

Article

Not peer-reviewed version

The Role of Government Effectiveness in the Light of ESG Data at Global Level

[Lucio Laureti](#) , [Alberto Costantiello](#) , [Angelo Leogrande](#) *

Posted Date: 31 January 2023

doi: 10.20944/preprints202301.0572.v1

Keywords: analysis of collective decision-making; general; political processes: rent-seeking; lobbying; elections; legislatures; and voting behavior; bureaucracy; administrative processes in public organizations; corruption; positive analysis of policy formulation; implementation



Preprints.org is a free multidiscipline platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This is an open access article distributed under the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Article

The Role of Government Effectiveness in the Light of ESG Data at Global Level

Lucio Laureti ^{1,*}, Alberto Costantiello ^{2,*} and Angelo Leogrando ^{3,*}

¹ Professor of Economics at LUM University Giuseppe Degennaro. Email: laureti@lum.it. Strada Statale 100 km 18, Casamassima, Bari, Puglia, Italia

² Professor of Economics at LUM University Giuseppe Degennaro. Email: costantiello@lum.it. Strada Statale 100 km 18, Casamassima, Bari, Puglia, Italia

³ Professor of Economics at LUM University Giuseppe Degennaro and Researcher at LUM Enterprise s.r.l. Email: leogrando.cultore@lum.it, Strada Statale 100 km 18, Casamassima, Bari, Puglia, Italia

* Correspondence: leogrando.cultore@lum.it

Abstract: In this article we estimate the level of Government Effectiveness-GE in 193 countries in the period 2011-2020 using data of the ESG World Bank Database. Different econometric techniques are used i.e. Panel Data with Random Effects, Panel Data with Fixed Effects, and Pooled OLS. Results show that GE is positively related among others to "Control of Corruption", "Political Stability and Absence of Violence/Terrorism", and negatively associated with "Percentage Annual GDP Growth". We perform a cluster analysis with the k-Means algorithm optimized with the Elbow Method and we find the presence of four clusters. Finally, we confront eight machine learning algorithms for the prediction of GE. Results show that the Polynomial Regression is the best predictive algorithm. The value of GE is expected to growth on average by 15.97%.

JEL CODE: D7, D70, D72, D73, D78.

Keywords: Analysis of Collective Decision-Making; General; Political Processes: Rent-Seeking; Lobbying; Elections; Legislatures; and Voting Behavior; Bureaucracy; Administrative Processes in Public Organizations; Corruption; Positive Analysis of Policy Formulation; and Implementation

1. Introduction-Research Question

In this article we analyze the role of the GE variable in the context of the World Bank Environment, Social and Governance-ESG database [1]. By GE we mean the quality perceived by the population relating to public services, the independence of politicians from the pressures of the lobbies, the quality of political staff and the decision-making process and also the credibility of the government in realizing economic policies. It is an indicator that varies in a range between -2.5 and +2.5. The variable therefore captures a set of elements which, however, substantially refer to the quality of human capital employed in politics, the quality of the institutions in offering public services to the population and the general credibility of the government both nationally and internationally. These variables impact on the methodologies of public spending and tend to be very connected also with the forms of government at country level. The democratic countries that have a liberal political system also generally have high levels of GE while the countries that are autocratic tend to have reduced GE levels. These differences derive from the fact that the democratic political system tends to promote a spare of the ruling classes and to select the most deserving for the exercise of public management activities.

However, if we look at the data of the variations between 2011 and 2020 in terms of GE it is possible to verify that most of the countries of Western and Southern Europe, together with the USA and UK have negative variations of the indicator. On the contrary, the countries of Eastern Europe and the Baltic together with China and India have growing values in terms of GE. This condition could mean a decrease in the ability of governments to operate in large part of Western Europe and also in Anglo-Saxon countries. For example, the level of GE has decreased by 39% in Poland, of 35%

in Belgium, of 18.60% in Israel, of 14.712% in the United Kingdom and 13.423% in the USA. On the contrary, some countries of Northern Europe and the Baltic have marked positive values or: Netherlands with +1.266%, Ireland with +1.48%, Estonia +24.64%, Lithuania +50.53%. In addition, the most relevant increases were obtained in China, with a value of +856% and in India with +1944%.

The reasons for the reduction of the indicator in many of the Western countries is certainly to be connected to the sum of a set of factors among which an insufficient economic growth and inefficiencies in the public management of the Covid 19 pandemic. The growth of GE in countries such as China and India is mainly associated with the economic trend that bodes the population about the possibility of accessing further levels of socio-economic well-being. Therefore even if in a broad sense the countries that have greater GDP per capita are also those that have higher values of GE in absolute value, it is true that in terms of percentage variation between 2011 and 2020 many Western countries have lost in terms of GE.

