The Rule of Law in the ESG Framework in the World Economy

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Abstract

In this article, I have estimated the Rule of Law for 193 countries using data from the Environment Social and Governance-ESG database of World Bank. I have used different econometric techniques to estimate the value of *"Rule of Law"* i.e.: Panel Data with Fixed Effects, Panel Data with Random Effects, Pooled OLS. I found that Rule of Law is positively associated, among others to *"Regulatory Quality"* and *"Control of Corruption"* and negatively associated among others to, *"Access to Electricity"* and *"Prevalence of Overweight"*. I have performed a cluster analysis with the k-Mean algorithm optimized with the Elbow Method and I find the presence of four clusters. Finally, I present a confrontation among eight different machine-learning algorithms to predict the level of Rule of Law. I find that Linear Regression is the best predictor according to MAE, MSE, RMSE and R-squared.

1. Introduction-Research Question

The following analysis is investigated the role of Rule of Law in the context of the ESG variables of the World Bank. The connection between Rule of Law and ESG models is necessary to consider the role of legal systems in promoting or delaying the adoption of models that are aimed at sustainability, respect for the environment and good governance. Certainly, the law has a very relevant impact for the economic growth and prosperity of the countries as has been analysed widely in the context of the theories of Law and Economics and in a particular way of Legal Origin Theory-LOT [1]. However, in this specific case, the element of innovativeness consists in the analysis of the relationship between rule of Law and ESG models. The relevance of the ESG models is due to the need to keep the requests that refer to environmental sustainability, with social and justice in governance in a single coherent system. In particular, the Rule of Law variable is part of the variable set used to evaluate governance. Therefore, in a broad sense this article analyses as one of the representative variables of good governance, or Rule of Law, interacts with a set of variables capable of representing the orientation to environmental, social, and political sustainability at the country level.

The article continues as below: the second paragraph contains a synthesis of reference literature, the third paragraph presents the results of the econometric analysis, the fourth paragraph contains the analysis in Cluster, the fifth paragraph presents the results of the application of machine learning

algorithms for the prediction of the future value of rule of law, the sixth paragraph concludes. The appendix shows the tables and graphs of the statistical results obtained.

2. Literature Review

In the following paragraph is presented a synthesis of the literature.

There is a negative relationship between monetary profligacy and rule of law, as in the case of Second Polish Republic [2]. There is a positive relationship between rule of law and the increase in potential GDP per worker [3]. Rule of law is positively associated to GDP growth in African countries [4]. The absence of rule of law impedes economic growth in Nigeria [5]. The absence of rule of law has a positive effect on economic crime, which reduces either economic growth, either social inequality, as in the case of North Macedonia [6]. The lacking of rule of law and control of corruption have a negative effect on economic growth in Serbia [7]. Rule of law is essential also to promote a good governance and a sustainable democracy [8]. Institutional reforms that promote the improvement of rule of law can generate positive effect on economic growth, investments, and human capital in Sub-Saharan African-SSA countries [9]. Rule of law, together with voice and accountability and regulatory has a positive impact of GDP per capita as in the case of ASEAN countries [10], [11] and even in ASEAN-10 countries [12].

Rule of law and government effectiveness are positively associated to economic growth in Bangladesh [13]. Rule of law is positively associated to Economic Freedom and economic growth in a set of 97 countries [14]. Rule of law is a social determinant to promote better health systems, especially in African countries [15]. Countries that participate in international organizations can have economic incentive to strengthen rule of law to obtain greater Foreign Direct Investment-FDI [16]. There is a positive relationship between rule of law and economic growth in new EU member states and in Croatia in the period 1996-2012 [17]. Rule of law, together with other Good Governance Indicators, improves either GDP per capita either GDP rate in 16 Asian developing countries [18]. Rule of law and control of corruption have a positive effect on economic growth in Egypt, Jordan, Lebanon and Tunisia in the period 1996-2016 [19]. There is a positive relationship between rule of law and economic growth in Sub-Saharan African-SSA countries; and this positive relationship hold only if the level of rule of law is greater than -1.37 [20]; similar results have been obtained for a set of 44 African countries [21]. Rule of law can promote financial markets creating the condition for economic growth in developing countries such as Iran [22].

Rule of law reduces the probability that countries with high natural resource endowments suffer for low growth or underdevelopment due to the curse of raw materials [23]. Rule of law promotes economic growth in post-socialist economies either in the short either in the long run [24]. Rule of law and economic freedom are positively associate to economic growth, as in a set of 184 countries [25]. Rule of law, together with other variables i.e., judicial independence, contract enforcement, control of corruption and political stability, is positively associated to financial inclusion in Middle East and Northern Africa-MENA countries [26]. Rule of law and democracy improves corporate governance reducing agency costs [27]. Rule of low is positively associate to economic growth and FDI [28]. There is a positive relationship between rule of law and environmental quality [29]. The increase in rule of law can strengthen the relation between FDI and economic growth, in country with low and middle income per capita [30]. Rule of law decrease financial development in a set of 189 countries [31]. Differences in rule of law can explain the difference in growth between two countries at their border [32].

Synthesis of the References

Main Theme	References
Rule of Law and Economic Growth	[2], [3], [4], [5], [7], [9], [10], [11], [12], [13], [14], [17], [18], [19], [23], [24], [30], [32]
Rule of Law, Democracy and Freedom	[8], [25]
Rule of Law and International Economics	[16], [28]
Rule of Law and Finance	[22], [26], [31]
Rule of Law and the Curse of Natural Resources	[20], [21]
Miscellaneous	[6], [15], [29], [27]
Theoretical Framework	[1]

3. The Econometric Model to Estimate the Level of Rule of Law

I have estimated the following equation:

$$
\begin{aligned}
RuleOfLaw_{it} = \ &\alpha_1 + \beta_1(AccessToElectricity)_{it} + \beta_2(AdjustedSavingsNaturalResourcesDepletion)_{it} \\
&+ \beta_3(ControlOfCorruption)_{it} + \beta_4(IndividualsUsingTheInternet)_{it} \\
&+ \beta_5(LifeExpectancyAtBirth)_{it} + \beta_6(PoliticalStabilityAndAbsenceOfViolence/Terrorism)_{it} \\
&+ \beta_7(PopulationAges65AndAbove\%) + \beta_8(PrevalenceOfOverweight)_{it} \\
&+ \beta_9(RegulatoryQuality)_{it} + \beta_{10}(ScientificAndTechnicalJournalArticles)_{it} \\
&+ \beta_{11}(VoiceAndAccountability)_{it}
\end{aligned}
$$

$$i = 193 \ t = 22$$

Average Value of Variables Applied to the Estimation of Rule of Law		
Variables	**Average**	
Regulatory Quality: Estimate	0,336408	Positive
Control of Corruption: Estimate	0,267216	Positive
Voice and Accountability: Estimate	0,154476	Positive
Political Stability and Absence of Violence/Terrorism: Estimate	0,121656	Positive
Scientific and technical journal articles	0,061850	Positive
Life expectancy at birth, total (years)	0,012983	Positive
Population ages 65 and above (% of total population)	0,007655	Positive
Individuals using the Internet (% of population)	0,000968	Positive
Adjusted savings: natural resources depletion (% of GNI)	-0,001668	Negative
Access to electricity (% of population)	-0,002048	Negative
Prevalence of overweight (% of adults)	-0,005722	Negative

I found that there is a positive relationship between the rule of law and:

- *Regulatory Quality:* is a variable that considers the ability of governments to create and implement economic policies capable of improving and developing the private sector. It is a composite variable that varies approximately within a range of -2.5 to +2.5. There is a positive relationship between the Rule of Law value and the Regulatory Quality value. This relationship indicates that the ability of a government to work to improve services for citizens is also associated with the ability of a government to strengthen the private sector. If we consider the top 10 countries in terms of Rule of Law and Regulatory Quality, we can see that

6 of the 10 countries are present in both rankings, namely: Singapore, Luxembourg, Finland, Denmark, New Zealand, Switzerland. In particular, countries that have high levels of Regulatory Quality also have high levels of Rule of Law such as: Singapore with a value of 2.23 and 1.86, Luxembourg with a value of 1.92 and 1, 79, Finland with a value of 1.90 and 2.06, Australia with a value of 1.84 and 1.67, Denmark with a value of 1.81 and 1.94, New Zealand with a value of 1.81 and 1.82, Macau with a value of 1.78 and 0.81, the Netherlands with a value of 1.75 and 1.74, Sweden with a value of 1.75 and 1.73, Switzerland with a value of 1.73 and 1.81.
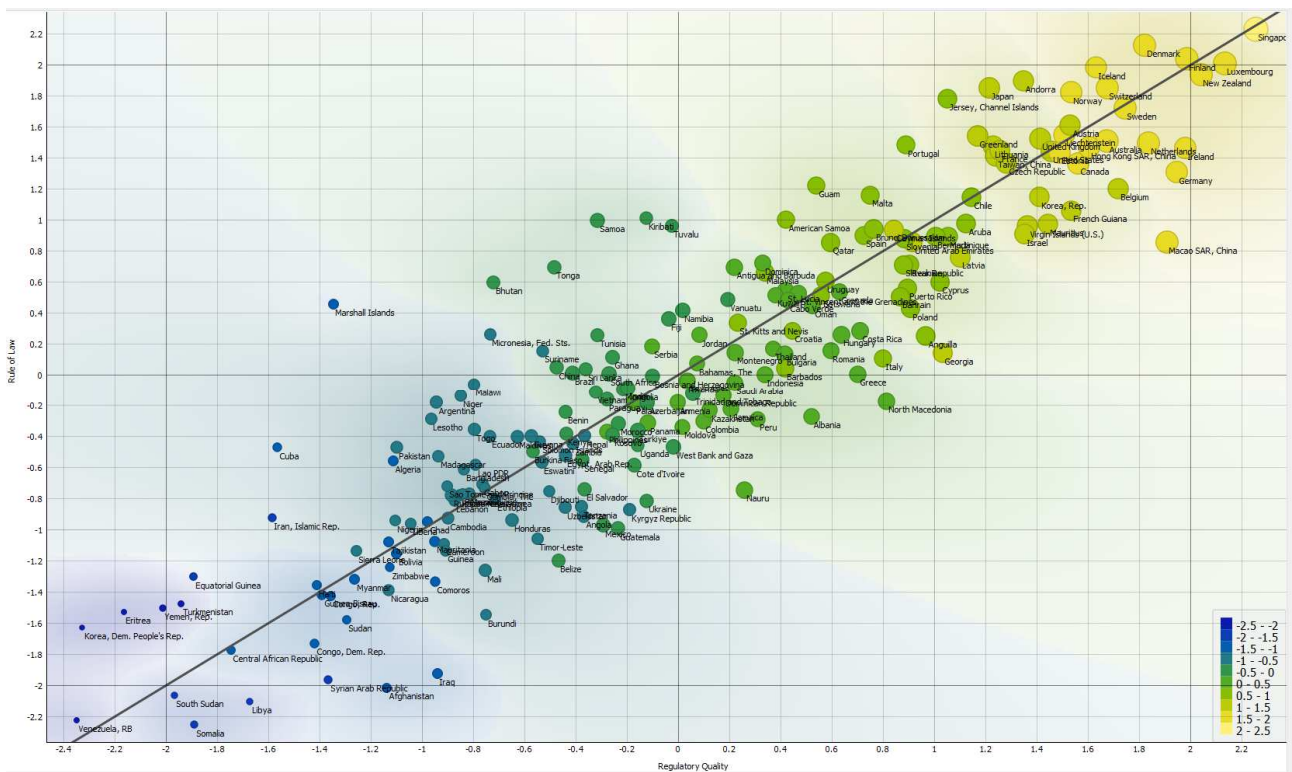

Figure 1. The positive relationship between Rule of Law and Regulatory Quality.

- *Control of Corruption:* is a variable that considers the perception of the population according to which public power is exercised for private interests, and for corruption purposes. The indicator is measured in a range between -2.5 and 2.5. There is a positive relationship between the Rule of Law value and the control of corruption. In fact, it is possible to verify that the countries that have high levels of control of corruption also have other Rule of Law levels and vice versa. This condition is evident considering the countries that are part of the top ten in the control of corruption ranking also have very high levels of Rule of Law. For example, Denmark which is in first place for control of corruption with a value equal to 2.27 with a rule of law value of 1.85, followed by Finland with 2.20 in terms of control of corruption e with a rule of Law value of 2.07 units. They follow in the top ten Singapore ranking with 2.15 in terms of control of corruption and rule of law with 1.87, followed by New Zealand with corresponding values of 2.15 and 1.87; Sweden with 2.13 and 1.80; Norway with 2.10 and 1.97; Switzerland with 2.08 and 1.82; Luxembourg with 2.06 and 1.78; Netherlands with 2.03 and 1.75; Liechtenstein with 2.00 and 1.75. It therefore follows that there is a significant positive relationship between Rule of Law and Control of Corruption which has its precise metric dimension.
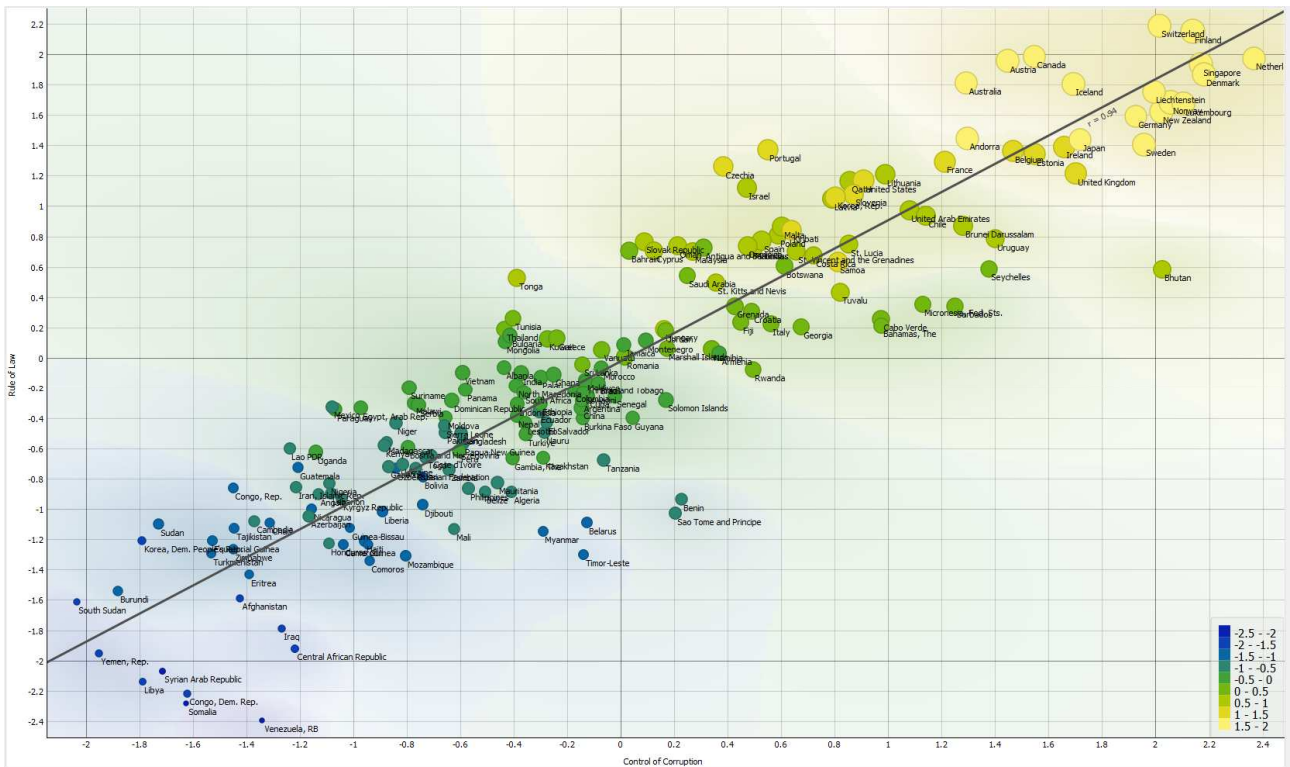
Figure 2. The positive relationship between Rule of Law and Control of Corruption in 2020.

