged effect that requires a longer time horizon to materialize in measurable outcomes.

4.2. Civil Liberties Impact on Economic Complexity

Civil liberties show a similar sector-specific influence on economic complexity, with results paralleling those observed for political rights. The estimation results indicate a negative and significant relationship between civil liberties and trade complexity, suggesting that stronger protections for individual freedoms, such as freedom of expression, association, and press, may be associated with lower complexity in the trade sector. As with political rights, this may reflect institutional and societal pressures that emerge in freer civil environments [62]. Civil liberties tend to strengthen the role of non-governmental organizations, media, and public scrutiny, which may result in more stringent social and environmental oversight of trade-related industries [63]. In Indonesia, such dynamics could impose higher compliance costs on low-complexity, resource-intensive exporters, potentially leading to a contraction in their dominance and a temporary decline in trade complexity [11].

On the other hand, the positive and significant association between civil liberties and technological complexity underscores the vital role that open civic space holds in fostering innovation. With similar findings from such as Knutsen [43] and Wang et al. [31], civil liberties ensure the free flow of information and public debate, conditions that are conducive to collaboration and knowledge creation. In the Indonesian setting, this could translate into higher levels of entrepreneurial activity and increased international collaboration, particularly in areas such as digital technology, renewable energy, and telecommunications [69, 70]. The consistency of this effect across both GI-GLMs and RLS methods further suggests that civil liberties are not only symbolically important but substantively influential in promoting technologically complex production structures.

Meanwhile, similar to political rights, civil liberties do not have a statistically significant impact on research complexity. This points to the fact that while civil freedoms can facilitate broader social and intellectual engagement, the mechanisms that drive research complexity are likely to be more institutionalized and policy-dependent [71]. Factors such as national research agendas, public and private R&D investment, higher education quality, and collaboration with global research networks may hold more decisive roles [72–74]. In Indonesia, the research ecosystem may still face developmental and structural challenges, which could limit the extent to which civil liberties translate into observable research outputs [75].

5. Conclusions and Recommendations

This study investigates the impact of political rights and civil liberties on Indonesia's economic complexity across three dimensions: trade, technology, and research. The findings show that both political rights and civil liberties have a negative and significant effect on trade complexity, a positive and significant effect on technological complexity, and no significant effect on research complexity. These results are consistent across both the main method and the robustness check. This suggests that while institutional openness may place pressure on traditional, low-complexity sectors, it simultaneously creates an environment that fosters innovation and technological development. However, the lack of impact on research-related complexity implies that improvements in political and civil freedoms alone are insufficient to advance research capacity without deeper structural reforms. Overall, institutional quality in Indonesia assumes a differentiated role by constraining traditional trade dynamics while enabling technological upgrading, highlighting the need for tailored, sector-specific governance approaches to support structural transformation.

Based on these findings, Indonesian policymakers should adopt a strategy that balances institutional reform with targeted sectoral support. First, in the trade sector, the government should anticipate the institutional pressures arising from political openness by gradually shifting away from reliance on extractive and low-complexity exports. This can be done by expanding export incentives for higher-value-added goods, particularly in agro-processing, light manufacturing, and green technology components. Second, to sustain the positive link between institutional freedoms and technological complexity, the state should strengthen digital infrastructure, improve policy certainty for startups, and incentivize private R&D investment, especially in regions with vibrant political participation. Third, given the stagnation in research complexity, the government must initiate long-term reforms to Indonesia's research ecosystem. This includes increasing public R&D spending, integrating university–industry collaboration through tax incentives, and strengthening national research priorities in line with industrial policy. These steps will ensure that institutional reforms not only promote democratic values but also strategically contribute to Indonesia's transition toward a more innovation-driven and diversified economy.

Despite providing valuable evidence on the relationship between political rights, civil liberties, and economic complexity, this study's focus on a single country limits the generalizability of its findings, as the results may not reflect variations in different political or economic contexts. Future research should expand to a multi-country analysis to test the consistency of these relationships across diverse settings. The analysis also relies on static methods, namely Generalized Linear Models (GLM) and Robust Least Squares, which do not capture dynamic relationships over time. Future studies should apply dynamic techniques, such as the Autoregressive Distributed Lag (ARDL) model, to explore both short- and long-term effects. In addition, the study includes only two control variables, economic growth and FDI, which may not fully capture other relevant factors influencing economic complexity within the scope of political freedom and civil liberties. Future research should incorporate additional controls such as human capital, institutional quality, or trade openness to provide a more comprehensive analysis.

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