These phenomena suggest that GE's culture is not a fact that it must be taken for granted or acquired, not even in the countries that are liberal democracies such as for example in Anglo-Saxon ones. In fact, above all, the USA are crossed by a set of social and political phenomena that question the efficiency of the ruling class due to the growing economic, social inequalities. A condition that has significantly growing the number of deaths from despair as analyzed in the book of Anna Case and Angus Deaton [2]. In addition, the US also have the problem of a political system susceptible to the interests of lobbies, that reduce the ability of the ruling class to decide in the interest of the nation.

Similar problems have also emerged in Europe, both due to the recent Qatargate [3], and also in connection with the management of pandemic at European level. In fact, in Europe, in the first months of the pandemic, a profound debate was turned on the possibility of offering aid to countries in difficulty due to Lockdown such as for example the countries of southern Europe. In fact, many countries of Northern Europe have expressed skepticism to the growth of public spending, creating the so-called group of "*frugal*" countries [4]. In any case, the management of Covid has certainly weakened many European countries in terms of GE, especially because the population has not received in many cases the financial and social support necessary to resist long periods of lockdown.

Finally, it should be emphasized that no nation, no managerial political group is free from the risk of hegemony of extracting and rent seeking elite that can drive the nation toward failure, as indicated in the book of Acemoglu and Robinson [5]. In fact, the growth of inequality, the growth of abstention in democratic countries also highlights the risk of a disconnection between political class and population that could involve a worsening of performance both in terms of GE and in terms of GDP, even in Western countries.

There is a problem in democratic systems in guaranteeing the replacement of the ruling classes. A condition that in fact associate Western democracies to Eastern autocracies, and which prevents criticizing the choices of stay in power in Asia as in the case of the XI Jinping in China, or Putin in Russia, or Erdogan in Turkey. Certainly there are advantages in electing people belonging to the same elite as this guarantees the stability of international relations and power groups within countries. However, precisely for this reason, new economic and institutional policy solutions that could be more suitable for the complexity of the current global condition are prevented.

Furthermore, there is the theme of information technology and its relationship with GE. Access to e-government, e-democracy seem very difficult to implement, both in developing countries and in developed countries. To induce a change towards digital transformation in e-government it is necessary to promote a cultural change that directly involves citizens. In fact, only if citizens are engaged in digitalization then it will be possible to offer new public services in terms of e-government that can increase the value of GE.

Finally, there is the question of economic growth and economic development. It is certain that GE increases economic growth and economic development, as indicated in the literature of paragraph two. However, on the contrary, it follows that the countries that grow little, many of which are European and western, have a questionable level of GE which should be subjected to greater investigation. Furthermore, it must be considered that in the current economic condition, the state is

no longer opposed to the market, and indeed the idea is accepted that the possibility of having a market that works also depends on GE [6].

The article continues as below: in the second paragraph there is a brief introductory analysis of the economic literature of reference, in the third paragraph the econometric model is introduced, the fourth paragraph contains the cluster analysis, the fifth paragraph shows the results of the machines algorithms Learning for the prediction of the future value of GE, the sixth paragraph concludes. In the appendix there are further metric and graphic references.

Table 1.