- *Voice and Accountability*: is a variable that takes into consideration the perception of citizens of a country about the possibility of participating in the selection of government, freedom of expression, freedom of association and free media. The variable varies in a range between -2.5 and +2.5. There is a positive relationship between the Rule of Law value and the Voice and Accountability value. This relationship can be understood considering the metric dimension or the fact that the countries that have high levels of Rule of Law also have high levels in terms of voice and accountability. In fact, if we take into consideration the ranking of countries by voice and accountability value and compare them with the relative values in terms of rule of law it appears that: Norway has a voice and accountability value equal to an amount of 1.72 and a Rule of Law value of 1.97, Finland has values for 1.61 and 2.07, New Zealand has values for 1.60 and 1.87, Switzerland has values for 1.54 and 1.82 , the Netherlands have values for 1.52 and 1.75, Denmark has values for 1.52 and 1.85, Sweden has values for 1.50 and 1.80, Luxembourg has values for 1.50 e 1.78, Canada has values for 1.48 and 1.65, and Austria has values for 1.40 and 1.80. This report highlights that countries that have a high value in terms of rule of law are also countries in which there is greater possibility on the part of the population to participate in democratic life. Leading countries in terms of voice and accountability are also the most advanced western countries from the point of view of democracy and political freedoms.
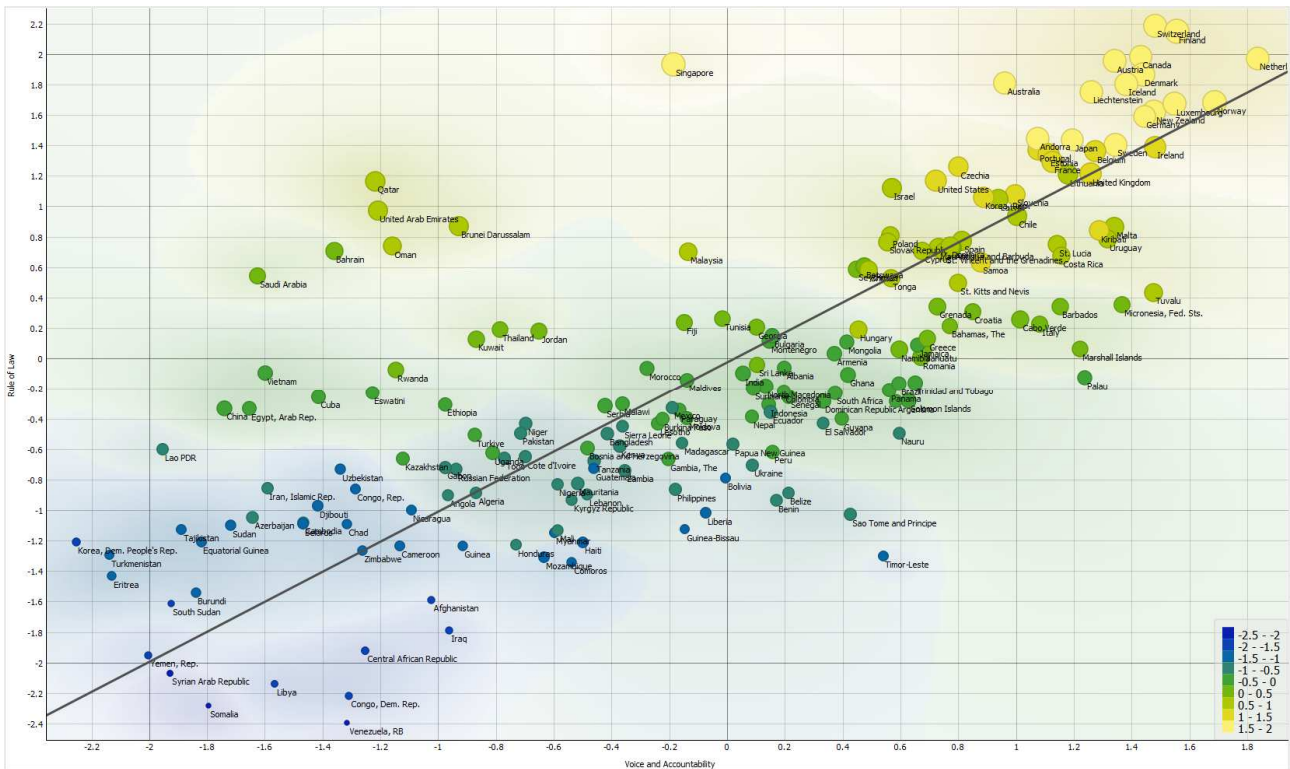
Figure 3. The positive relationship between Rule of Law and Voice and Accountability in 2020.

- *Political Stability and Absence of Violence/Terrorism:* It is an indicator that takes political stability and the absence of political violence and terrorism at the country level. The indicator varies in a range between -2.5 and 2.5. There is a positive relationship between the Rule of Law value and the value of the variable that measures political stability and the absence of terrorism. For example, it is possible to note that top ten countries for political stability value also have very high values in terms of rule of law. For example, Greenland has a value of political stability and absence of terrorism equal to 1.91 and a corresponding rule of Law value of 1.73; The corresponding values for Liechtenstein are 1.69 and 1.75; For Andorra there are 1.62 and 1.69; Anguilla with 1.55 and 0.43; Cayman Islands with 1.50 and 0.76; New Zealand with 1.49 and 1.87; Singapore with 1.46 and 1.87; Aruba with 1.39 and 1.30; Iceland with 1.38 and 1.79; Dominica with 1.36 and 0.81. As it is possible to notice, however, the countries that are in the top ten for political stability value are all small and medium -sized countries. In fact, there are no large countries in the top ten for value of political stability except for New Zealand. In fact, we can see that large high -income Western countries have political stability values from low -ranking average. Specifically, Japan is in the first place due to the value of political stability among large countries with a value of 1.04 units and an amount of rule of law of 1.51. Germany is in 62nd place for political stability value, followed by the United Kingdom in 79th place, from Italy to 83rd place, from France to 88th and even the United States are in 107th place. It follows that evidently the large western countries tend to be crossed by political phenomena tendentially violent with terrorist traits. It is certainly the case of the United States where the assault on the congress that also the manifestations of violence against the African American community have highlighted the presence of a form of widespread political violence that sometimes takes the form of ethnic-racial hatred. It therefore follows that large countries must act even more with the rule of Law to prevent violent social phenomenology from taking the form of political instability, riot or real terrorism.
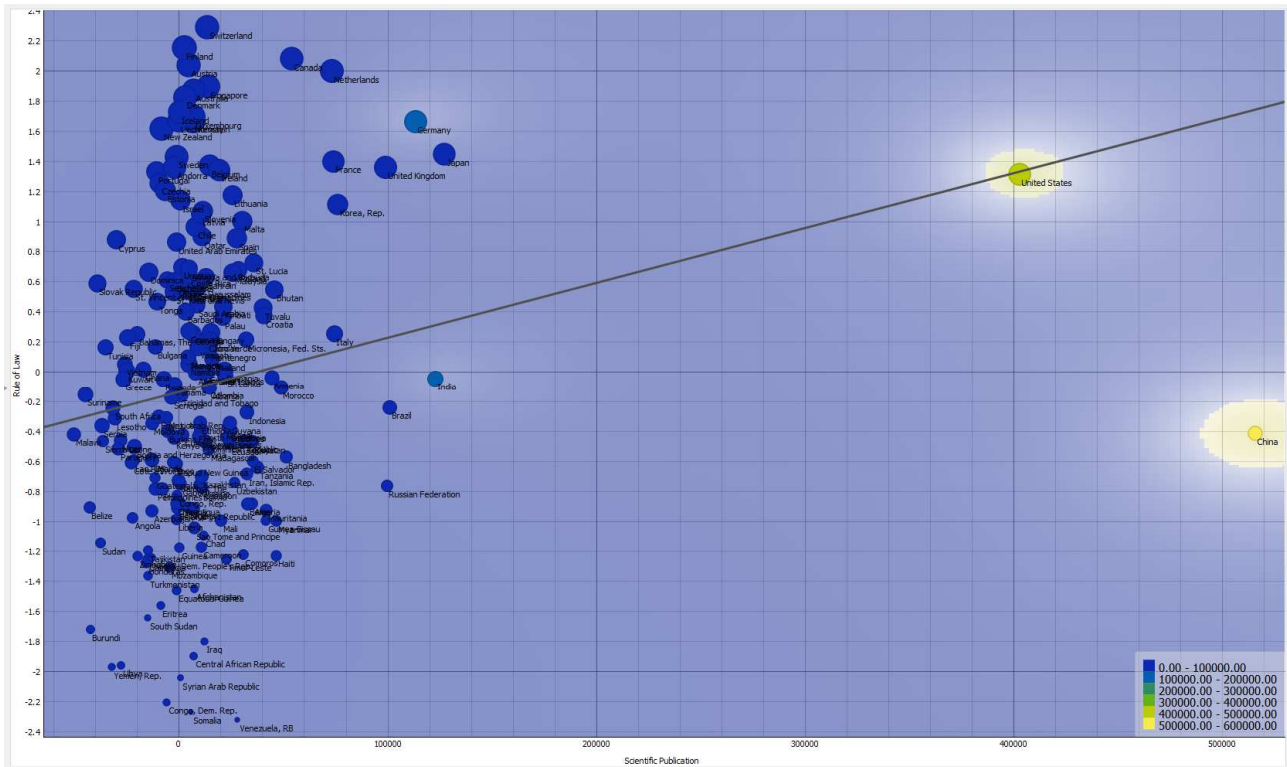
Figure 4. The positive relationship between Rule of Law and political Stability and Absence of Violence.

- *Scientific and technological journal articles:* is a variable that considers the publication of articles in scientific and technical magazines that refer to the following fields namely: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, earth and space sciences. There is a positive relationship between the countries that have the highest levels of scientific publications and the companies that have high levels in terms of Rule of Law. In particular, looking at the top ten of the countries by scientific publication value it is possible to note that at least 6 of the 10 countries also have high values in terms of rule of law. However, there are also countries that also having high levels in terms of scientific publication have reduced levels in terms of rule of law such as China, India, Russia and Italy. China is in the first place for the value of the number of scientific publications also with about 528,263 units, followed by the USA with 422,080, by India with 135,788, from Germany with 104,396, from Japan with 98,793, from the United Kingdom with 97,681, from the Russian Federation With 81,579 units, from Italy with 71,240, from South Korea with 66,376 and from France with 66,352 units. The case of China, India, and Russia shows that it is possible to invest effectively in scientific and technological research even without having high levels of Rule of Law. Above all, the case of Russia and China suggests that the development of science does not necessarily require a democratic and liberal legal system, as happens in western countries. In addition, the case of Russia shows that even medium-low pro-bass income countries can reach high levels of scientific and technological production despite low levels in terms of rule of law.

Figure 5. Relationship between rule of law and Scientific and Technological Journal Articles in 2018.

