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Research Article

The Role of Youth in Political Regime: Observations from the GYPI Dataset in the Machine Learning Context

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Abstract
Among the features in the Global Youth Participation Index dataset (2025), the key variable explaining YDI (Youth Development Index) is GDP, while GDP ranks 13th in relative influence on the Political Regime Score and 11th in predicting GYPI. The key difference between YDI and GYPI is that, as expected, the former is mainly determined by socio-economic factors, while the latter by political and electoral environments. The GYPI score is the 1st-ranked feature for predicting the Political Regime Score and the 5th-ranked variable for classifying the Political Regime. Combining these variables with high rankings, youth participation in requesting improvements to the voting environment tends to align with a shift in the Political Regime Class, a key finding of this study. RF (Random Forest) and SVM (Support Vector Machine) Classification outperformed the other 6 classification methods in predicting the Political Regime Class. The variables with high feature importance in Gradient Boost Regression are plotted in a PCA Biplot to observe the overall correlation structures.
Keywords: GYPI (Global Youth Participation Index), YDI (Youth Development Index), Political Regime Score, Political Regime Class, Gradient Boost Regression, Support Vector Machine, Feature Importance.

1. Introduction

YDI emphasizes overall youth development across dimensions like education, health, employment, and civic participation. Developed by the Commonwealth Secretariat, it targets holistic human development for ages 15-29. The GPYI[1] is an Index that scores 141 countries on the extent to which they respect young people's political rights, civil liberties, and economic needs, enabling youth to fully participate in political, civic, and economic life [1]. In the final report of GYPI 2025, youth are defined as young people aged 15-30. YDI is used as a supplementary index for deriving GYPI scores in the GYPI 2025 dataset.

All the variables, dimensions, and the overall GYPI are scored 0 to 100 [1]. Higher scores, i.e., those closer to 100, mean that young people are better able to enjoy a politically active and engaged life [1]. It is therefore in those countries and dimensions that have lower scores that the need for reform is most pressing. The average GYPI score across all countries is just 59.40 [1]. The maximum GYPI score is 84.18 (Norway), and the lowest is 14.31 (Afghanistan) [1].

The four dimensions of the GYPI are important because each addresses a different aspect of young people's lived reality [1]. Every dimension includes variables that provide insights into the context for youth participation and the extent to which all young people can participate (Figure 1). This means that, where possible, the additional barriers young people may face due to their gender, sexuality, faith, and ethnicity are taken into account [1].

[1]https://gypi.epd.eu/dataset

Socio-Economic Dimension:[2]
• Primary School Completion Rate • Not in Education, Employment or Training (NEET) Rate for Youth • Not in Education, Employment or Training (NEET) Rate for Female Youth • Proportion of Youth Seeking Work Who Are Employed • Educational Equality • Absence of Early Marriage

Civic Space Dimension:[3]
• Percent of Youth who Signed a Petition • Core Civil Society Index (strength of civil society) • Level of Civil Society Repression • Level of Government Efforts to Censor the Internet • Internet Access • Internet Access in Secondary Schools • Freedom of Peaceful Assembly • Freedom of Religion • Use of Social Media by Political Elites • Access to Online Governance • Acceptance of Gays and Lesbians

Political Affairs Dimension:[4]
• Age Requirements for Candidates to the Legislature • Presence of a National Youth Policy • Presence of a Youth Quota • Presence of a Youth Party Association (often called 'sections' or 'wings') • Representation of Young People in the Legislature • Representation of Disadvantaged Social Groups in the Legislature • Access to State Jobs by Class • Access to State Jobs by Gender • Trust in Political Parties • Quality of Freedom of Expression • Quality of Political Rights

Election Dimension:[5]
• Voting Age • Youth Turnout in National Elections • Extent of Free and Fair Elections • Accessibility of the Voting Process (composed of ten further variables)

Figure 1 illustrates the four dimensions that compose GYPI scores. In this study, the relations among 4 key variables, such as YDI, GYPI, Political Regime Score, and Political Regime Class, are investigated by applying several statistical and ML models.