| Main Positive and Negative Variations in the Levels of GE for a Subset of Countries. Source: World Bank | | | | | | | | | |
|---|--------|--------|---------|---------|----------------------|--------|--------|---------|----------|
| Negative Variations | | | | | Positive Variations | | | | |
| Country | 2011 | 2020 | Abs Var | % Var | Country | 2011 | 2020 | Abs Var | % Var |
| <i>Russian Federation</i> | -0,601 | -0,078 | 0,524 | -87,087 | <i>Netherlands</i> | 1,821 | 1,844 | 0,023 | 1,266 |
| <i>South Africa</i> | 0,219 | 0,097 | -0,122 | -55,799 | <i>Ireland</i> | 1,450 | 1,471 | 0,021 | 1,480 |
| <i>Cyprus</i> | 1,558 | 0,876 | -0,682 | -43,794 | <i>Czechia</i> | 0,929 | 0,949 | 0,021 | 2,220 |
| <i>Poland</i> | 0,596 | 0,360 | -0,236 | -39,651 | <i>Austria</i> | 1,603 | 1,646 | 0,043 | 2,697 |
| <i>Belgium</i> | 1,723 | 1,116 | -0,607 | -35,231 | <i>Liechtenstein</i> | 1,764 | 1,815 | 0,050 | 2,852 |
| <i>Israel</i> | 1,337 | 1,088 | -0,249 | -18,596 | <i>Luxembourg</i> | 1,742 | 1,833 | 0,090 | 5,180 |
| <i>United Kingdom</i> | 1,604 | 1,368 | -0,236 | -14,712 | <i>Norway</i> | 1,831 | 1,927 | 0,096 | 5,217 |
| <i>United States</i> | 1,514 | 1,310 | -0,203 | -13,423 | <i>Singapore</i> | 2,149 | 2,325 | 0,176 | 8,201 |
| <i>Malta</i> | 1,189 | 1,031 | -0,158 | -13,281 | <i>Japan</i> | 1,467 | 1,587 | 0,120 | 8,211 |
| <i>Finland</i> | 2,235 | 1,939 | -0,296 | -13,233 | <i>Portugal</i> | 0,921 | 1,015 | 0,094 | 10,254 |
| <i>Hungary</i> | 0,659 | 0,574 | -0,085 | -12,938 | <i>Slovenia</i> | 0,984 | 1,158 | 0,174 | 17,725 |
| <i>Sweden</i> | 1,925 | 1,710 | -0,215 | -11,177 | <i>Estonia</i> | 1,071 | 1,335 | 0,264 | 24,645 |
| <i>France</i> | 1,392 | 1,239 | -0,153 | -10,967 | <i>Latvia</i> | 0,692 | 0,875 | 0,182 | 26,319 |
| <i>Denmark</i> | 2,101 | 1,881 | -0,220 | -10,453 | <i>Romania</i> | -0,200 | -0,257 | -0,057 | 28,689 |
| <i>Germany</i> | 1,500 | 1,352 | -0,148 | -9,849 | <i>Lithuania</i> | 0,698 | 1,051 | 0,353 | 50,539 |
| <i>Croatia</i> | 0,506 | 0,461 | -0,045 | -8,873 | <i>China</i> | 0,071 | 0,677 | 0,606 | 856,195 |
| <i>Spain</i> | 0,972 | 0,887 | -0,085 | -8,738 | <i>India</i> | 0,020 | 0,406 | 0,386 | 1944,250 |

2. Literature Review

In the following paragraph a brief analysis of the GE literature review is presented.

An increase in the level of GE has been positively associated with a reduction in mortality during the Covid 19 pandemic [7], [8]. GE has a positive impact in reducing the negative impact of public debt on economic growth [9]. GE improves the quality of education in Asian countries [10]. GE has a positive impact in reducing the high rate of homicides in Latin America [11]. GE increases the environmental sustainability, especially in low-income per capita countries [12]. The application of digitalization to the delivery of public services has created a new dimension of GE i.e. the e-GE [13], [14]. There is a positive relationship between GE and fiscal transparency with positive externalities for public debt and the efficiency of public spending [15]. Empirical studies have showed that GE can reduce the number of deaths in case of extreme weather even as in the case of tropical cyclones [16]. The possibility of countries to create a relationship between economic growth and green sustainability in the sense of the Environmental Kuznets Curve-EKC [17] depends on GE and especially on the level of human capital of politicians [18]. GE plays an essential role in promoting green economy even in developed and in developing countries [19]. GE has a moderating effect in the positive relationship between health individual expenditures and life expectations [20]. Even if GE is related to jurisdiction, the size of jurisdiction has no impact on GE [21]. GE drives economic growth, especially in countries that have large endowment of natural resources, i.e. gas, with low per capita income [22]. GE has a central role in promoting an improvement in healthcare public expenditures in Organization of Petroleum Exporting Countries-OPEC [23].

GE can promote ICT diffusion if some cultural orientations are detectable at country level: Indulgence and Long-Term Orientation-LTO [24]. GE at national level has an impact on the ability of rotating European Council Presidency to guide the legislative efficiency and set priorities in EU [25]. GE can have a role in reducing poverty at least in some European countries [26]. GE has not effect on the relationship between optimal tax structure and GDP growth [27]. GE is positively associated to economic growth in European Transition Economies, even if the causal relationship is monodirectional [28]. Digitalization has a positive effect on GE even if the relationship is stronger in developed countries than in developing countries [29]. GE is positively associated to energy consumption in Middle East and Northern Africa-MENA countries, but, counterfactually energy consumption in these countries is negatively associated to economic growth [30]. GE has a negative impact on forest degradation in Africa [31]. The ability of public institutions to apply knowledge management can have positive effects on GE at local level [32]. Countries with a degree of GE above the average have greater probability to perform trade and financial openness at an international level [33].