- *Life expectancy at birth, total:* is a variable that considers the number of years in which a new born would live according to the prevailing models of mortality at birth were constant throughout his life. There is a positive relationship between the life expectancy at the birth and the Rule of Law value. This trend can be analysed considering the top ten of the countries by the value of the Life Expectancy at Birth. Japan is in the first place for Life Expectancy at Birth value with a value of 84.62, followed by Singapore with 83.74, South Korea with 83.43, Norway with 83.21, Australia with 83.20, Switzerland with 83.10, Iceland with 83.07, Israel with 82.70, Malta with 82.65 and Sweden with 82.41. The top ten countries have high levels of Rule of Law. There is therefore a positive relationship between Rule of Law and Life Expectancy. This relationship may be since the conditions that allow the achievement of high levels of life expectancy require a level of economic, psychological, and social well -being that only a system of rule of Law can guarantee. In fact, the presence of a legal system capable of guaranteeing compliance with the law is the prerequisite for development and economic growth that has a very positive impact in terms of life expectancy.
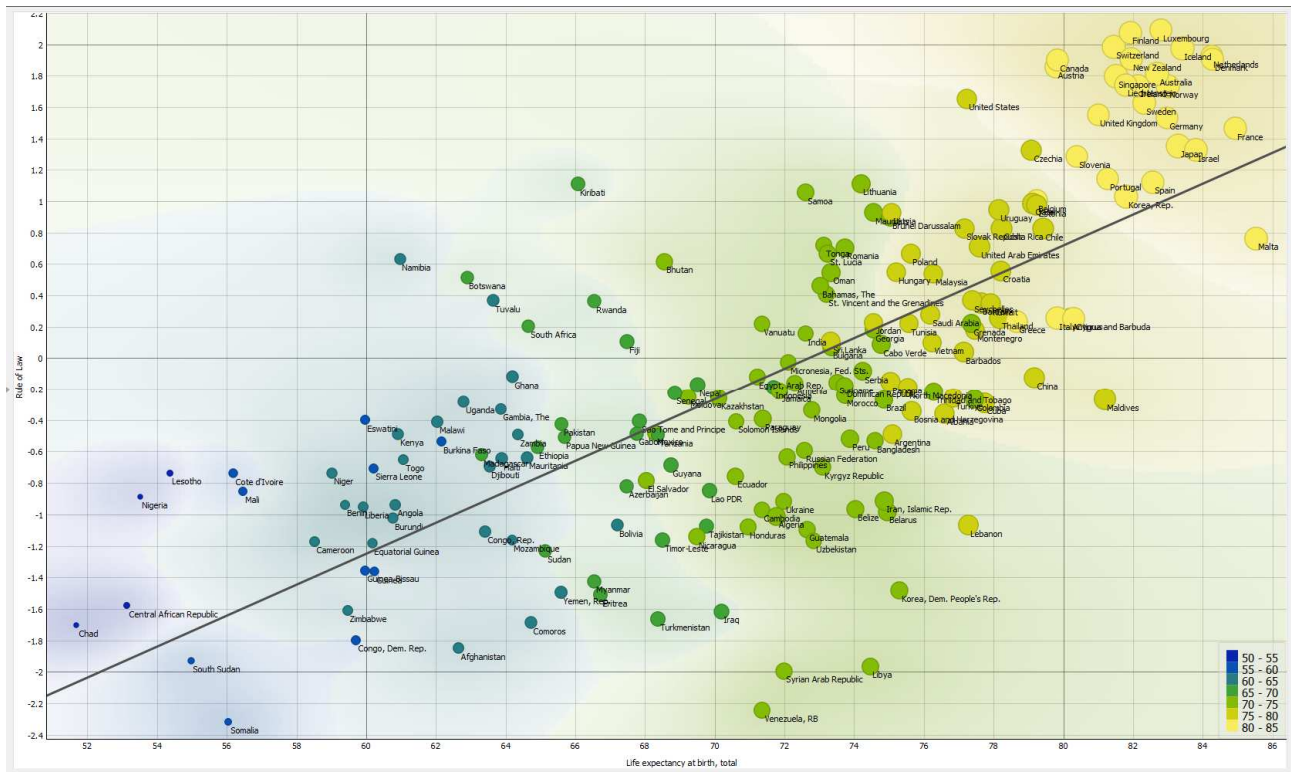
Figure 6. Rule of Law and Life Expectancy at Birth in 2020.

- *Population ages 65 and above:* Analyses the population having an age equal to or over 65 years of age in percentage of the total population. There is a positive relationship between the percentage of the population having an age equal to or over 65 years of age and the value of the rule of law at country level. In fact, if we consider, by way of example, the top ten of the countries by the value of the population having an age equal to or over 65 years of age, it is possible to note that 6 of the 10 countries have very high values of rule of Law or: Japan, Finland, Portugal, Germany, Latvia, and France. There are also 4 countries in the top ten for percentage of the population equal to or over 65 years of age who have the values of medium-low rule of law i.e.: Italy, Bulgaria, Greece, and Croatia. The presence of a positive relationship between Rule of Law and percentage of the population having an age equal to or over 65 years of age has its social-economic reasons. Generally, the legal systems inspired by the Rule of Law also allow the implementation of a series of economic policies that are positively connected to the ageing of the population such as pensions, efficient health systems, and social protection organizations. These economic policies are scarce in countries that have low level of Rule of Law or countries that have an anti-democratic and anti-social inspiration.
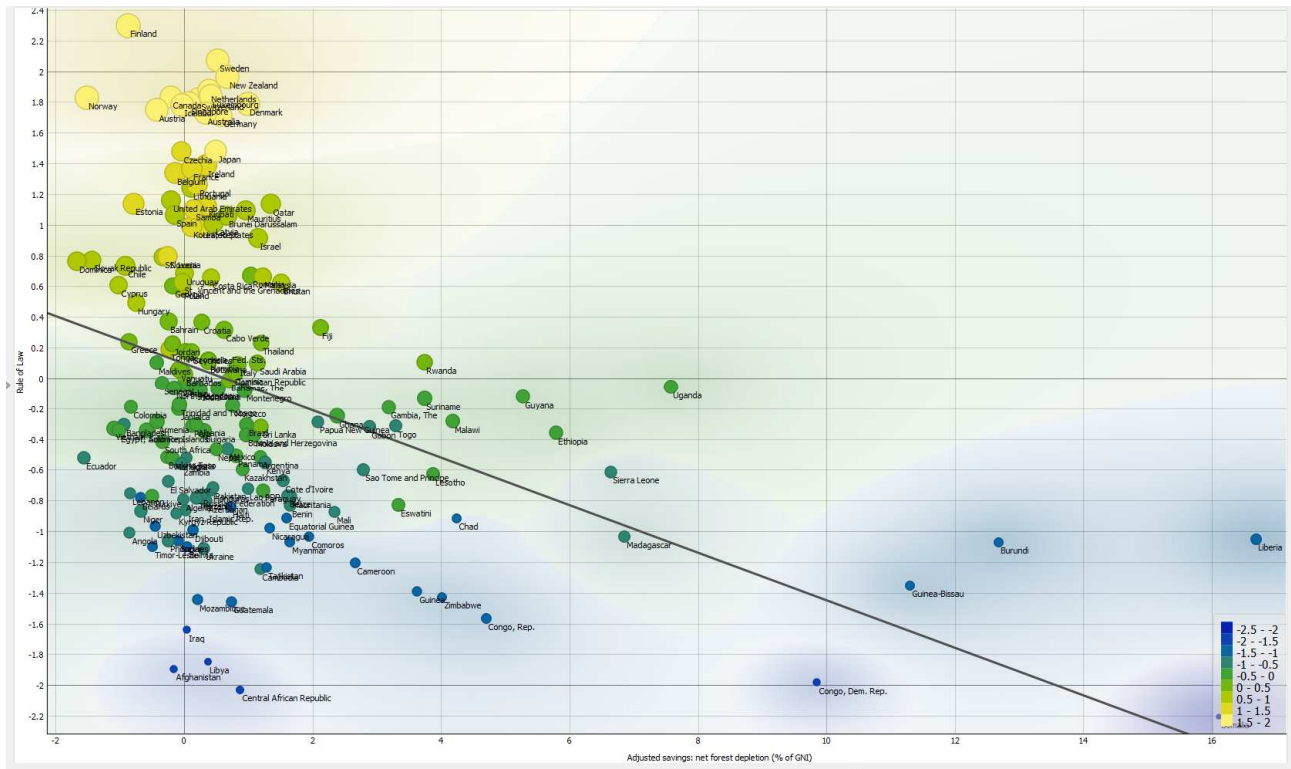
Figure 7. The relationship between rule of law and population ages 65 and above.

- *Individuals using the Internet:* this variable considers people who have used the Internet in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games for games, digital TV etc. There is a positive relationship between the use of the Internet and the value of Rule of Law. For example, if we consider the top ten of the countries for the value of the percentage of the population that uses the Internet, it is possible to note that 7 of these countries also have very high values of Rule of Law or: United Arab Emirates, Qatar, Iceland, Luxembourg, Norway, Denmark, South Korea. Three of the countries in the top ten for the value of the use of the internet as a percentage of the population have instead the medium-low values of Rule of Law or Bahrain, Kuwait, and Saudi Arabia. The creation of economic and industrial systems that can facilitate the spread of new technologies at the population, as precisely in the case of the Internet, requires a solid legal structure at the country level. The motivation lies in the fact that to create digital infrastructures it is necessary to involve large companies, and invest large amount of human and financial resources i.e. activities that requires medium-high levels of rule of law.

Figure 8. Relationship between rule of law and individuals using the internet as percentage of population.

We found that there is a negative relationship between Rule of Law and:

- *Adjusted Savings Natural Resources Depletion:* is a variable that considers the depletion of the forests due to the excess of wood collection. There is a negative relationship between the value of the depletion of the forests and the value of Rule of Law. In fact, if we consider the top ten of the countries for the value forest depletion in connection with the related value of Rule of Law we have the following results: Liberia with 17.65 and -1.02; Somalia with 14.92 and -2.31; Burundi with 12.35 and -1.32; Guinea -Bissau with 10.35 and -1.38; Congo dem. Rep. With 9.64 and -1.80; Uganda with 7.40 and -0.34; Sierra Leone with 7.08 and -0.77; Madagascar with 5.44 and -0.86; Congo, Rep. With 5.18 and -1.16; Ethiopia with 5.12 and -0.39. Considering these values, it is evident why there is a negative relationship between rule of law and depletion of forests. The top ten for forest depletion is a set of African countries that have very low values of rule of law. In fact, one of the reasons for which the depletion of the forests exists is precisely the lack of rule of law since forests are generally protected areas precisely by regulatory provisions. Therefore it is possible that if there was a greater level of rule of law it would also be possible to defend the forests from depletion.

Figure 9. The negative relationship between rule of law and adjusted savings: net forest depletion % of GNI.

- *Access to Electricity:* measures the percentage of population that has access to electricity. There is a negative relationship between the value of the population that has access to the electricity and the value of Rule of Law. This negative relationship is counterfactual. However, it can be better analysed considering that many of the countries that have 100% of the population with access to electricity have very low levels of rule of law as for example: Venezuela with a rule of law value of -2.33, Iraq with -1.78, Turkmenistan with -1.38, Uzbekistan -1.08, Belarus -1.05, Lebanon -0.89, Iran Islamic Rep. -0.87, Lao PDR -0.86, Russian Federation -0.79, El Salvador -0.75, Nauru -0.75, Azerbaijan -0.72, Ukraine -0.69. The negative relationship between rule of law and access to electricity is mainly due to the fact that the technologies that allow the access to electricity to the entire population are also widely available in countries, such as Venezuela, which have low levels of Rule of Law.

- *Prevalence of Overweight*: is a variable that considers the prevalence of overweight adults as a percentage of adults aged 18 or over 18 whose body mass index (BMI) is more than 25 kg/m2. The body mass index (BMI) is a simple weight index for height or the weight in kilograms divided by the height square into meters. There is a negative relationship between the Rule of Law value and the percentage of overweight people. This relationship may seem counterfactual. If we consider the values of the top ten countries for percentage of overweight, it is possible to note that these are countries that have medium-low values of rule of law. For example, the first country for the value of overweight people as a percentage of the population is Nauru with a value of 88.5%, a country that has a rule of law value of -0.77. Another country that is in the top ten for percentage of overweight people is Marshall Islands which has an amount of 83.5 and a rule of law value of -0.03. In the top ten there are then a set of countries that have a high value in terms of percentage of overweight population and which at the same time also have a medium low value of rule of law such as Palau, Tuvalu, Kiribati, Tonga, Samoa, Micronesia , Kuwait, Qatar. On the other hand, it is possible to note that countries that have high Rule of Law values are in the middle-low part of the ranking for percentage of the

population in overweight population such as: France is in 54th place in the ranking with an equal value At 59.5, Italy is in 64th place, Germany at 80 °, Austria is in 98th place, Switzerland in the 99th and Japan in 160th place.

Estimation of Rule of Law with Different Econometric Techniques							
Rule of Law		**Random Effects**		**Fixed-Effects**		**Pooled OLS**	**Average**
		Coefficient	*p-Value*	*Coefficient*	*p-Value*	*Coefficient*	*p-Value*	
	Const	-0,765239	***	-0,6588370	***	-0,41340	***	-0,612492
A2	*Access to electricity (% of population)*	-0,002770	***	-0,0027642	***	-0,00061	*	-0,002048
A3	*Adjusted savings: natural resources depletion (% of GNI)*	-0,002833	***	-0,0038019	***	0,00163	***	-0,001668
A12	*Control of Corruption: Estimate*	0,219044	***	0,1242020	***	0,45840	***	0,267216
A32	*Individuals using the Internet (% of population)*	0,000433	*	0,0012710	***	0,00120	***	0,000968
A34	*Life expectancy at birth, total (years)*	0,013853	***	0,0182216	***	0,00687	***	0,012983
A47	*Political Stability and Absence of Violence/Terrorism: Estimate*	0,124325	***	0,1089850	***	0,13166	***	0,121656
A48	*Population ages 65 and above (% of total population)*	0,010750	***	0,0186308	***	-0,00642	***	0,007655
A51	*Prevalence of overweight (% of adults)*	-0,002404	**	-0,0137176	***	-0,00105	**	-0,005722
A55	*Regulatory Quality: Estimate*	0,358027	***	0,3396790	***	0,31152	***	0,336408
A62	*Scientific and technical journal articles*	0,058489	***	0,0475984	*	0,07946	***	0,061850
A67	*Voice and Accountability: Estimate*	0,169535	***	0,1778630	***	0,11603	***	0,154476

Variables	**Meaning**
Rule of Law: Estimate	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Regulatory Quality: Estimate	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Control of Corruption: Estimate	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Voice and Accountability: Estimate	Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Political Stability and Absence of Violence/Terrorism : Estimate	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.

Scientific and technical journal articles	Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.
Life expectancy at birth, total (years)	Life expectancy at birth indicates the number of years a new born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Population ages 65 and above (% of total population)	Population ages 65 and above as a percentage of the total population. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.
Individuals using the Internet (% of population)	Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.
Adjusted savings: natural resources depletion (% of GNI)	Natural resource depletion is the sum of net forest depletion, energy depletion, and mineral depletion. Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.
Access to electricity (% of population)	Access to electricity is the percentage of population with access to electricity. Electrification data are collected from industry, national surveys, and international sources.
Prevalence of overweight (% of adults)	Prevalence of overweight adults is the percentage of adults ages 18 and over whose Body Mass Index (BMI) is more than 25 kg/m2. Body Mass Index (BMI) is a simple index of weight-for-height, or the weight in kilograms divided by the square of the height in meters.