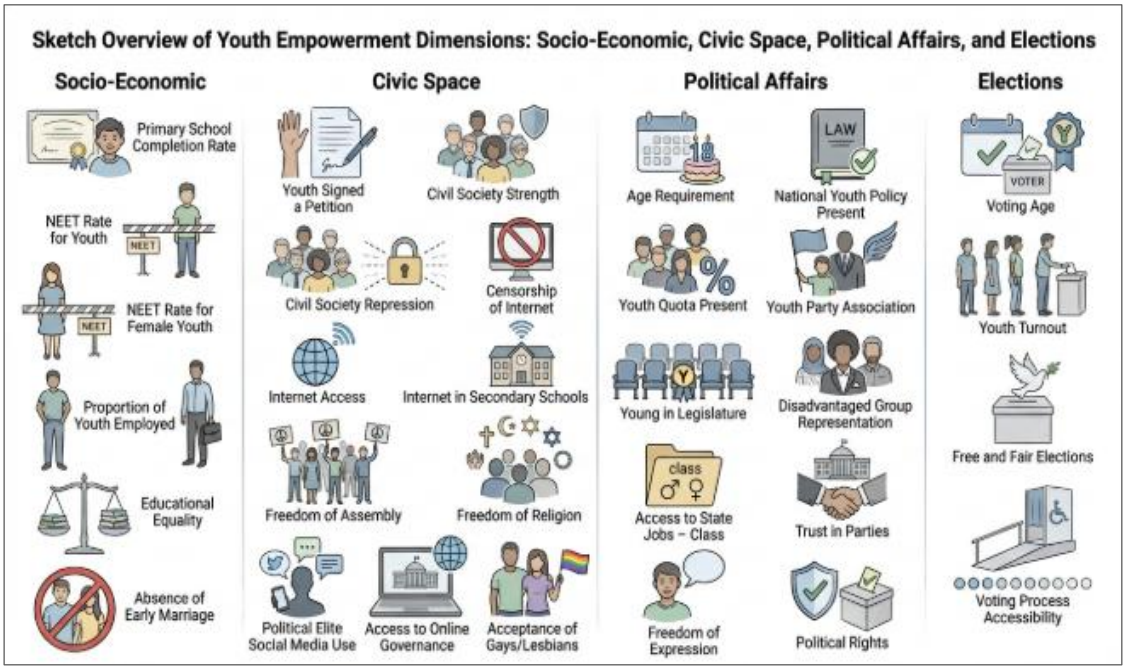

Figure 1. Four dimensions of GYPI score.

2. Literature Review

Youth civic engagement globally shows mixed trends: declines in traditional forms like voting and political involvement, offset by rises in digital activism, volunteering, and community service, especially post-digital revolution and during COVID-19 [2, 3, 4]. Literature highlights a shift from conventional participation to innovative, online-driven modes, influenced by technology, education, and crises [5, 6].

[2]https://gypi.epd.eu/dataset
[3]https://gypi.epd.eu/dataset
[4]https://gypi.epd.eu/dataset
[5]https://gypi.epd.eu/dataset

Traditional Civic Engagement Trends

Studies spanning over 30 years (e.g., U.S. high school seniors from 1976-2005) document declines in conventional participation (voting intentions down 3-9%) and alternative forms (e.g., protests), but increases in community service due to school programs [3]. Globally, the Commonwealth YDI reports overall improvements in civic participation (2010-2018: +3.1% in youth conditions), yet political engagement deteriorated in 102 countries [6]. European reviews note "shrinking civic space" and changing norms, with patterns of both decline and rise varying by context [7].

Digital and Modern Shifts

Meta-analyses of 106 studies confirm that digital media boosts youth engagement: social platforms enable rapid mobilization in movements like #BlackLivesMatter and Friday for Future, transcending borders despite challenges such as misinformation [4, 5]. Digital activism has grown exponentially, reshaping civic forms from offline protests to online petitions and campaigns [5].

COVID-19 Impacts

A 2024 scoping review of more than 27 global studies (US, Europe, Asia, Africa) finds that the pandemic spurred youth civic adaptations: online volunteering surged (from pre-COVID 1-in-3 globally), alongside community aid such as food distribution and awareness drives [2]. A positive youth development framework emphasizes reciprocal benefits for resilience and social integration in low - and middle-income contexts [2].

Measurement and Regional Insights

Recent scales validate civic engagement metrics for sustainability, while regional work (e.g., Indonesia) links formal education (Pacasila curriculum) and agents like family/ peers to rising participation, now digital-inclusive [8, 9]. Gaps persist, class divides widen (e.g., college plans predict voting), and data needs longitudinal global tracking beyond snapshots [3].

The Role of Youth Civic Engagement

Youth civic engagement plays a pivotal role in fostering personal development, democratic resilience, and social cohesion [10]. Among these roles, the implications of youth civic engagement, as measured by the GYPI scores, for the political regime status, as represented by the Political Regime Score and Political Regime Class, will be examined. In addition, it will be checked whether the GYPI 2025 dataset can also validate the recent trends in youth civic engagement observed in previous studies. Therefore, this study is an exploration of the value and implications of the GYPI 2025 dataset.

3. Data Preprocessing

The GYPI is an Index that scores 141 countries on the extent to which they respect young people's political rights [1]. The raw dataset GYPI contains 52 features, including 157 country names. Table 1, a part of the summary statistics for the GYPI 2025 dataset, shows characteristics of 153 countries after omitting 4 countries with many missing values and replacing some missing values with medians. Among the 51 features, GYPI, YDI, Political Regime Score, and Political Regime Class will serve as dependent variables in three separate regressions. Since the GYPI score is a linear combination of 4 sub-dimension scores, regressing GYPI on the other 50 variables can be problematic due to multicollinearity. Therefore, a sub-index of YDI is used as a proxy for GYPI while comparing the predictors of these two indicators. However, more focus will be placed on the relationships between these indicators and the Political Regime Score or Political Regime Class to approach the meaning of youth civic engagement.