The impact of digitalization on GE is low in Eastern European Countries since high levels of corruption, the absence of rule of law and quality of regulation reduce the generally positive impacts that the ICT sector has on the efficiency of public management [34]. Countries with lower levels of GE are less oriented to drug legalization in Latin America [35]. ICT access and e-government promote GE and actively participate in the fight against corruption at country level [36], [37]. GE and education have positive effects on reducing the dimensions of shadow economy and the informal sector [38]. Empirical analysis for a wide set of countries show that e-Government improves GE but reduces government efficacy [39]. Local GE has positive effects in promoting psychological health of citizens, as statistical evidence on China suggests [40]. GE has no direct effect on tax obedience, contrary to rule of law and control of corruption [41]; but GE could act indirectly in promoting tax obedience creating the conditions for an increase in the level of rule of law and control of corruption. There is the possibility that GE has a causal nexus with some cultural issues that can be measured with Hofstede's dimensions [42]. In this sense GE is positively associated to high individualism and low uncertainty avoidance [43]. GE has a positive effect on Human Development Index-HDI in sub-Saharan Africa [44] and South Asia [45]. The application of a machine learning approach has questioned the presence of a linear relationship between digitalization and GE, and further analysis has showed that the relationship between digitalization and GE has a non-linear U-shaped form [46]. Control of corruption improves GE [47].

Table.2.

| Literature Review by Main Themes | |
|--|--|
| Main Themes | References |
| <i>GE, Covid 19 Pandemic and Health Issues</i> | [7], [8], [20], [23], [40] |
| <i>GE, Public Debt and Taxation</i> | [9], [15], [27], [41] |
| <i>GE, Cultural, Educational and Social Issues</i> | [10], [26], [43] |
| <i>GE, Institutions and Legal Order</i> | [11], [21], [25], [32], [35], [31], [47] |
| <i>GE, Energy and Environmental Sustainability</i> | [12], [16], [18], [19], [30], [24] |
| <i>GE, e-Government, and ITC Sector</i> | [13], [14], [24], [22], [34], [36], [37], [39], [46] |
| <i>GE, Economic Growth and Development</i> | [22], [28], [33], [44], [45] |
| <i>Methodology and Statistical Analysis</i> | [48], [49], [50], [51], [52], [53], [54], [1] |
| <i>Theoretical Frameworks</i> | [42], [17], [2], [5], [4], [3], [6] |

3. The Econometric Model to Estimate the Level of Government Effectiveness

We have estimated the value of "Government Effectiveness" in 193 countries for the period 2010-2011. Different econometric techniques have been used i.e., Panel Data with Fixed Effects, Panel Data with Random Effects and Pooled OLS. We have estimated the following formula:

Government Effectiveness_{it}

$$= a_{it}$$

$$+ b_1(\text{Annualized Average Growth Rate In Per Capita Real Survey Mean Consumption Or Income})_{it}$$

$$+ b_2(\text{Control Of Corruption})_{it} + b_3(\text{GDP Growth})_{it}$$

$$+ b_4(\text{Political Stability And Absence Of Violence Or Terrorism})_{it}$$

$$+ b_5(\text{Regulatory Quality})_{it} + b_6(\text{Strength Of Legal Rights Index})_{it}$$

$$+ b_7(\text{Voice And Accountability})_{it}$$

where $i = 193$ and $t = [2011; 2020]$

We found that Government Effectiveness is positively associated with:

- *Annualized average growth rate in per capita real survey mean consumption or income, total population (%)*: is a variable that considers the value of the growth of real consumption or pro-capita income in the population. There is a positive relationship between the value of the growth of real consumption or pro-capita income and the value of "Government Effectiveness" [48]. It should be considered that the "Government Effectiveness" measures the ability of governments to offer public quality services, to formulate and implement effective economic policies, and to be credible towards the population and towards markets and foreign institutions. Obviously, the richest countries, which are both the countries that have more income and the countries that consume the most, generally also can have more resources deriving from the taxes, from the issue of government bonds and also from the application of expansive monetary policies. It follows that the states that have greater production capacity of added production, or of gross domestic product, also have the best economic conditions to offer quality public and economic policies to the population.