4. Clusterization with k-Means optimized with the Elbow Method

We apply a k-Means algorithm optimized with the Elbow Method. We found four different clusters.
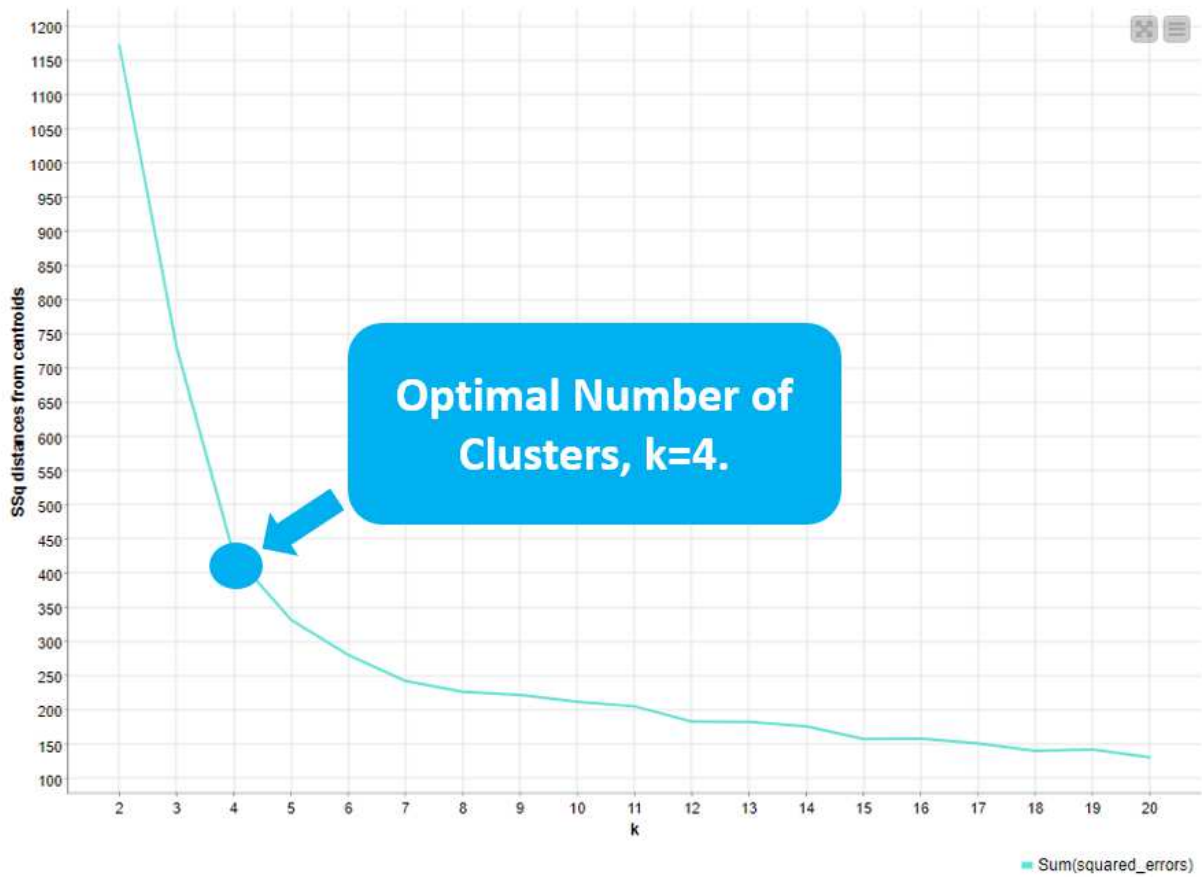
Figure 10. Clusterization with k-Means algorithm optimized with the Elbow Method.
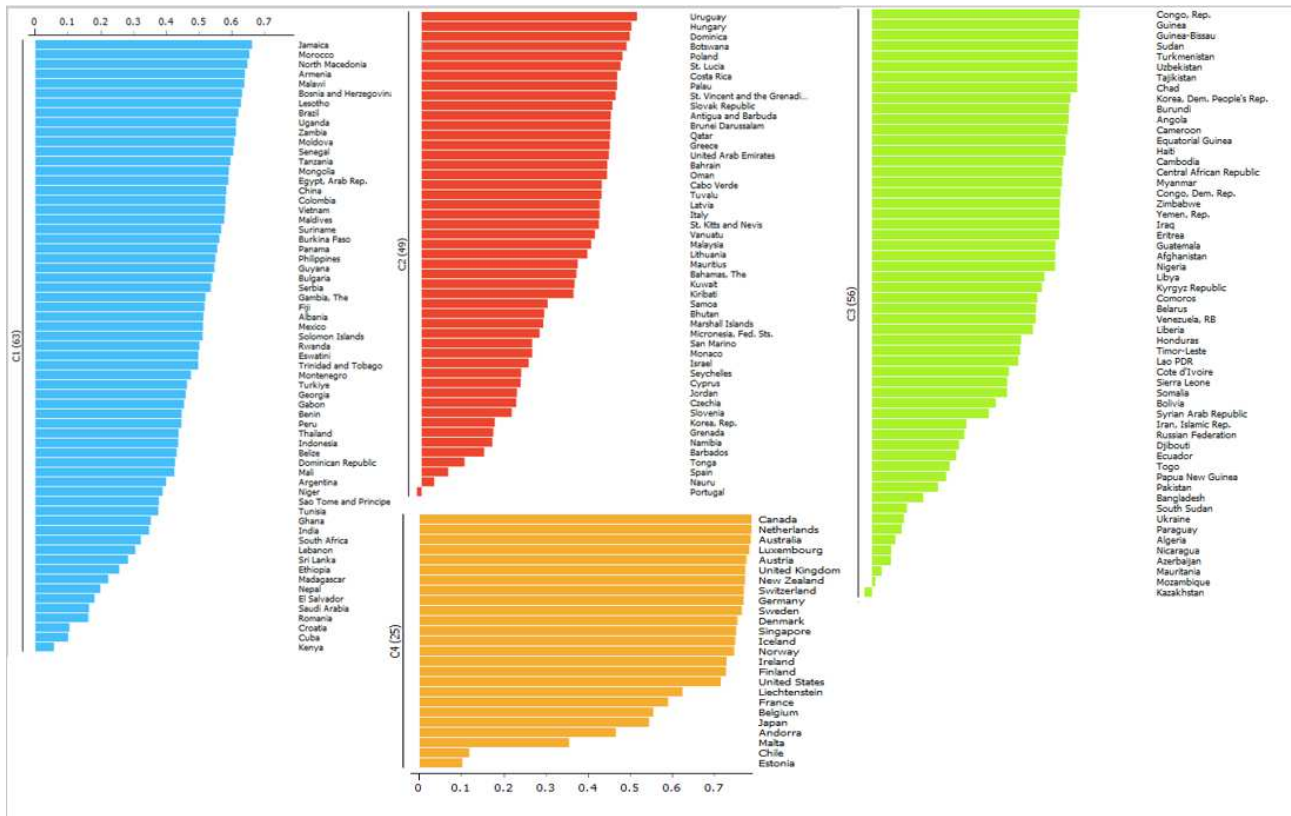

Figure 11. Clusterization with the k-Means algorithm.

- *Cluster 1:* Kenya, Cuba, Croatia, Romania, Saudi Arabia, El Salvador, Nepal, Madagascar, Ethiopia, Sri Lanka, Lebanon, South Africa, India, Ghana, Tunisia, Sao Tome and Principe, Niger, Argentina, Mali, Dominican Republic, Belize, Indonesia, Thailand, Peru, Benin, Gabon, Georgia, Turkiye, Montenegro, Trinidad and Tobago, Eswatini, Rwanda, Solomon Islands, Mexico, Albania, Fiji, Gambia, Serbia, Bulgaria, Guyana, Philippines, Panama, Burkina Faso, Suriname, Maldives, Vietnam, Colombia, China, Egypt, Mongolia, Tanzania, Senegal, Moldova, Zambia, Uganda, Brazil, Lesotho, Bosnia and Herzegovina, Malawi, Armenia, North Macedonia, Morocco, Jamaica;
- *Cluster 2*: Portugal, Nauru, Spain, Tonga, Barbados, Namibia, Grenada, Korea Rep., Slovenia, Czechia, Jordan, Cyprus, Seychelles, Israel, Monaco, San Marino, Micronesia Fed. Sts., Marshall Islands, Bhutan, Samoa, Kiribati, Kuwait, The Bahamas, Mauritius, Lithuania, Malaysia, Vanuatu, St. Kittis and Nevis, Italy, Latvia, Tuvalu, Cabo Verde, Oman, Bahrain, United Arab Emirates, Greece, Qatar, Brunei Darussalam, Antigua and Barbuda , Slovak Republic, St. Vincent and the Grenada, Palau, Costa Rica, St. Lucia, Poland, Botswana, Dominica, Hungary, Uruguay;
- *Cluster 3*: Kazakhstan, Mozambique, Mauritania, Azerbaijan, Nicaragua, Algeria, Paraguay, Ukraine, South Sudan, Bangladesh, Pakistan, Papua New Guinea, Togo, Ecuador, Djibouti, Russian Federation, Iran Islamic Rep., Syrian Arab Republic, Bolivia , Somalia, Sierra Leone, Cote d'Ivoire, Lao PDR, Timor, Honduras, Liberia, Venezuela, Belarus, Comoros, Kyrgyz Republic, Libya, Nigeria, Afghanistan, Guatemala, Eritrea, Iraq, Yemen Re., Zimbabwe, Congo Dem. Rep., Myanmar, Central African Republic, Cambodia, Haiti, Equatorial Guinea, Cameroon, Angola, Burundi, Korea Dem. People's Rep., Chad, Tajikistan, Uzbekistan, Turkmenistan, Sudan, Guinea-Bissau, Guinea, Congo Rep.;
- *Cluster 4:* Canada, Netherlands, Australia, Luxembourg, Austria, United Kingdom, New Zealand, Switzerland, Germany, Sweden, Denmark, Singapore, Iceland, Norway, Ireland, Finland, United States, Liechtenstein, France, Belgium, Japan, Andorra, Malta, China, Estonia.

Considering the value of the median of each individual cluster, it is possible to verify that the median Rule of Law value of Cluster 4-C4 is equal to an amount of 1.55 units, while the median value of Cluster 2-C2 is equal to an amount of 0.58 units, the value of Cluster 1-C1 is equal to an amount of -0.29 units, and the median value of cluster 3 is equal to an amount of -1.16 units. The following ordering therefore derives: C4=1.55>C2=0.58>C1=-0.29>C3=-1.16.
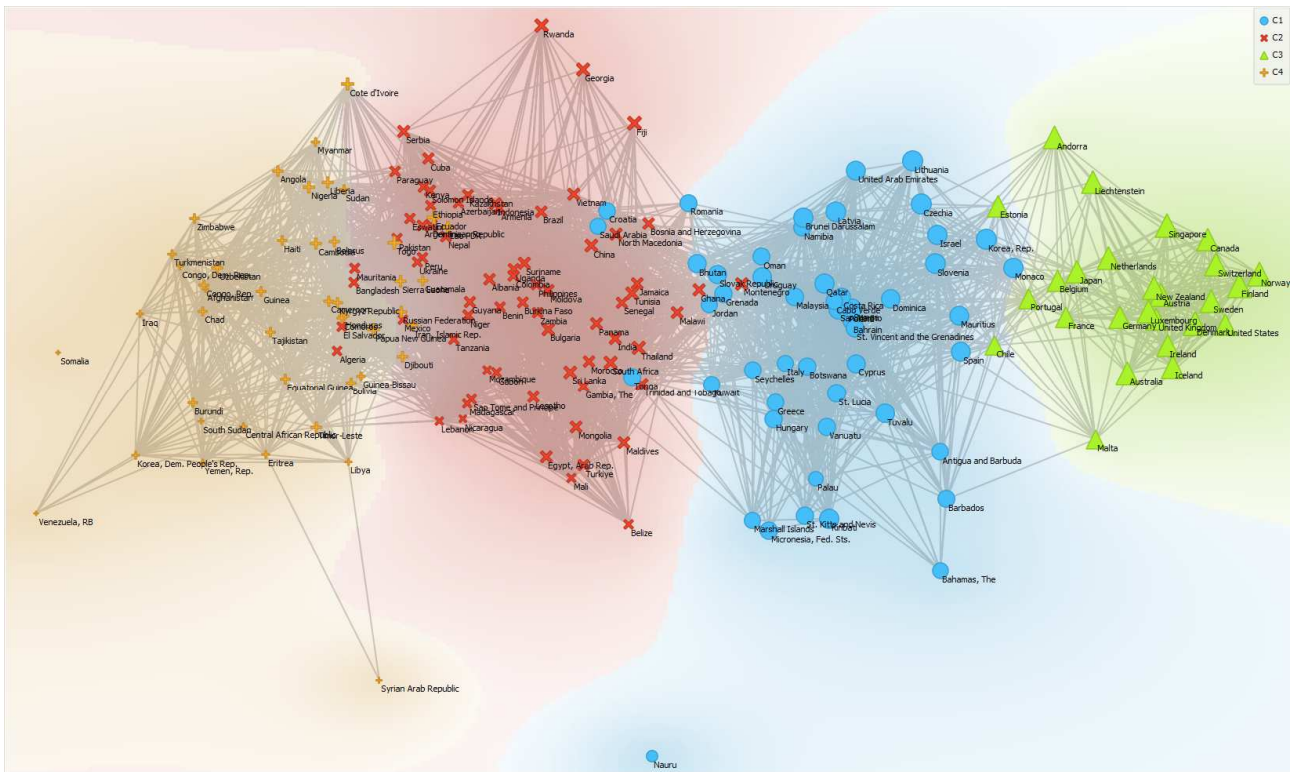
Figure 12. The structure of the clusters.