Table 1. Part of summary statistics for GYPI 2025 dataset.

	gdp	overall_score	political_affairs__youth_quota	political_affairs__age_requirement_legislature	political_affairs__national_youth_policy
count	153.000000	153.000000	153.000000	153.000000	153.000000
mean	18082.333333	59.400915	53.379085	68.163399	15.359477
std	24369.457639	13.081532	35.117661	28.484173	35.946344
min	193.000000	14.310000	0.000000	3.000000	0.000000
25%	2183.000000	49.620000	15.000000	50.000000	0.000000
50%	6947.000000	59.910000	58.000000	81.000000	0.000000
75%	22798.000000	70.060000	85.000000	91.000000	0.000000
max	128678.000000	84.180000	100.000000	98.000000	100.000000

8 rows × 51 columns

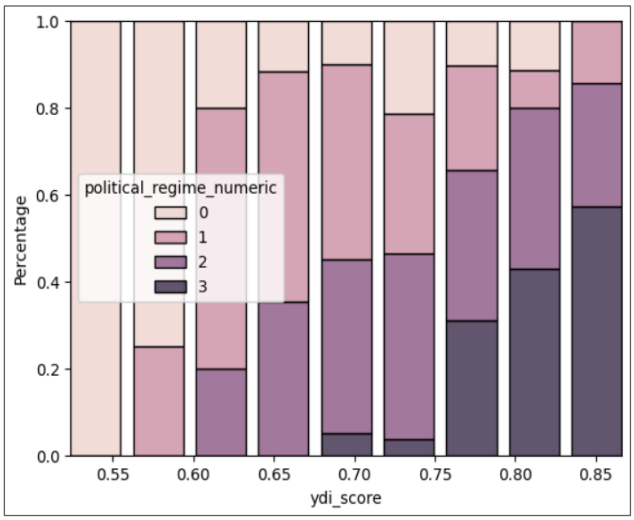

Figure 2. YDI score with political regime class.

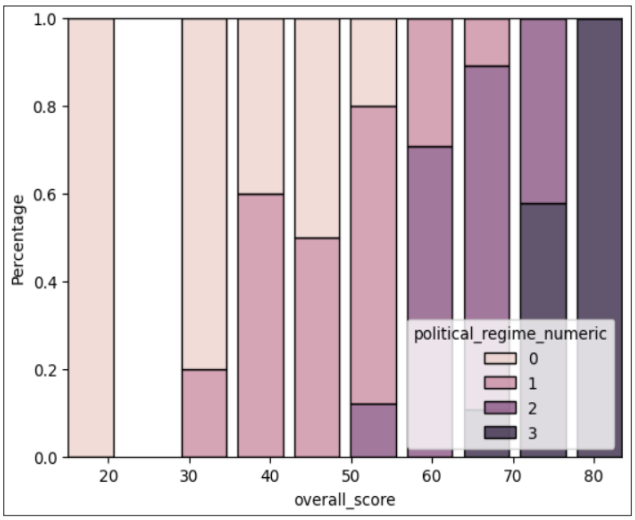

Figure 3. GYPI score with political regime class.

Figure 2 above shows a segmented bar chart of the YDI score, separated by the numerical values for 4 regime classes: Closed Autocracy, Electoral Autocracy, Electoral Democracy, and Liberal Democracy. As the YDI score increases, the proportion of Liberal Democracies (numeric value: 3) also increases. The interesting fact is that the proportion of Electoral Democracy (numeric value: 2) does not change much.

The replacement of Electoral Autocracy (numeric value: 1) by Liberal Democracies is clearly observed as the YDI score increases. Moreover, according to Figure 3 above, Liberal Democracy does not appear below a threshold of 65 in the GYPI score, while Autocracy disappears above this level.

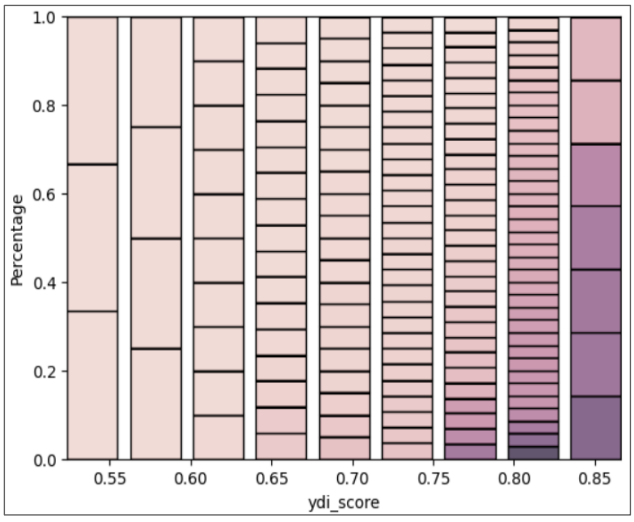

Figure 4. YDI score with GDP.