Table.3.

| Top Ten Countries for Average Growth Rate in 2020. Source: World Bank. | | | |
|---|---------------------|--|---------------------------------|
| <i>Rank</i> | <i>Country Name</i> | <i>Average Growth of Income or Consumption</i> | <i>Government Effectiveness</i> |
| 1 | Romania | 13,43 | -0,2574 |
| 2 | Bulgaria | 9,25 | -0,1827 |
| 3 | Lithuania | 8,2 | 1,0508 |
| 4 | Latvia | 6,71 | 0,8746 |
| 5 | Croatia | 6,21 | 0,461 |
| 6 | Hungary | 6,12 | 0,5738 |
| 7 | Estonia | 6,1 | 1,3348 |
| 8 | Portugal | 4,16 | 1,0155 |
| 9 | Czechia | 4,13 | 0,9492 |
| 10 | Ukraine | 4,12 | -0,383 |

If we look at the top ten of the countries for the value of the growth of consumption or annual pro-capita income, we see that many of these countries also have high employment values. Obviously, there are some exceptions. In particular, the exceptions are three namely Romania, Bulgaria, and Ukraine which, even having high levels of the pro-capita income growth rate, however, have negative values in terms of Government Effectiveness. However, the other countries, taken from the top ten for the value of the pro-capita income growth rate, show a very positive trend also in terms of government effects or Lithuania with 1.05, Latvia with 0.8746, Croatia with 0,4610, Hungary with 0.5738, Estonia with 1.3348, Portugal with 1.0155, Czech Republic with 0.9492. Obviously, it is also necessary to consider the case of Romania, Bulgaria and Ukraine, or of the countries which, even having a high level of pro-capita income growth rate, have a low value in terms of Government Effectiveness. For countries that have a low per capita income it is easier to access a sustained growth

rate, in fact countries that have low GDP levels tend to grow more. However, precisely because they have an absolute pro-capita income value, the lowest also tend to have difficulties in orienting the public economy towards the production of quality services and credible economic policies.

- Control of Corruption*: is a variable that measures the perception that citizens have about the possibility that public power is corrupt and that the government operates in the interest of economic and private groups. The indicator varies in a range between -2.5 and 2.5 [49]. There is a positive relationship between the ability of a country to keep the corruption and the ability of a country to have a government capable of guaranteeing a high quality of public services. Obviously one of the reasons that prevent governments from being performing in economic policies aimed at the population is corruption. In fact, corruption can significantly reduce the effectiveness of public spending and operates as a distortive element in the allocation of resources. Public works, schools, hospitals that could be made with low or market costs, due to corruption, can cost much more both in the construction phase and in the provision of services. It follows that one of the ways to have a government that is efficient in promoting quality services consists precisely in fighting corruption especially in public affairs. In fact, if we take into consideration the top ten of the countries by corruption control value, it is possible to verify that the same countries have a high value also of Government Effectiveness. In this regard, it should be remembered that it is Government Effectiveness that control of corruption have the same scale of values or vary in a range between -2.5 and 2.5. Specifically, Denmark has a value equal to 1.8813 followed by Finland with a value of 1,9392, Singapore with an amount of 2.32, New Zealand with an amount of 1,5804, Sweden with a value of 1, 7098, Norway with 1.9270, Switzerland with an amount of 2,0103, Luxembourg with 1.8327, Netherlands with 1.8438, and Liechtenstein with 1.8146. A significant association between Control of Corruption and Government Effectiveness is therefore evident, so much so that it can be concluded by claiming that a method to increase the Government Effectiveness is to increase the Control of Corruption.

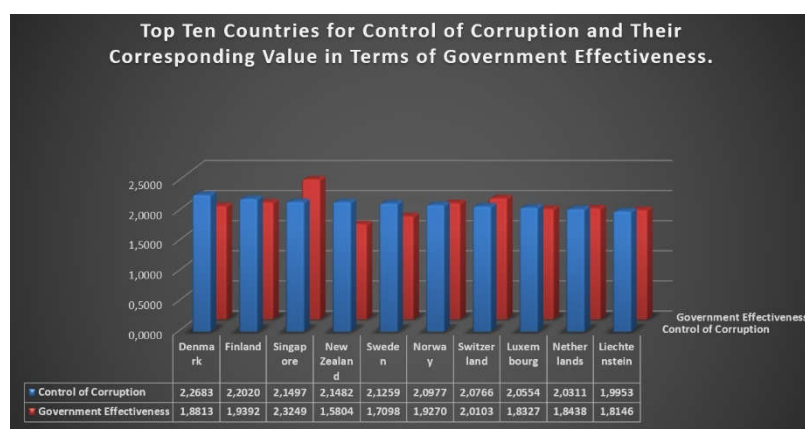


Figure 1. Top Ten Countries for Control of Corruption and Their Corresponding Value in Terms of Government Effectiveness.