From a geo-political point of view, it can be noted that the countries which are part of the cluster 4-C4 are coincident with Western countries with a very high per capita income, with few exceptions. Among these countries in Cluster 4-C4 there are all the countries of Western Europe, together with Canada, New Zealand, Australia, United States. Estonia is the only country of Eastern Europe with high levels of Rule of Law. Finally, there are also three Asian countries, namely China, Japan and Singapore. It is relevant to consider the case of China. China is the only country in Cluster 4-C4 with a low per capita income that has a level of Rule of Law comparable to that of Western countries. It therefore follows that the Chinese model, regardless of the size of the per capita income, allows the State and the institutions to obtain high levels of Rule of Law. The high performance of China in terms of Rule of Law is due to its cultural traditions reinforced during the governance of the Communist Party. However, China is also the only country in Cluster 4-C4 that is not a democracy. In fact, China is non-democratic republic. In fact, even if China is a Republic, despite other Republics, it does not contemplate the presence of a plurality of political parties. The Republic of China is a parliamentary republic ruled by a single party. This condition has limited the introduction of democratic freedoms in China. But the absence of democracy in China has not prevented the Chinese State from reaching very high levels in terms of Rule of Law. The high levels of Rule of Law is also essential for Foreign Direct Investments-FDI which require an institutional framework able to recognize intellectual property rights and also the presence of impartial judicial courts. However, this dominance of the law in China has also had paradoxical effects such as those that have occurred in connection with the lockdowns ordered during the COVID-19 pandemic. In fact, the forced closures in the lockdown also had harmful effects and essentially culminated in forms of protest that questioned Xi Jinping's regime. However, with the exception of China, it is possible to verify that in general, high levels of Rule of Law are associated with high levels of GDP and the presence of a liberal and democratic political systems. As can be verified from a comparison between the Freedom Index and the Rule of Law, it can be verified that the vast majority of Cluster 4-C4 countries tend to have both high Freedom Index values and high values in terms of Rule of Law. In the first places for

level of Freedom Index with a maximum level equal to 100 are Finland, Norway, and Sweden which also have high levels in terms of Rule of Law with values equal to 2.05, 1.94 and 1.73 respectively unit. In the last places, within Cluster 4-C4, there are the United States which have a Freedom Index value equal to 83 and a Rule of Law value equal to 1.41, Singapore with a Freedom Index value equal to 48 and a Rule of Law amount equal to 1.85, and finally China with a Freedom Index amount equal to 9 and a Rule of Law value equal to 0.03.
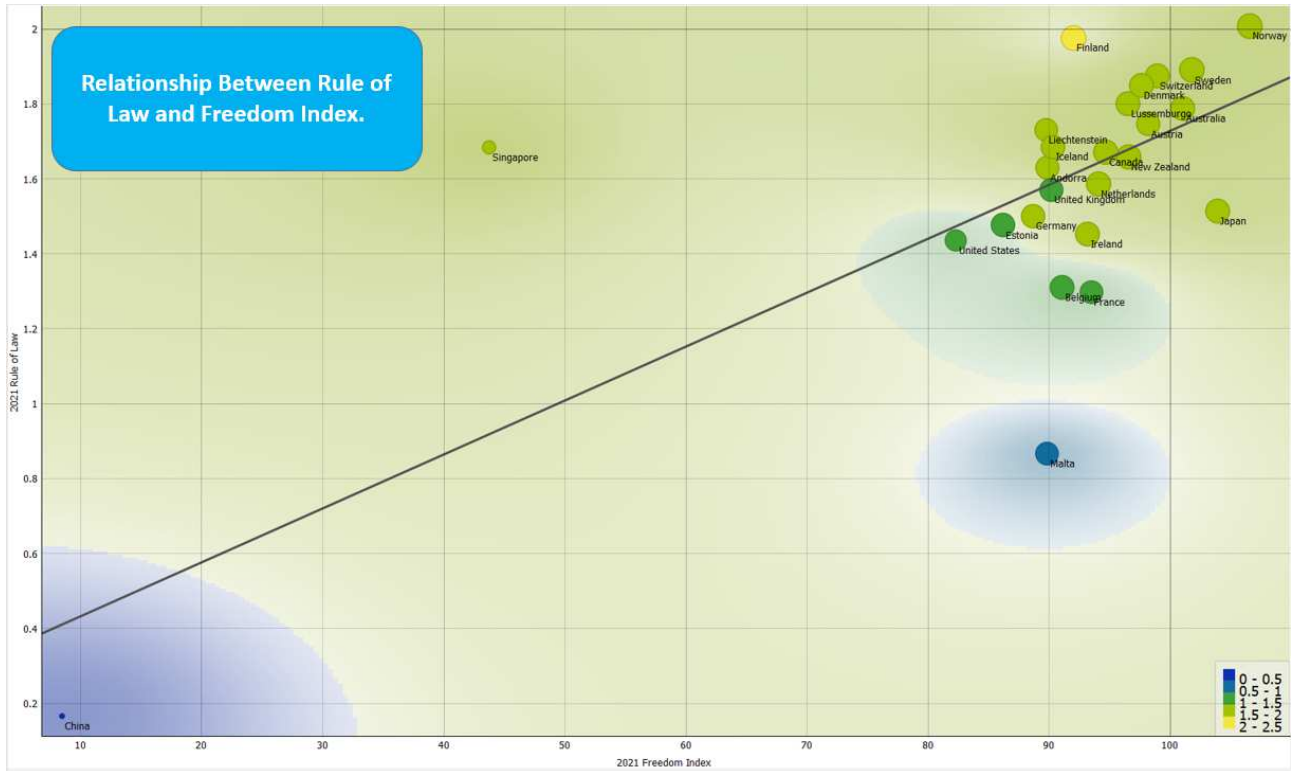
Figure 13. Relationship between Rule of Law and Freedom Index.

5. Machine Learning and Predictions for the Estimation of the Future Value of Rule of Law

Eight different machine learning algorithms were applied to predict the future value of the Rule of Law variable and evaluated based on the analysis of the following statistical indicators, i.e. R-squares, MAE, MSE, RMSE. The algorithms were trained with 80% of the available data, while the remaining 20% was used for the actual prediction. Specifically, the following ordering of the clusters was obtained, i.e.:

- Linear Regression with a payoff equal to 6;
- Gradient Boosted Tree with a payoff equal to 8;
- Polynomial Regression with a payoff equal to 10;
- Simple Tree Regression with a payoff equal to 17;
- Tree Ensemble with a payoff equal to 19;
- Random Forest Regression with a payoff equal to 25;
- ANN-Artificial Neural Network with a payoff equal to 27;
- PNN-Probabilistic Neural Network with a payoff equal to 32.

Ranking of Algorithms for Predictive Performance					
Algorithm	**R^2**	**MAE**	**MSE**	**RMSE**	**Sum**
Linear Regression	3	1	1	1	6
Gradient Boosted Tree Regression	2	2	2	2	8
Polynomial Regression	1	3	3	3	10
Simple Tree Regression	4	5	4	4	17
Tree Ensemble	5	4	5	5	19
Random Forest Regression	6	7	6	6	25
ANN-Artificial Neural Network	7	6	7	7	27
PNN-Probabilistic Neural Network	8	8	8	8	32

Since the construction of the overall ranking, i.e. the payoff, is built by adding the positioning of the individual algorithms within the rankings of the statistical indicators, it follows that the lower the payoff, the greater the performance of the algorithm within the ranking. This method also makes it possible to take into account the variations in predictive capacity that may occur in the transition from one statistical indicator to another. However, it must be considered that, apart from the marginal variations, the Linear Regression algorithm tends to be more performing in all the rankings identified.

Statistical Results of Machine Learning Algorithms				
	ANN	**PNN**	**Simple Tree Regression**	**Random Forest Regression**
R^2	0,96121	0,92901	0,98017	0,97481
MAE	0,03326	0,04487	0,02770	0,03361
MSE	0,00163	0,00353	0,00108	0,00159
RMSE	0,04042	0,05943	0,03280	0,03983
	Gradient Boosted Tree Regression	**Tree Ensemble**	**Linear Regression**	**Polynomial Regression**
R^2	0,98668	0,97840	0,98635	0,98859
MAE	0,01803	0,02769	0,01571	0,01814
MSE	0,00100	0,00127	0,00000	0,00100
RMSE	0,02413	0,03566	0,02206	0,02490

The analysis shows that through the application of the most performing algorithm, i.e. the "Linear Regression", it is possible to verify the following predictions, i.e.:

- Albania with a diminutive variation from an amount of -0.256 units up to a value of -0.349 units or equal to a value of -0.093 units equal to a value of -36.330%;
- Central African Republic with a diminutive variation from an amount of -1.667 units up to a value of -1.820 units or equal to a value of -0.153 units equal to an amount of -9.180%;
- Chad with a variation from an amount of -1.325 up to a value of -1.387 units or equal to a value of -0.062 equal to a value equal to -4.680%;
- Chile with an increase from an amount of 0.914 units up to a value of 0.921 units or equal to an amount of 0.007 units equal to a value of 0.770%;
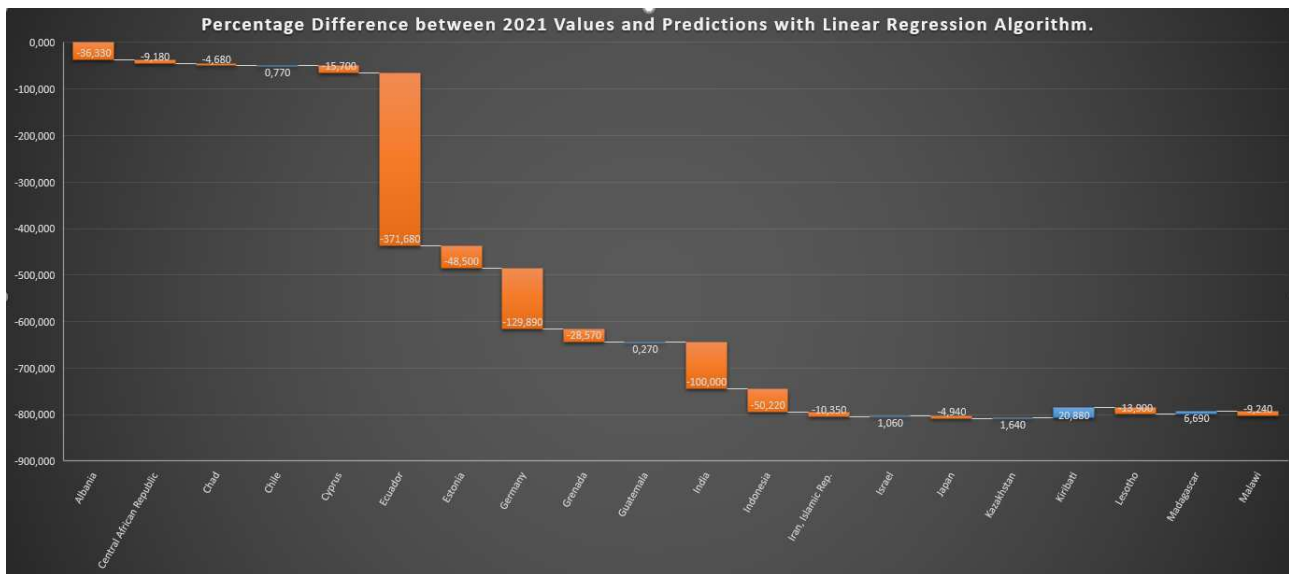
Figure 14. Percentage Difference Between 2021 Values and Predictions with Linear Regression Algorithm.

- Cyprus with a diminutive variation from an amount of 0.637 units up to a value of 0.537 units or equal to a value of -0.100 units equal to a value of -15.700%;
- Ecuador with a diminutive variation from an amount of -0.339 units up to a value of 0.921 or equal to an amount of 1.260 units equal to an amount of -371.680%;
- Estonia with a diminutive variation from an amount of 1.043 units up to a value of 0.537 units or equal to a variation of -0.506 equal to a value of -48.500%;
- Germany with a diminutive variation from an amount of 1.609 units up to a value of -0.481 units equal to an amount of -2.090 units equal to a value of -129.890%;
- Grenada with a diminutive variation from an amount of 0.511 units up to a value of 0.365 units or equal to a value of -0.146 units equal to a value of -28.570%;
- Guatemala with an increasing variation from an amount of -1.093 units up to a value of -1.090 units equal to a value of 0.003 units equal to a value of 0.270%;
- India with a diminutive variation from an amount of -0.081 units up to a value of 0.000 units;
- Indonesia with a variation from an amount of -0.225 units up to a value of -0.338 units or equal to a value of -0.113 units equal to a value of -50.220%;
- Iran Islamic Rep. with an increasing variation from an amount of -0.947 units up to a value of -0.849 units or equal to a value of 0.098 units equal to a value of -10.350%;
- Israel with an increasing variation from an amount of 0.9432 units up to a value of 0.952 units equal to an amount of 0.010 units equal to a value of 1.060%;
- Japan with a variation from an amount of 1.579 units up to a value of 1.501 units equal to an amount of -0.078 units equal to a value of -4.940%;
- Kazakhstan with an increasing variation from an amount of -0.487 units up to an amount of -0.479 units equal to an amount of 0.008 units equal to a value of 1.640%;
- Kiribati with an increasing variation from an amount of 0.891 units up to a value of 1.077 units equal to a value of 0.186 units equal to a value of 20.880%;
- Lesotho with a variation from an amount of -0.410 units up to an amount of -0.467 units or equal to a value of -0.057 units equal to an amount of -13.900%;
- Madagascar with an increasing variation from an amount of -0.867 units up to a value of -0.809 units equal to an amount of 0.058 units equal to an amount of 6.690%;
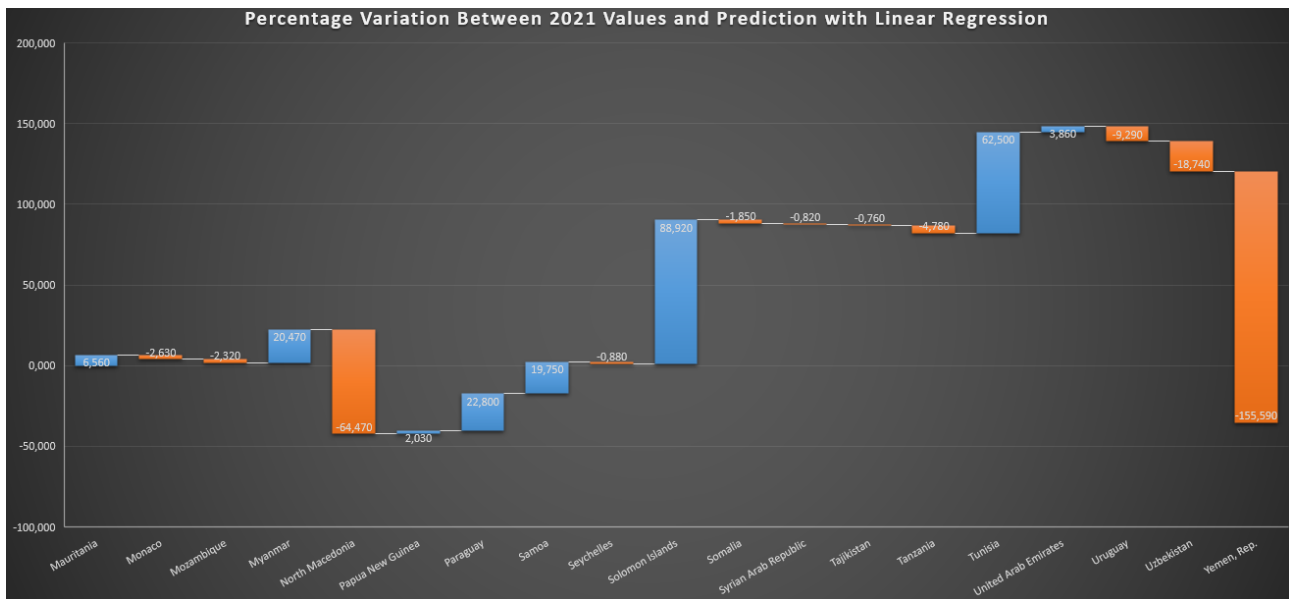
Figure 15. Percentage Variation Between 2021 Values and Prediction with Linear Regression.