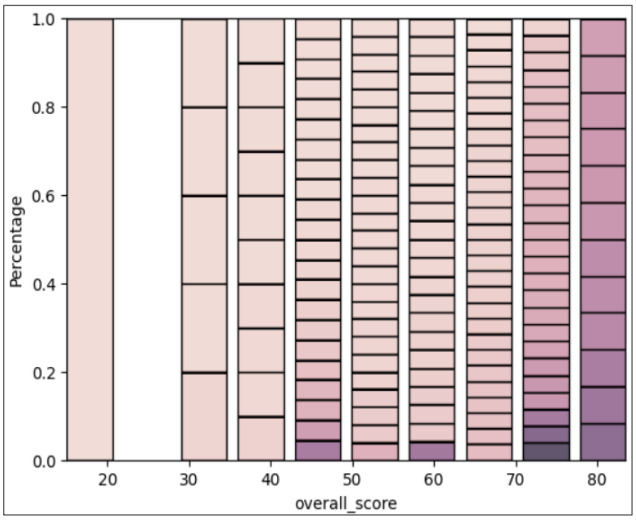

Figure 5. GYPI score with GDP.

Figures 4 and 5 show bar charts of the YDI and GYPI scores, respectively, segmented by GDP, with darker bars indicating higher GDP. As the YDI score increases, the proportion of high GDP increases above the threshold value of 0.75. However, when the YDI score is below 0.75, the relationship between GDP and the YDI score is unclear. That is, GDP shows a positive correlation with the YDI score above some threshold, while the relationship is ambiguous below it. But the relationship between GYPI and GDP is less certain. This difference between YDI and GYPI is not surprising, since YDI is more concentrated on the socio-economic conditions.

A similar pattern is observed for the Political Regime Score in Figure 6 below. As the Political Regime Score rises, the proportion of higher GDP increases, but this positive correlation is less apparent than that of the YDI score. That is, there are countries with high GDP and lower Political Regime Scores.

According to Figure 7, a direct proportional relationship between the Political Regime Score and the numeric values of the Political Regime Classes is not evident, suggesting that the relative importance of the variables for these two dependent variables needs to be compared.

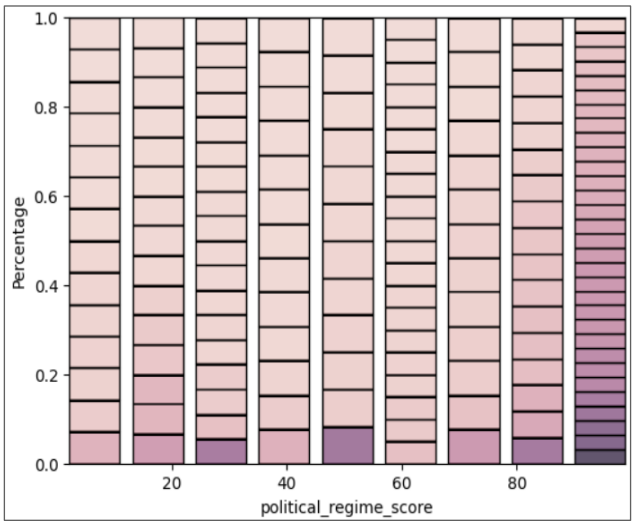

Figure 6. Political regime score with GDP.

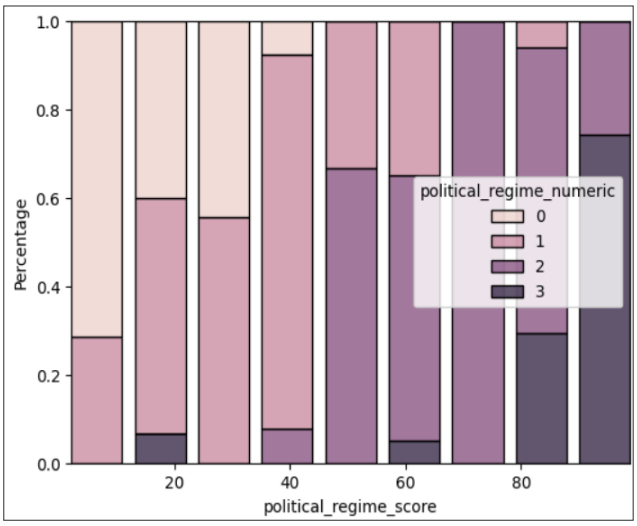

Figure 7. Political regime score with regime class.

4. Data Analysis: Multiple Linear Regression

To detect the relations of variables, multiple linear regressions from [Eq 1] to [Eq 3] are implemented. The relatively high R^2value of 0.991 is obtained in the case where GYPI is regressed, which is not very meaningful since GYPI is already a linear combination of sub-dimension scores[6]. When the dependent variable is YDI, 15 features, including the intercept term, among 50 features are found to be significant, with an adjusted R^2 of 0.800 [Eq 1]. When the political regime score is a dependent variable, 16 features are significant, with an adjusted R^2 of 0.916 [Eq 2]. After encoding 4 Political Regime Classes such as Closed Autocracy, Electoral Autocracy, Electoral Democracy, and Liberal Democracy into numeric values, these regime class values are regressed on the other 49 features, resulting in 9 significant variables with adjusted R^2 of 0.800 [Eq 3]. In the following regressions, the values in parentheses are standard errors. The full names of the variables are in the footnotes.