- Political Stability and Absence of Violence/Terrorism*: is a variable that measures the presence of political stability or the absence of violence or terrorism. The indicator consists of a number that varies in a range between -2.5 and +2.5 [50]. There is a positive relationship between the value of political stability or of the absence of violence and terrorism and the value of

"Government Effectiveness". From a metric point of view, looking at the results of the regression it appears that while the coefficient obtained through Pooled OLS is negative and equal to -0.0845504, the regressions with Panel Data With Fixed Effects and Random Effects are instead positive and equal to 0.223079 and 0.206671. From a metric point of view, the positive values of the panel data models exceed the value of the Pooled OLS. However, the positive sign of the relationship must not be identified only for the motivations of mere media. In fact, in case of contradiction between the Pooled OLS models and the Panel Data Models with Fixed Effects and Panel Data with Random Effects, they are the panel models that are chosen, as they have greater explanatory capacity than the analyzed dataset. Considering the top ten of the countries for the value of political stability and the absence of terrorism it is possible to verify that many of these countries also have very high values also in terms of "Government Effectiveness". In this regard, it is necessary to emphasize that both "Government Effectiveness" and political stability and the absence of terrorism are calculated with the same scale or vary between -2.5 and +2.5. For example, Liechtenstein has a value of political stability and absence of terrorism equal to a value of 1,693371892 and a value of "Government Effectiveness" equal to a value of 1.8146; Andorra has a political stability value of 1.61 and of the "Government Effectiveness" of 1.8161; New Zealand has a political stability value equal to an amount of 1,616 units and a value of "Government Effectiveness" equal to 1.8161. In the top ten of the countries by the value of political stability and absence of violence and terrorism there are only two countries that have a negative value of "Government Effectiveness" that are Dominica with -0.0981 and Tuvalu with a value of -0.5391.

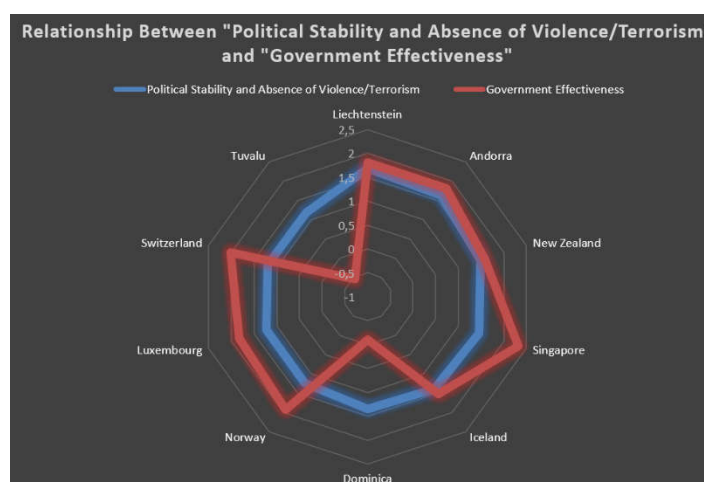


Figure 2. Relationship between "Political Stability and Absence of Violence/Terrorism" and "Government Effectiveness" in 2020. Source: World Bank.

- *Regulatory Quality*: is a variable that calculates the government's ability to formulate and implement legislation capable of allowing the development of the private sector [51]. There is a positive relationship between the legislator's ability to promote the private sector and the "Government Effectiveness". Obviously, an effective government can promote the private sector. It is not an ideological element aimed at promoting a liberal economy compared to a public economy. It is the possibility of developing those private economic freedoms such as the right of private property, the freedom to do business, the regulations relating to credit-debit activities, which are essential to allow the market to produce wealth, income, goods,

and services. Obviously, the growth of per capita income at the country level allows you to generate greater tax revenues for the State and develops a type of relationship between citizen and state that is similar to that synthesized in the old motto “*No taxation without representation*”. In this regard, it should be considered that with a view to governance indicators promoted by the World Bank there is no contradiction between the State and the market, between public economy and private economy. On the contrary, there is the idea that the development of the private economy can be an essential tool for the efficiency of the State and its ability to offer quality goods and services to the population. In fact, if we look at the top ten of the countries by the value of the “*Regulatory Quality*” it appears that they are also countries with very high levels of “*Government Effectiveness*”. For example, in the first place for “*Regulatory Quality*” in 2020 there is Singapore with a value equal to 2.2 and a value of “*Government Effectiveness*” equal to 2.32. New Zealand and Finland also have high levels of regulatory quality equal to 2.21 units and 1.88 units and high values of “*Government Effectiveness*” equivalent to 2.32 and 1.58 respectively. That is, in the data of the World Bank, the growth in terms of “*Regulatory Quality*” is equivalent, but also induces and produces an increase in “*Government Effectiveness*”. This condition obviously rewards those countries that are oriented to apply the set of values and institutions that are typical of western culture and civilization or: freedom of economic initiative, private property, financial markets, and a system of economic policy determined by representative democracy. There is therefore a close connection between the ability of the countries to orient themselves towards democratic, liberal, and western institutions and their ability to generate a political class capable of being credible and offering quality economic policies for the population.