- Malawi with a diminutive variation from an amount of -0.238 units up to a value of -0.260 units or equal to a value of -0.022 units equal to a value of -9.240%;
- Mauritania with an increasing variation from an amount of -0.671 units up to a value of 0.627 units equal to a value of 0.044 units equal to a value of 6.560%;
- Monaco with a variation from an amount of 0.911 units up to a value of 0.887 units or equal to a value of -0.024 units equal to a value of -2.630%;
- Mozambique with a variation from an amount of -1.035 units up to a value of -1.059 or equal to an amount of -0.024 units equal to a value of -2.320%;
- Myanmar with a variation from an amount of -1.456 units up to a value of -1.158 units or equal to a value of 0.298 units equal to an amount of 20.470%;
- North Macedonia with a variation from an amount of -0.076 units up to a value of -0.0125 units or equal to an amount of -0.049 units equal to a value of -64.470%;
- Papua New Guinea with a variation from an amount of -0.740 to an amount of -0.725 or equal to an amount of 0.015 units equal to a value of 2.030%;
- Paraguay with a variation from an amount of -0.557 units up to a value of -0.430 units equal to an amount of 0.127 units equal to a value of 22.800%;
- Samoa with a variation from an amount of 0.891 units up to a value of 1.067 units or equal to an amount of 0.176 units equal to an amount of 19.75%;
- Seychelles with a variation from an amount of 0.341 units up to a value of 0.338 units or equal to a value of -0.003 units equal to an amount of -0.880%;
- Solomon Islands with a variation from an amount of -0.352 units up to a value of -0.039 units equal to an amount of 0.313 units equal to a value of 88.920%;
- Somalia with a diminutive variation from an amount of -2.273 units up to a value of -2.315 units or equal to an amount of -0.042 units equal to an amount of -1.85%;
- Syrian Arab Republic with a change from an amount of -2.070 units equal to a value of -2.087 units equal to a value of -0.017 units equal to a value of -0.820%;
- Tajikistan with a variation from an amount of -1.185 units up to a value of -1.194 units or equal to a value of -0.009 units equal to a value of -0.760%;
- Tanzania with a change from an amount of -0.523 units equal to a value of -0.548 units equal to an amount of -0.025 units equal to an amount of -4.780%;

- Tunisia with a change from an amount of 0.096 units equal to an amount of 0.156 units equal to a value of 0.060 units equal to a value of 62.500%;
- United Arab Emirates with a variation from an amount of 0.830 units up to a value of 0.862 units or equal to a value of 0.032 units equal to an amount of 3.860%.

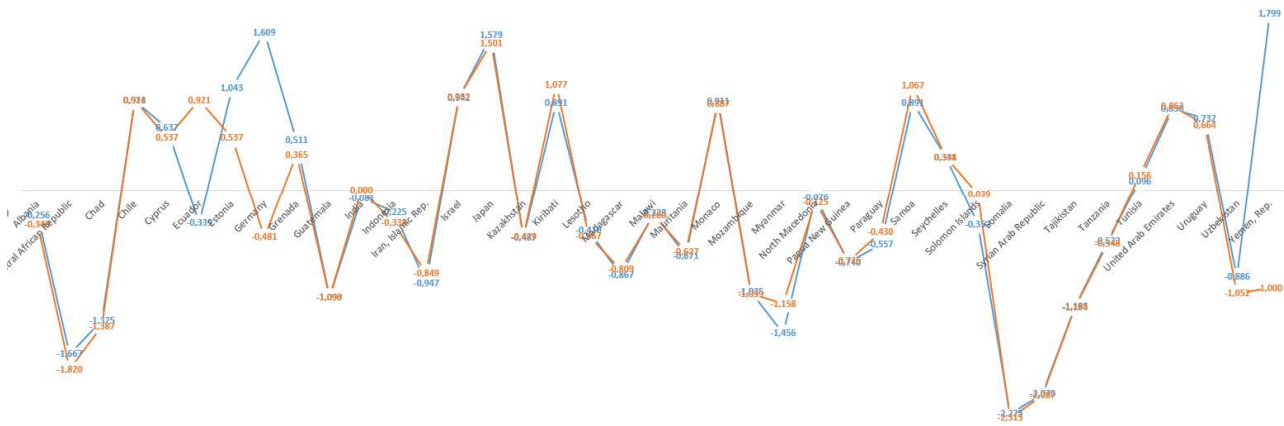RELATIONSHIP BETWEEN DATA OF 2021 AND PREDICTIONS

Figure 16. Relationship between data of 2021 and Predictions with the Linear Regression Algorithm.

- Uruguay con una variazione diminutiva da un ammontare di 0,732 unità fino ad un valore di 0,664 unità ovvero pari ad un ammontare di -0,068 unità pari ad un valore di -9,290%;
- Uzbekistan con una variazione da un ammontare di -0,886 pari ad una variazione di -1,052 unità pari ad un ammontare di -0,166 unità pari ad un valore di -18,74%;
- Yemen Rep. con una variazione da un ammontare di 1,799 unità fino ad un valore di 1,00 unità ovvero pari ad un ammontare di -2,799 unità equivalente ad una variazione di 155,590%;

2021 Values and Predictions with the Application of the Best Predictor Linear Regression										
Rank	*Country*	2021	Prediction	Abs Var	% Var	Rank	*Country*	2021	Prediction	Abs Var	% Var
1	*Albania*	-0,256	-0,349	-0,093	-36,330	21	*Mauritania*	-0,671	-0,627	0,044	6,560
2	*Central African Republic*	-1,667	-1,820	-0,153	-9,180	22	*Monaco*	0,911	0,887	-0,024	-2,630
3	*Chad*	-1,325	-1,387	-0,062	-4,680	23	*Mozambique*	-1,035	-1,059	-0,024	-2,320
4	*Chile*	0,914	0,921	0,007	0,770	24	*Myanmar*	-1,456	-1,158	0,298	20,470
5	*Cyprus*	0,637	0,537	-0,100	-15,700	25	*North Macedonia*	-0,076	-0,125	-0,049	-64,470
6	*Ecuador*	-0,339	0,921	1,260	-371,680	26	*Papua New Guinea*	-0,740	-0,725	0,015	2,030
7	*Estonia*	1,043	0,537	-0,506	-48,500	27	*Paraguay*	-0,557	-0,430	0,127	22,800
8	*Germany*	1,609	-0,481	-2,090	-129,890	28	*Samoa*	0,891	1,067	0,176	19,750
9	*Grenada*	0,511	0,365	-0,146	-28,570	29	*Seychelles*	0,341	0,338	-0,003	-0,880
10	*Guatemala*	-1,093	-1,090	0,003	0,270	30	*Solomon Islands*	-0,352	-0,039	0,313	88,920

11	*India*	-0,081	0,000	0,081	-100,000	31	*Somalia*	-2,273	-2,315	-0,042	-1,850
12	*Indonesia*	-0,225	-0,338	-0,113	-50,220	32	*Syrian Arab Republic*	-2,070	-2,087	-0,017	-0,820
13	*Iran, Islamic Rep.*	-0,947	-0,849	0,098	-10,350	33	*Tajikistan*	-1,185	-1,194	-0,009	-0,760
14	*Israel*	0,942	0,952	0,010	1,060	34	*Tanzania*	-0,523	-0,548	-0,025	-4,780
15	*Japan*	1,579	1,501	-0,078	-4,940	35	*Tunisia*	0,096	0,156	0,060	62,500
16	*Kazakhstan*	-0,487	-0,479	0,008	1,640	36	*United Arab Emirates*	0,830	0,862	0,032	3,860
17	*Kiribati*	0,891	1,077	0,186	20,880	37	*Uruguay*	0,732	0,664	-0,068	-9,290
18	*Lesotho*	-0,410	-0,467	-0,057	-13,900	38	*Uzbekistan*	-0,886	-1,052	-0,166	-18,740
19	*Madagascar*	-0,867	-0,809	0,058	6,690	39	*Yemen, Rep.*	1,799	-1,000	-2,799	-155,590
20	*Malawi*	-0,238	-0,260	-0,022	-9,240						

6. Conclusion

The analysis conducted shows that Rule of Law value is positively associated with the other variables that are representative of the good governance i.e. Regulatory Quality, Control of Corruption, Voice and Accountability, Political Stability and Absence of Violence/Terrorism. These positive relationships represent the fact that the variables relating to good governance are closely connected to each other. Furthermore, it appears that Rule of Law is also positively connected to the life expectancy, the production of scientific and technological articles, and the percentage of the over 65 on the total population. These relationships indicate that Rule of Law is needed either to support the scientific and technological progress either to guarantee longevity for the population. However, there are many differences in terms of rule of law among countries as showed in the cluster analysis. Many low-income countries also have low values of Rule of Law and this condition indicates that the law is a key element not only for economic growth, but also for environment sustainability and social justice.

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8. Declarations

9. Table of Abbreviations

Partial List of Abbreviations	
Abbreviations	**Definitions**
OLS	*Ordinary Least Squares*
WLS	*Weighted Least Squares*
ANN	*Artificial Neural Network*
PNN	*Probabilistic Neural Network*
MAE	*Mean Average Error*
MSE	*Mean Squared Error*
RMSE	*Root Mean Squared Error*
FDI	*Foreign Direct Investment*

10. Appendix

12.1 Appendix 1

Random-effects (GLS), using 2696 observations
Included 177 cross-sectional units
Time-series length: minimum 3, maximum 16
Dependent variable: A59

	Coefficient	Std. Error	z	p-value	
const	−0.765239	0.0928035	−8.246	<0.0001	***
A2	−0.00277038	0.000527456	−5.252	<0.0001	***
A3	−0.00283262	0.000719967	−3.934	<0.0001	***
A12	0.219044	0.0147554	14.84	<0.0001	***
A32	0.000432623	0.000249229	1.736	0.0826	*
A34	0.0138528	0.00167421	8.274	<0.0001	***
A47	0.124325	0.00826474	15.04	<0.0001	***
A48	0.0107502	0.00300415	3.578	0.0003	***
A51	−0.00240401	0.00114940	−2.092	0.0365	**

A55	0.358027	0.0138802	25.79	<0.0001	***
A62	5.84888e-07	2.18627e-07	2.675	0.0075	***
A67	0.169535	0.0137171	12.36	<0.0001	***

Mean dependent var	−0.097467	S.D. dependent var	0.965008
Sum squared resid	219.1156	S.E. of regression	0.285670
Log-likelihood	−442.0796	Akaike criterion	908.1591
Schwarz criterion	978.9534	Hannan-Quinn	933.7624
rho	0.619791	Durbin-Watson	0.690472

'Between' variance = 0.0380941

'Within' variance = 0.0167052

mean theta = 0.830488

Joint test on named regressors -

Asymptotic test statistic: Chi-square(11) = 5408.27

with p-value = 0

Breusch-Pagan test -

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: Chi-square(1) = 7287.02

with p-value = 0

Hausman test -

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: Chi-square(11) = 223.825

with p-value = 8.23618e-42

Actual and fitted A59

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.658837	0.102372	−6.436	<0.0001	***
A2	−0.00276417	0.000634221	−4.358	<0.0001	***
A3	−0.00380188	0.000749058	−5.076	<0.0001	***
A12	0.124202	0.0161229	7.703	<0.0001	***
A32	0.00127103	0.000317381	4.005	<0.0001	***
A34	0.0182216	0.00193721	9.406	<0.0001	***
A47	0.108985	0.00846487	12.88	<0.0001	***
A48	0.0186308	0.00455252	4.092	<0.0001	***
A51	−0.0137176	0.00232340	−5.904	<0.0001	***
A55	0.339679	0.0146256	23.22	<0.0001	***
A62	4.75984e-07	2.45567e-07	1.938	0.0527	*
A67	0.177863	0.0156953	11.33	<0.0001	***

Fixed-effects, using 2696 observations

Included 177 cross-sectional units

Time-series length: minimum 3, maximum 16

Dependent variable: A59

|			
Mean dependent var	−0.097467	S.D. dependent var	0.965008
Sum squared resid	41.89668	S.E. of regression	0.129249
LSDV R-squared	0.983306	Within R-squared	0.450288
LSDV F(187, 2508)	789.9785	P-value(F)	0.000000
Log-likelihood	1788.042	Akaike criterion	−3200.084
Schwarz criterion	−2090.974	Hannan-Quinn	−2798.966
rho	0.619791	Durbin-Watson	0.690472