[Eq 1][7]

$$\text{YDI Score} = 0.528_{(0.017)} + 4.511 \cdot 10^{-7}{}_{(1.595\times10^{-7})} \cdot \text{GDP} + 2.060 \cdot 10^{-4}{}_{(1.180\times10^{-4})} \cdot \text{Youth Quota} - 2.810 \cdot 10^{-4}{}_{(7.979\times10^{-5})} \cdot \text{VDEM} - 1.559 \cdot 10^{-4}{}_{(7.888\times10^{-5})} \cdot \text{Online Governance} + 1.665 \cdot 10^{-4}{}_{(8.411\times10^{-5})} \cdot \text{Freedom of Religion} + 1.315 \cdot 10^{-4}{}_{(6.233\times10^{-5})} \cdot \text{CSO Repression} - 4.375 \cdot 10^{-4}{}_{(1.753\times10^{-4})} \cdot \text{Voting Age} - 5.896 \cdot 10^{-4}{}_{(2.225\times10^{-4})} \cdot \text{Vote} + 4.937 \cdot 10^{-4}{}_{(1.593\times10^{-4})} \cdot \text{Free and Fair} + 6.941 \cdot 10^{-4}{}_{(3.770\times10^{-4})} \cdot \text{Elections} + 8.712 \cdot 10^{-4}{}_{(1.917\times10^{-4})} \cdot \text{Absence of Early Marriage} + 5.302 \cdot 10^{-4}{}_{(1.506\times10^{-4})} \cdot \text{Educational Quality} + 7.254 \cdot 10^{-4}{}_{(1.968\times10^{-4})} \cdot \text{Primary School Completion} + 4.416 \cdot 10^{-4}{}_{(2.206\times10^{-4})} \cdot \text{Regime Score}$$

[Eq 2][8]

$$\text{Political Regime Score} = -26.809_{(6.111)} + 0.730_{(0.163)} \cdot \text{GYPI} + 0.094_{(0.041)} \cdot \text{Youth Quota} + 0.121_{(0.050)} \cdot \text{Age Requirement} - 0.047_{(0.024)} \cdot \text{Party Trust} + 0.059_{(0.026)} \cdot \text{Jobs Gender} - 0.156_{(0.059)} \cdot \text{Social Groups}$$

[6]The output table is in appendix

[7]Youth Quota: Political Affairs Youth Quota, VDEM: Civil Society VDEM Civil Society Index, Online Governance: Civil Society Access to Online Governance, Freedom of Religion: Civil Society Freedom of Religion, CSO Repression: Civil Society CSO Repression, Voting Age: Elections Voting Age, Vote: Elections Vote, Free and Fair: Elections Free and Fair, Absence of Early Marriage: Socio-Economic the Absence of Early Marriage, Educational Quality: Socio-Economic Educational Quality, Primary School Completion: Socio-Economic Primary School Completion, Regime Score: Political Regime Score

[8]GYPI: Overall GYPI Score, Youth Quota: Political Affairs Youth Quota, Age Requirement: Political Affairs Age Requirement Legislature, Party Trust: Political Affairs Party Trust, Jobs Gender: Political Affairs State Jobs Gender, Social Groups: Political Affairs Social Groups, Political Rights: Political Affairs Political Rights, VDEM: Civil Society VDEM Civil Society Index, Freedom of Religion: Civil Society Freedom of Religion, Freedom of Assembly: Civil Society Freedom of Peaceful Assembly, Mobile Voting: Elections Mobile Voting, Vote Proxy: Elections Vote Proxy, Online Vote: Elections Online Vote Registration, Vote: Elections Vote

$+ 0.206_{(0.053)}$ ·Political Rights $+ 0.056_{(0.021)}$ ·VDEM $- 0.076_{(0.025)}$ ·Freedom of Religion $- 0.040_{(0.021)}$ ·Freedom of Assembly $+ 0.236_{(0.047)}$ ·Civil Society $-0.112_{(0.055)}$ ·Mobile Voting $+ 0.135_{(0.042)}$ ·Vote Proxy $+ 0.096_{(0.037)}$ ·Online Vote $+ 0.103_{(0.057)}$ ·Vote

[Eq 3][9]

Political Regime Class = $-1.812_{(0.254)} + 0.039_{(0.007)}$ ·GYPI $+ 0.006_{(0.002)}$ ·Age Requirement $+ 0.007_{(0.002)}$ ·Civil Society $+ 0.004_{(0.002)}$ ·Mobile Voting $- 0.003_{(0.002)}$ ·Vote Abroad $+ 0.006_{(0.002)}$ ·Online Vote $+ 0.005_{(0.002)}$ ·Ed Frequency $- 0.004_{(0.002)}$ ·Compulsory

Several observations from these multiple linear regressions are as follows: GDP is a significant predictor of YDI, but not of Political Regime Scores or Political Regime Classes. Voting environment, such as voting age, vote proxy, online vote, vote abroad, and mobile voting, is a significant factor for predicting YDI, Political Regime Scores, and Political Regime Classes, indicating that enhancing the overall quality of the voting system is critical for the youth development index and Political Regime scores.

The recent trend of expanding youth civic engagement through online and mobile channels is supported by all three equations, since Online Governance, Online Voting, and Mobile Voting are all revealed to be significant. Freedom of Religion is significant for both the YDI and the Political Regime Score, but not for the Political Regime Class. That is, Freedom of Religion can affect the quality of the political system, but does not affect the formation of political regime types. However, the interpretability of these models is limited by potential multicollinearity, nonlinearity, and inaccuracies introduced by using medians for missing values. Moreover, the relative importance among regressors is not captured, necessitating other analytic tools.