Figure 3. Relationship between Regulatory Quality and Government Effectiveness in 2020 for Top Performing Countries. Source: World Bank.

Table.4.

| Top Ten Countries for Strengths of Legal Rights and Corresponding Values of Government Effectiveness | | | |
|--|-----------------------|---------------------------|--------------------------|
| Rank | Country Name | Strengths of Legal Rights | Government Effectiveness |
| 1 | Montenegro | 12 | -0,07089214 |
| 2 | New Zealand | 12 | 1,580373883 |
| 3 | Australia | 11 | 1,610074997 |
| 4 | United States | 11 | 1,310419917 |
| 5 | Vanuatu | 11 | -0,397548378 |
| 6 | Rwanda | 10 | 0,308448911 |
| 7 | Cambodia | 10 | -0,392002016 |
| 8 | Marshall Islands | 10 | -1,40530467 |
| 9 | Micronesia, Fed. Sts. | 10 | 0,18357487 |
| 10 | Palau | 10 | -0,052545074 |

- Strength of legal rights index (0=weak to 12=strong)*: is an indicator that considers the presence of laws that guarantee mutuals and financiers. These laws allow you to facilitate loans by strengthening the protection of creditors. The indicator varies from 0 to 12. The increase in the score indicates a greater ability to design and expand access to credit on a national basis [52]. There is a positive relationship between the “*Government Effectiveness*” and the ability of the countries to have laws favorable to credit-debit activities. This relationship may appear without economic sense and must be more analyzed. In fact, the development of a government that is effective in promoting goods and services towards the population also requires an economy that is adequately developed. A country with an economy with high pro-capita income generally also has a higher tax revenue, a greater public debt capacity and the possibility of operating with expansive monetary policies. Economic growth requires strengthening of the credit and banking sector. The major legal protection granted to banks and credit institutions allows to finance the entrepreneurial system and strengthen the industrial production. Among the countries that most have the greatest levels in terms of protection of credit rights-debtors there are also countries that have very high levels in terms of “*Government Effectiveness*”. For example, among the first four countries for the value of the protection of the rights of creditors there are in second place the New Zealand which also has a value of “*Government Effectiveness*” equal to 1,580373883, Australia with a value of 1.610074997 and the United States with a value of 1,310419917. The relationship between “*Government Effectiveness*” and the defense of the rights of creditors therefore highlights the role that the credit intermediation activity has compared to the promotion of an efficient economy both in the private and in the public sector.
- Voice and Accountability*: is a variable that considers the ability of the population to actively participate in the choice of political and government representatives. The indicator also measures the freedom of expression of the population, the freedom of association and the

presence of freedom of the press [53]. There is a positive relationship between the value of “Government Effectiveness” and the value of “Voice and Accountability”. This report highlights the role of democracy, participatory processes, political freedoms, and freedom of expression as essential elements not only for the well-being of individuals and groups as well as for the government's ability to be efficient. The “Voice and Accountability” variable can be considered as a proxy of the level of democracy of a certain country. It therefore follows that the countries that have greater democracy are also those who have the greatest ability to develop forms of government more efficient at a political-institutional level. In fact, looking at the top ten of the countries for Voice and Accountability value in 2020 it is possible to verify that the same countries that have high values also of “Government effectiveness”. The comparison between Voice and Accountability and Government Effectiveness is facilitated by the fact that both variables are expressed in the same unit of measurement or vary in a range between -2.5 and +2.5. The first country for Voice and Accountability value in 2020 was Norway with an amount of 1.724 and a value of Government Effectiveness of 1.927. Finland follows with 1.614, New Zealand with 1.59, Switzerland 1,540, Netherlands with 1.524, Denmark with 1.519, Sweden with 1.503, Luxembourg with 1.502, Canada with 1.475 and Austria with 1.399. As is evident, these are European countries except for New Zealand and Canada. In the top ten for Voice and Accountability value are not present nor UK, which is in 19th place, nor use that they are in 48th place. Very far from the top ten also China and India with voice and accountability values corresponding to 87 and 183 respectively. Therefore, it derives that European democracies can better combine the ability to offer democratic rights and freedoms with effective governments in the serve the population.