Joint test on named regressors -

 Test statistic: F(11, 2508) = 186.763

 with p-value = P(F(11, 2508) > 186.763) = 0

Test for differing group intercepts -

 Null hypothesis: The groups have a common intercept

 Test statistic: F(176, 2508) = 36.5188

 with p-value = P(F(176, 2508) > 36.5188) = 0

Actual and fitted A59
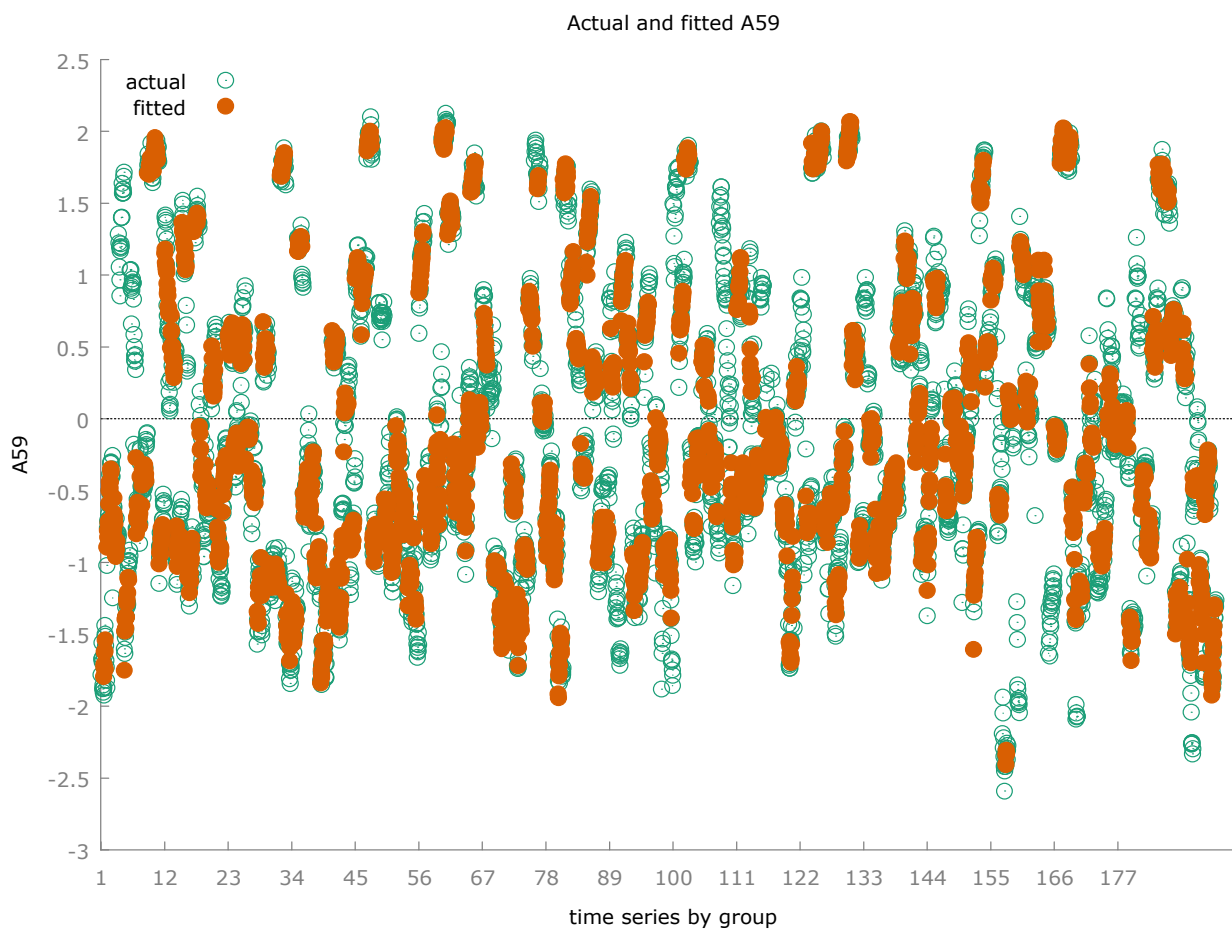
Pooled OLS, using 2696 observations

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.413400	0.0622900	−6.637	<0.0001	***
A2	−0.000609479	0.000317974	−1.917	0.0554	*
A3	0.00162961	0.000602505	2.705	0.0069	***
A12	0.458403	0.0108731	42.16	<0.0001	***
A32	0.00119896	0.000294367	4.073	<0.0001	***
A34	0.00687454	0.00114912	5.982	<0.0001	***
A47	0.131659	0.00734270	17.93	<0.0001	***
A48	−0.00641677	0.00140125	−4.579	<0.0001	***
A51	−0.00104570	0.000409541	−2.553	0.0107	**
A55	0.311517	0.0113467	27.45	<0.0001	***
A62	7.94614e-07	1.20978e-07	6.568	<0.0001	***
A67	0.116029	0.00905782	12.81	<0.0001	***

Included 177 cross-sectional units
Time-series length: minimum 3, maximum 16
Dependent variable: A59