5. Data Analysis: Gradient Boost Regression

To determine the relative importance of various features in predicting YDI, GYPI, and the Political Regime Score, Gradient Boost Regression was used with parameter settings of a shrinkage rate of 0.1, an interaction depth of 1, a minimum number of observations per node of 10, and a maximum number of trees of 100. Loss function type is Gaussian.

Table 2 summarizes the results of Gradient Boost Regression when YDI, GYPI, and Political Regime Scores are treated as separate dependent variables. Model performance measured by R^2 is ranged from 0.788 for YDI to 0.952 for the political regime score.

Table 2. Outputs of gradient boost regression.

Dependent: YDI score		**Dependent: GYPI score**		**Dependent: Political regime score**	
	Value		Value		Value
MSE	0.001	MSE	40.747	MSE	48.799
MSE (scaled)	0.217	MSE (scaled)	0.151	MSE (scaled)	0.047
RMSE	0.032	RMSE	6.383	RMSE	6.986
MAE/MAD	0.031	MAE/MAD	3.591	MAE/MAD	5.81
MAPE	4.41%	MAPE	11.39%	MAPE	59.06%
R^2	0.788	R^2	0.85	R^2	0.952

Table 3 demonstrates key findings of this study:

1) GDP is a variable with the highest ranking in predicting the YDI score.
2) GYPI is ranked 1st in predicting the Political Regime Score.
3) GDP is ranked 11th in predicting GYPI score.
4) GDP is ranked 14th in predicting the Political Regime Score.
5) Election and voting environments have high rankings in predicting the Political Regime Score.

[9]Age Requirement: Political Affairs Age Requirement Legislature, Mobile Voting: Elections Mobile Voting, Vote Abroad: Elections Vote Abroad, Online Vote: Elections Online Vote Registration, Ed Frequency: Elections Voter Ed Frequency, Compulsory: Elections Compulsory Registration

Table 3. Feature importance of gradient boost regression.

Dependent: YDI score			**Dependent: GYPI score**			**Dependent: Political regime score**		
	Relative influence	Mean dropout loss		Relative influence	Mean dropout loss		Relative Influence	Mean dropout loss
GDP	33.799	0.048	Elections	63.934	9.408	GYPI	25.736	12.605
Socio-economic	30.239	0.046	Political affairs	11.817	4.093	Political regime class	14.349	7.648
Educational quality	14.060	0.039	Mail ballot	10.445	3.254	Mail ballot	12.445	8.311
Primary school completion	8.798	0.039	Socio-economic	4.747	2.498	Elections	11.879	8.834
Free election	4.763	0.036	Civil society	2.511	2.304	Vote	11.561	8.421
NEET rate_ female	3.098	0.035	Youth quota	1.402	2.026	Youth quota	10.647	9.644
Voting process	2.055	0.035	Regime score	1.127	2.043	Compulsory registration	4.531	7.535
Social group	1.360	0.035	NEET rate_ female	0.776	2.027	Political affairs	2.970	7.452
Absence of early marriage	1.111	0.035	Educational quality	0.744	2.039	Age requirement	2.589	6.634
Mail ballot	1.122	0.037	Political rights	0.504	1.998	Civil society	1.299	6.653
Social_ group	0.717	0.034	GDP	0.461	2.019	Political rights	1.009	6.495
Youth quota	0.000	0.034	Vote	0.273	1.947	Freedom of expression	0.425	6.365
Age requirement	0.000	0.034	Age requirement	0.252	1.962	State jobs gender	0.345	6.333
Youth policy	0.000	0.034	Youth unemployed	0.252	1.998	GDP	0.137	6.223
Youth association	0.000	0.034	Internet censorship	0.187	1.968	CSO repression	0.079	6.154

Before proceeding to detect the characteristics of the political regime classification, several machine learning models are applied and compared.

6. Data Analysis: ML Classification Comparison

Table 4 summarizes the validation and test accuracies of 8 classification models. RF (Random Forest) and SVM (Support Vector Machine) classification outperform others due to their robustness with sparse, high-dimensional features such as textual political data or categorical regime indicators. Political regime data typically has high dimensionality and small-to-medium sample sizes, making RF and SVM more reliable [k5 Are random forests better than support vector machines for microarray-based cancer classification?, Alexander Statnikov, Constantin Faliferis].

SVM excels at finding optimal decision boundaries via maximum-margin hyperplanes, which is effective for linearly separable or kernel-transformed political features (e.g., policy indices, geopolitical variables) [11]. More specifically, SVM handles class imbalance common in regime data (few autocracies vs. democracies) through soft margins and kernels such as the RBF [11]. In addition, SVMs are less prone to overfitting than neural networks at moderate sample sizes [11]. Simultaneously, the strengths of Random Forests stem from aggregating multiple decision trees, reducing variance, and capturing non-linear regime interactions (e.g.,

economic freedom correlating with democracy) [12]. More specifically, bagging and feature randomness in RF mitigate overfitting on noisy political datasets with multicollinearity [12], which is typical in the GYPI 2025 dataset. Also, RF provides feature importance rankings, which aid the interpretability of regime predictors [12].

Therefore, SVM and RF models generalize well without extensive tuning, unlike gradient boosting, which is prone to overfitting, or naïve Bayes, which assumes independence in regimes where it is violated [13]. Table 5 below shows the top 5 features in random forest classification for political regime classes.

Table 4. Classification performance comparison.

Features	Validation accuracy	Test accuracy
Gradient boosting classification	0.600	0.767
Decision tree classification	0.560	0.700
K-nearest neighbors classification	0.720	0.733
Linear discriminant classification	0.783	0.533
Naïve bayes classification	0.833	0.667
Neural network classification	0.480	0.433
Random forest classification	0.700	0.842
Support vector machine classification	0.900	0.800

Table 5. Top 5 features in random forest classification for political regime class.

Features	Mean decrease in accuracy
Political regime score	0.088
Elections	0.033
Online voting	0.025
Elections vote	0.022
GYPI	0.020

Since the main contributor to the political regime score is GYPI, its role in political regime classification is remarkable. Combining the above features, youth participation in enhancing the election and voting environment can be a crucial factor in explaining the political regime class. In this respect, youth civic engagement, as measured by GYPI scores, is pivotal across both political regime types and statuses.

7. Data Analysis: Extracted Feature Importance-Based PCA

As a supplementary investigation, the features selected from the gradient boosting regression rankings are plotted in a PCA biplot to detect the overall relationships among these variables, avoiding the complexities when using all 50 features.

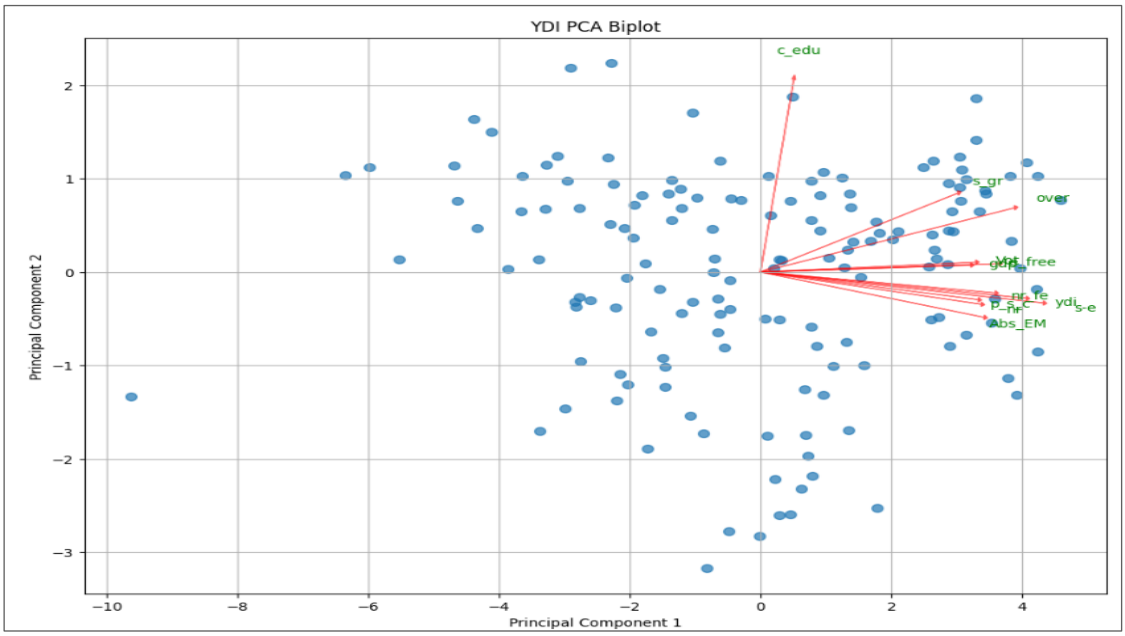

Figure 8. PCA biplot of variables with high feature importance in predicting YDI.

According to Figure 8, most variables show positive correlation. There are two clusters along the first principal component: one composed of Vote, Free and Fair Elections, and GDP; and the other composed of YDI, NEET Rate Female, Socio-Economic, Primary School Completion, and Absence of Early Marriage. Within this second cluster, Absence of Early Marriage is only weakly correlated with Civic Education for Elections, suggesting that a more nuanced, fundamental cultural and historical approach, rather than mere civic education for elections, is necessary to reduce early marriage.