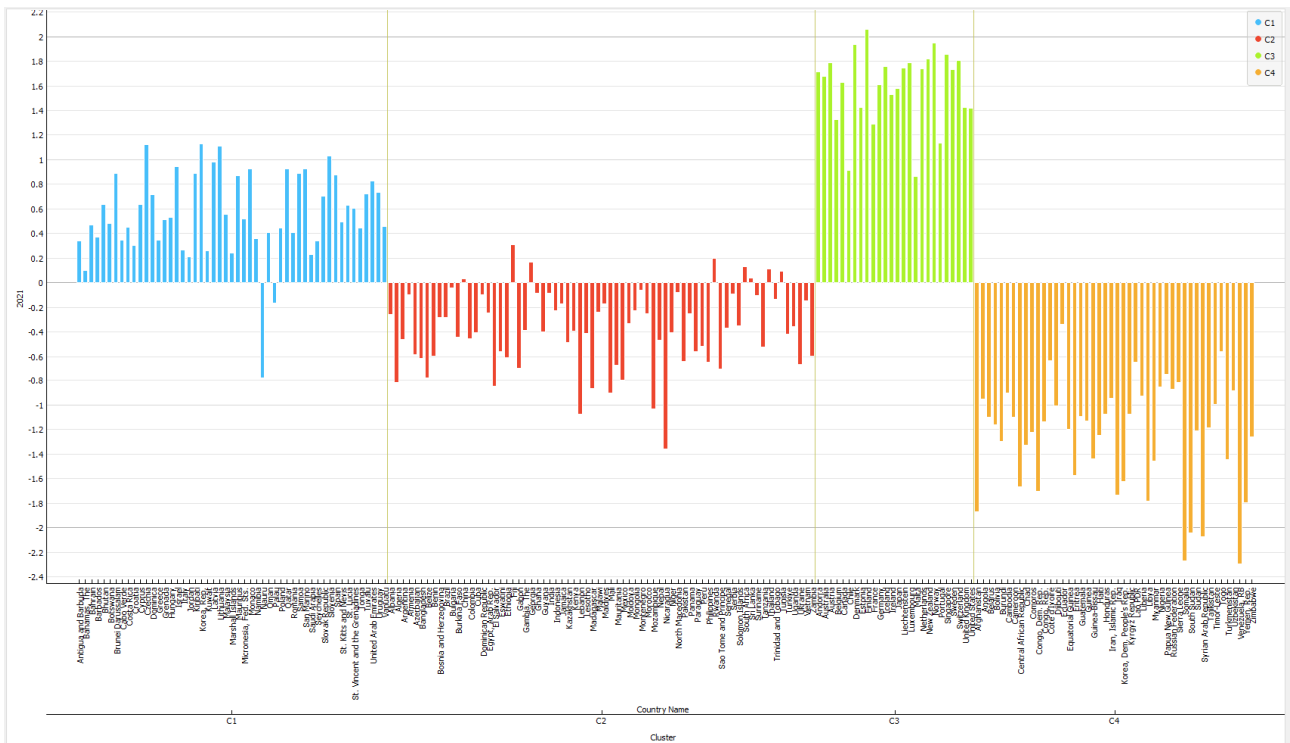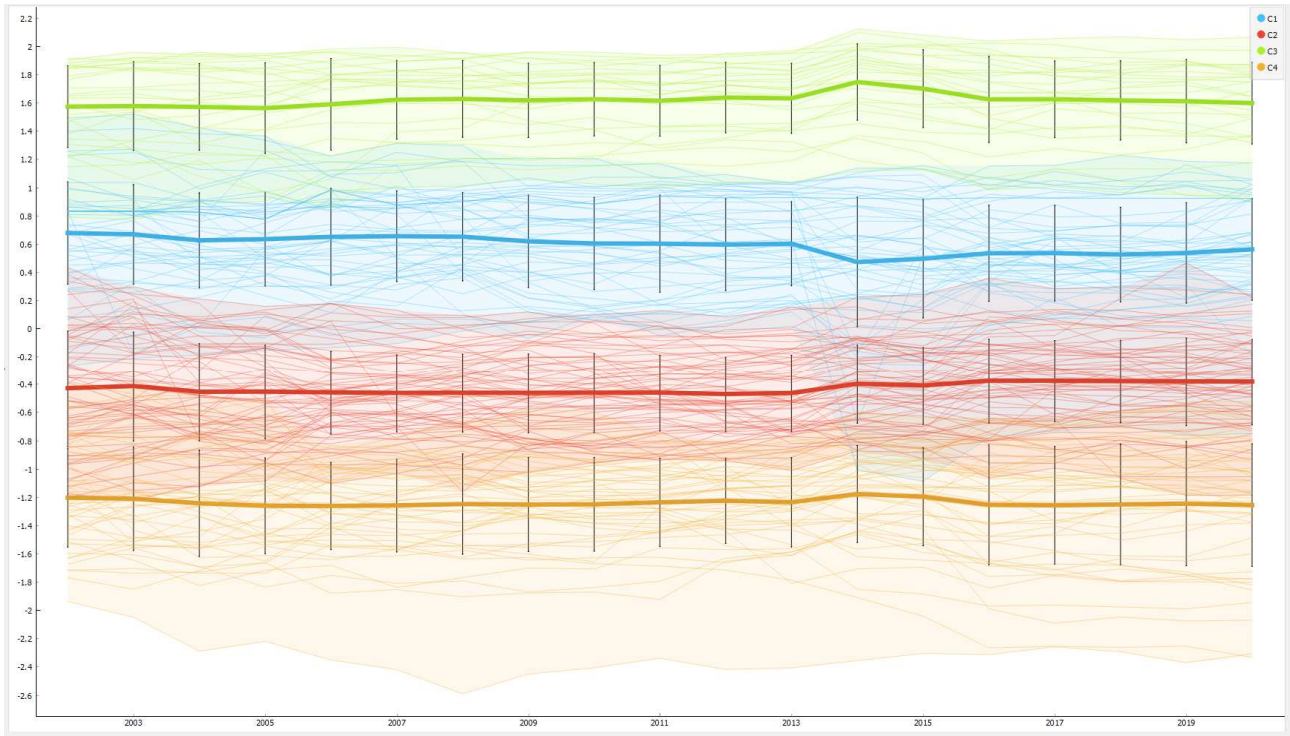|			
Mean dependent var	−0.097467	S.D. dependent var	0.965008
Sum squared resid	149.2664	S.E. of regression	0.235825
R-squared	0.940524	Adjusted R-squared	0.940280
F(11, 2684)	3858.496	P-value(F)	0.000000
Log-likelihood	75.37339	Akaike criterion	−126.7468
Schwarz criterion	−55.95249	Hannan-Quinn	−101.1435
rho	0.873429	Durbin-Watson	0.268576
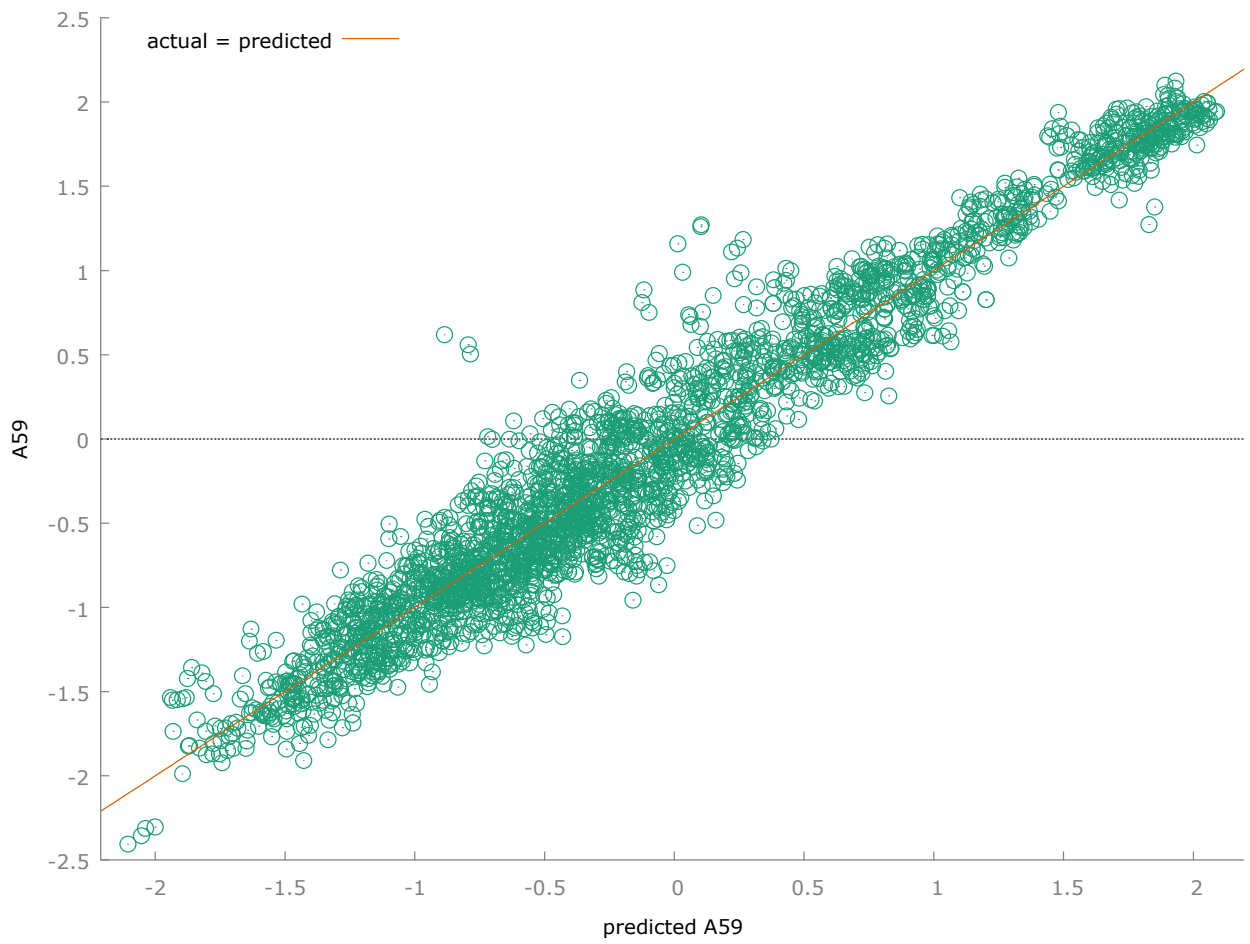
9.2 Clusterization
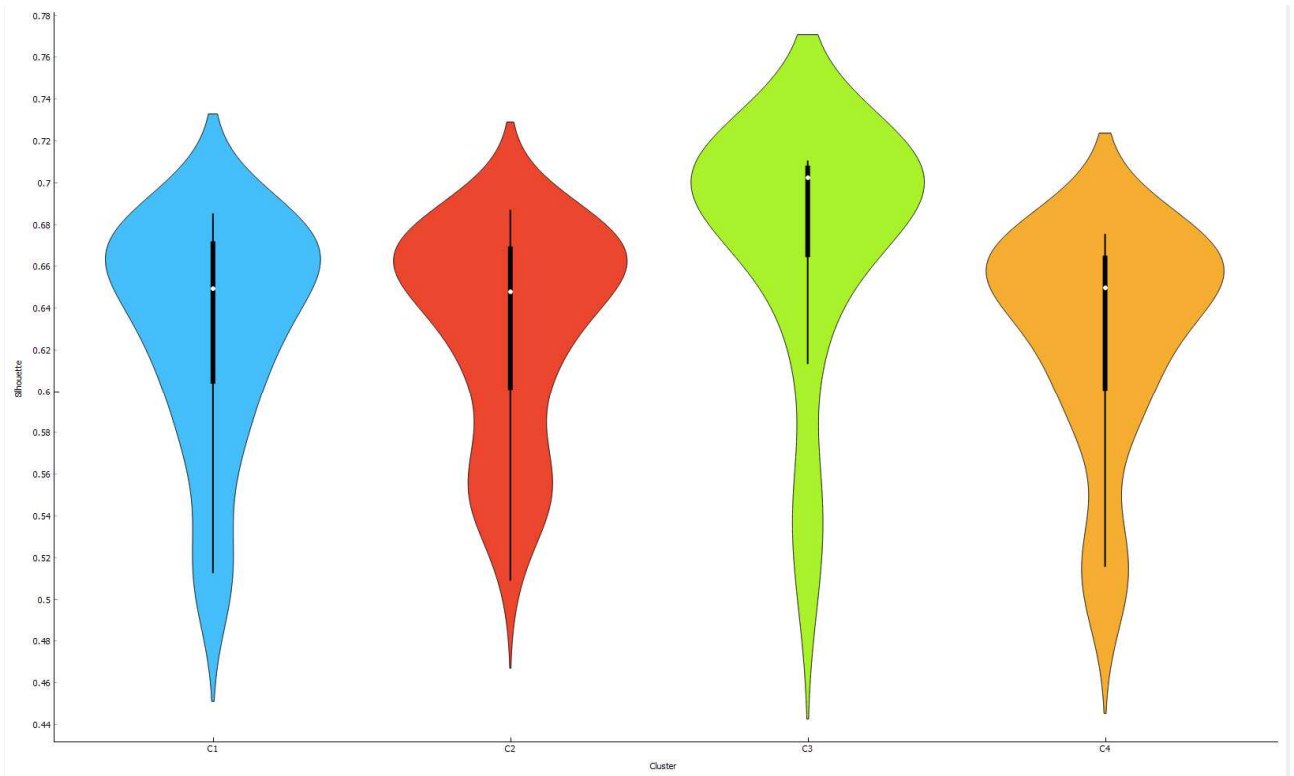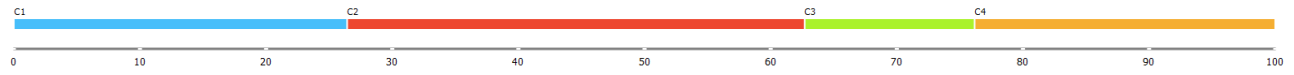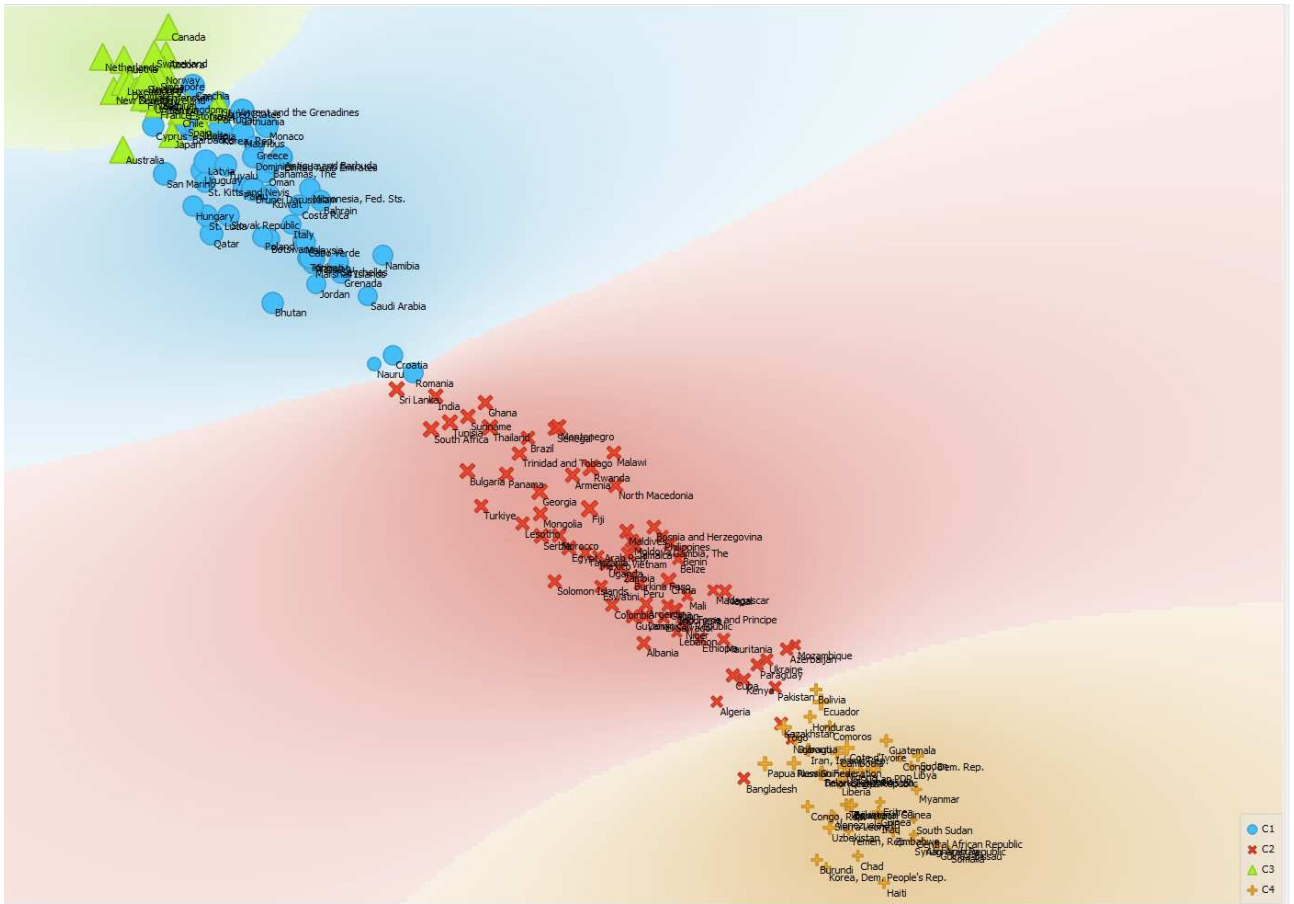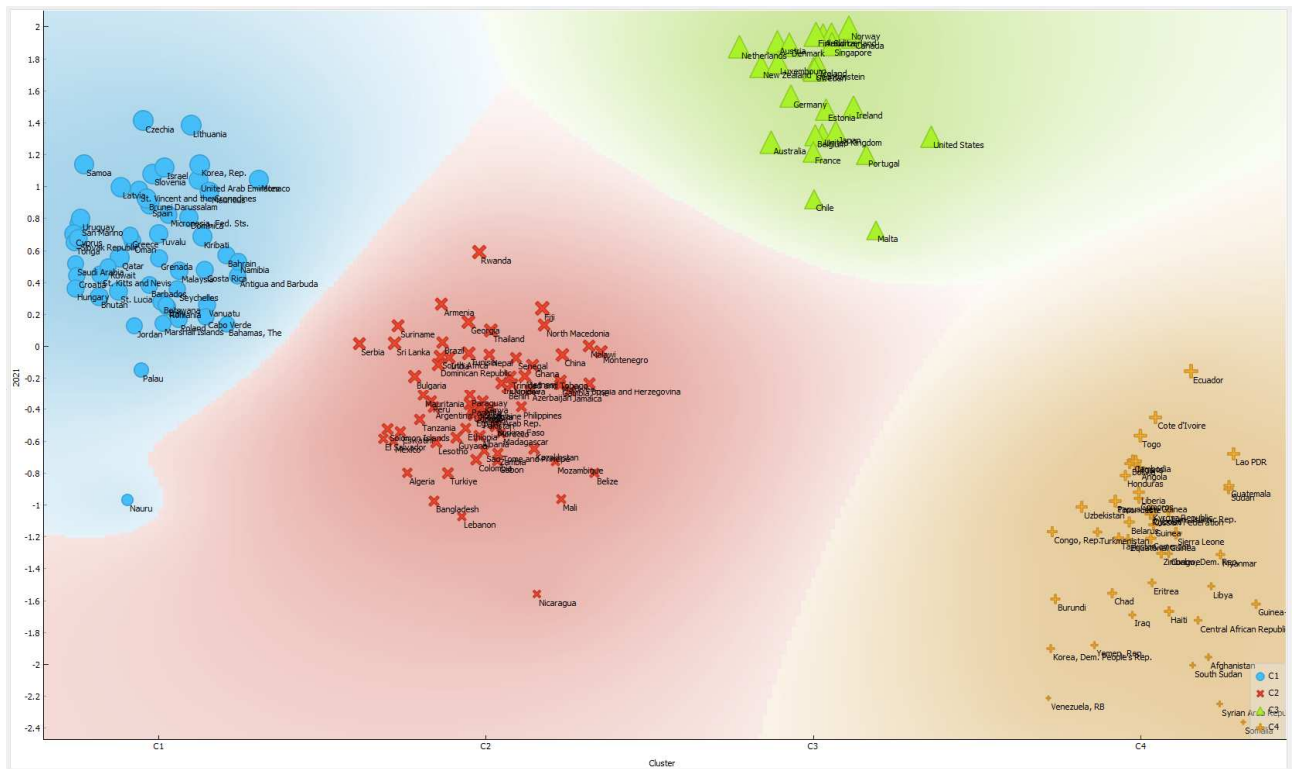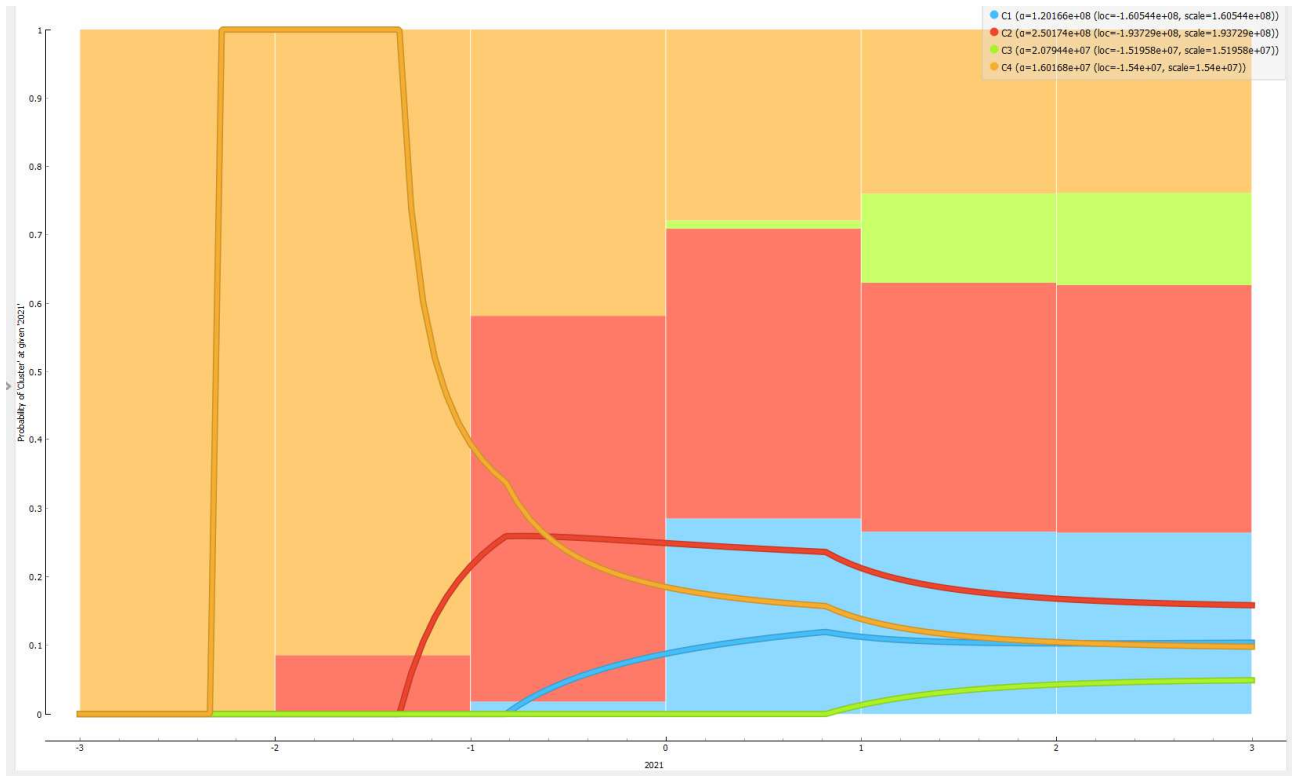
Machine Learning and Predictions

Ranking of Algorithms Based on Predictive Performance					
Algorithm	R^2	MAE	MSE	RMSE	SUM
Linear Regression	1	1	1	1	4
Tree Ensemble Regression	3	3	2	3	11
Polynomial Regression	2	2	8	2	14

Gradient Boosted Tree	4	4	3	4	15
Simple Regression	5	5	4	5	19
PNN	6	6	5	6	23
ANN	7	7	6	7	27
Random Forest	8	8	7	8	31

Statistical Results of Machine Learning Algorithms for the Prediction of Rule of Law

Metrics	ANN	PNN	Gradient Boosted Tree	Random Forest
R^2	0,900672	0,945300	0,955362	0,837283
MAE	0,056753	0,045574	0,043613	0,081977
MSE	0,004619	0,003756	0,002609	0,008671
RMSE	0,067963	0,061282	0,051074	0,093117
Metrics	**Tree Ensemble Regression**	**Linear Regression**	**Polynomial Regression**	**Simple Regression**
R^2	0,967906	0,992175	0,986411	0,951016
MAE	0,032218	0,018075	0,020903	0,043906
MSE	0,002083	0,001000	0,029000	0,002908
RMSE	0,045645	0,022701	0,028530	0,053930