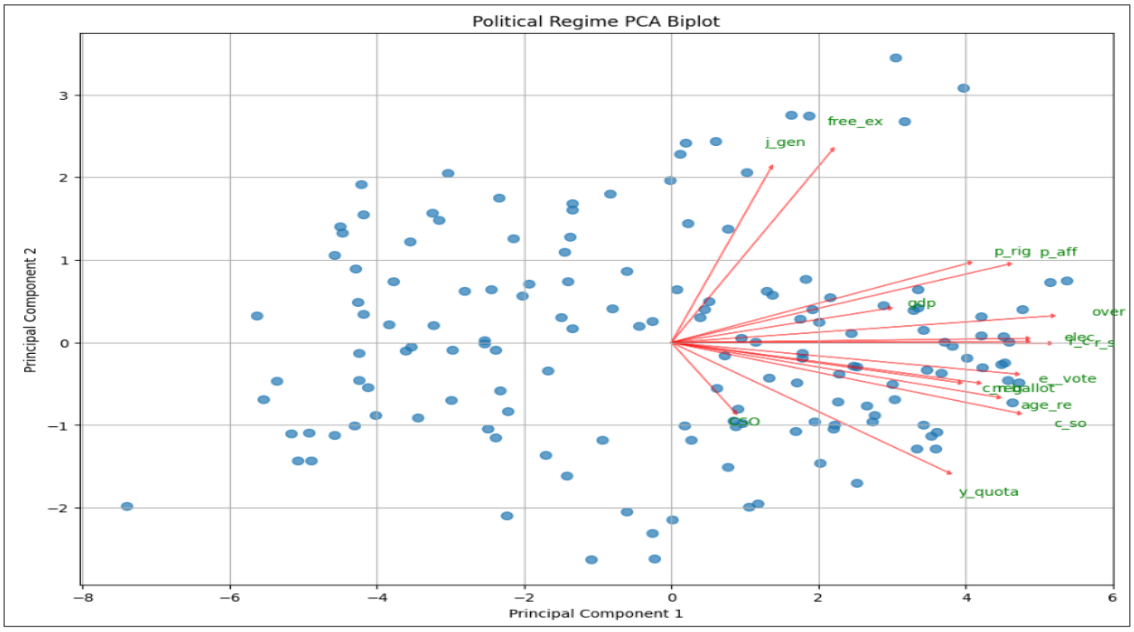

Figure 9. PCA biplot of variables with high feature importance in predicting political regime score.

Similarly, almost all variables exhibit positive correlations, as shown in Figure 9. There are two clusters, although more vague compared to the previous case, along the first principal component: one is composed of Political Regime Score, Political Regime Class, Elections, and GYPI score, while the other is composed of Elections Vote, Civil Society, Compulsory Registration, Mail Ballot, and Age Requirement. This second cluster is almost uncorrelated with Freedom of Expression, implying that Freedom of Expression does not automatically guarantee the legislature of more desirable election and voting mechanisms. The slight negative correlation between CSO (Civil Society Organization) Repression and State Jobs Gender, along with Freedom of Expression, comprises the second principal component. CSO Repression can lower the freedom of expression and increase gender discrimination in state job access.

8. Conclusion

The statistical outcome of this study is strictly limited by potential multicollinearity among variables and by the inaccuracy introduced by replacing missing values with medians. With these limitations in mind, GDP is the crucial factor only for YDI scores, not for GYPI, Political Regime Score, or Political Regime Class. Therefore, the assertion that political rights can naturally be enhanced by economic development is not supported by the evidence. An increase in GDP does not automatically enhance political rights or conditions for better political systems. Youth civic engagement, along with the struggle for improvements in election- and voting-related legislation, is strongly associated with the Political Regime Class, suggesting that youth engagement coexists with the desirable political regime class, although it may be hasty to say that youth civic engagement can cause a political regime shift. In this respect, the GYPI 2025 dataset is valuable enough. Since this GYPI 2025 dataset is high-dimensional (51 features) and has a small-to-medium sample size (153 countries), RF and SVM perform better. According to the PCA Biplot, reducing the prevalence of early marriage cannot be achieved safely through mere civic education for elections.

Declarations

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Appendix

Table 6. Regression output when GYPI is a regressand (adjusted R^2 is 0.991).

Dependent variable: GYPI				
	Coefficient	**SE**	**t**	**p-value**
Intercept	6.115	0.846	7.226	<0.001
Youth association at the party	0.011	0.005	2.106	0.037
Political affairs	0.246	0.015	16.794	<0.001
CS (civil society) petition	0.024	0.005	4.785	<0.001
CS online national dialogue	0.005	0.003	1.844	0.067
CS VDEM civil society index	0.011	0.003	3.718	<0.001
CS internet secondary	0.010	0.004	2.606	0.010
CS access to online governance	0.006	0.003	2.065	0.041
CS freedom of religion	0.010	0.003	3.171	0.002
CS internet censorship	0.005	0.003	1.748	0.083
CS CSO repression	0.008	0.002	3.386	<0.001
Civil society	0.088	0.005	16.399	<0.001
Elections vote proxy	0.060	0.006	10.373	<0.001
Elections early voting	0.018	0.005	3.448	<0.001
Elections online voter registration	0.020	0.005	3.577	<0.001
Elections voter education frequency	0.017	0.005	3.068	0.003
Elections civic education	0.023	0.005	4.705	<0.001
Elections voting age	-0.026	0.007	-3.575	<0.001
Elections vote	0.066	0.009	7.580	<0.001
Elections: overall voting process	0.019	0.005	4.174	<0.001
Elections free and fair	0.021	0.007	3.032	0.003
Elections	0.046	0.017	2.709	0.008
Socio-economic NEET rate	-0.048	0.013	-3.652	<0.001
Socio-economic	0.292	0.017	17.500	<0.001