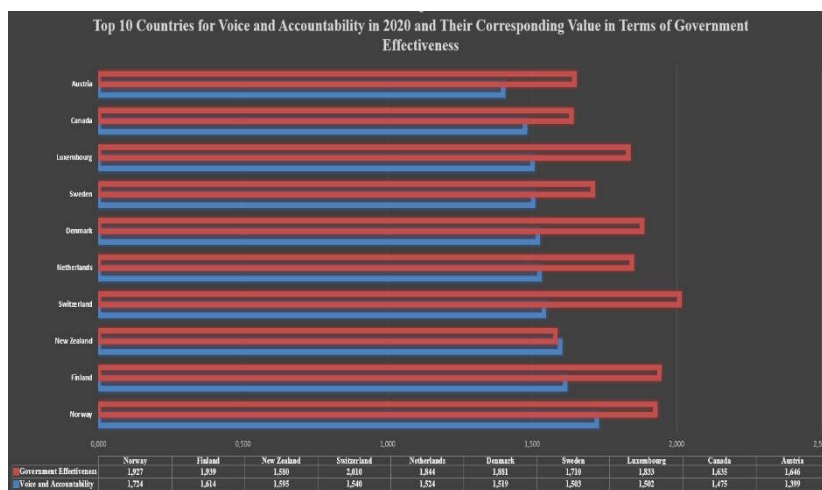


Figure 4. Relationship between Voice and Accountability and Government Effectiveness in 2020.
Source: World Bank.

Table.5.

| Results of the Econometric Models for the Estimation of the Value of Government Effectiveness | | | | | | | | |
|---|--|-------------|---------|---------------|---------|----------------|---------|-----------|
| | | Pooled OLS | | Fixed Effects | | Random Effects | | Average |
| A27 | <i>Government Effectiveness</i> | Coefficient | p-Value | Coefficient | p-Value | Coefficient | p-Value | |
| | Const | -0,0456923 | *** | 0,0527053 | *** | 0,0497381 | | 0,0512217 |
| A8 | <i>Annualized average growth rate in per capita real survey mean consumption or income, total population (%)</i> | 0,0914567 | *** | 0,022245 | *** | 0,02266 | *** | 0,0454539 |
| A12 | <i>Control of Corruption: Estimate</i> | 1,19682 | *** | 1,44191 | *** | 1,42881 | *** | 1,3558467 |
| A24 | <i>GDP growth (annual %)</i> | 0,0187262 | *** | -0,00300977 | *** | -0,00232263 | ** | 0,0187262 |
| A47 | <i>Political Stability and Absence of Violence/Terrorism: Estimate</i> | -0,0845504 | *** | 0,223079 | *** | 0,206671 | *** | 0,214875 |
| A55 | <i>Regulatory Quality: Estimate</i> | 0,0680405 | *** | 0,00817326 | *** | 0,00916899 | *** | 0,0284609 |
| A63 | <i>Strength of legal rights index (0=weak to 12=strong)</i> | 0,0010452 | *** | 0,00127469 | *** | 0,00128897 | *** | 0,0012029 |
| A67 | <i>Voice and Accountability: Estimate</i> | -0,0704004 | *** | 0,172528 | *** | 0,151071 | *** | 0,1617995 |

We also find that Government Effectiveness is negatively associated with:

- *Annual Percentage GDP Growth*: is a value that considers the percentage growth rate of GDP. There is a positive relationship between the value of the growth rate of the gross domestic product and the value of the "Government Effectiveness" [54]. There is a negative relationship between the value of GDP Growth and Government Effectiveness. This relationship must be better investigated from a strictly metric point of view. In fact, looking at the regressions results with Pooled OLS, Panel Data with Fixed Effects and Panel Data with Random Effects, the corresponding values are or 0.0187262, -0.00300977, -0.00232263. However, doing the average of these values, the result is a positive value equal to 0.0187262. However, this positive value cannot be truly taken into consideration as there is a contradiction between the value of the Pooled OLS coefficient or 0.0187262 which is positive, and the value of the regressions with the Panel Data models that are both negative. From a methodological point of view, however, the value of the results obtained through Panel Data regressions must be considered much more relevant than the values of the Pooled OLS, which is instead a simple regression. For these reasons, only the Panel Data results are analyzed. The motivation of a negative relationship between the value of the growth rate of the Gross Domestic Product and the value of Government Effectiveness depends on the fact that in general the countries that have a high GDP growth rate are the countries that have low-per capita income and which also have a low level of Government Effectiveness. It is the case of developing countries, or new industrialization countries. If we look at the countries which, in 2020, have had the greatest level of GDP growth rate it appears that they also had reduced levels of Governments Effectiveness or: Guyana with a GDP growth rate of +43.48% and a value of the Government Effectiveness equal to -0.4170; Timor : GDP growth rate of +10.37 and a value of Government Effectiveness equal to -0.7642; Ethiopia with a GDP growth rate value equal to +6.06% and a value of the Government Effectiveness equal to -0.5505. The only country that, in 2020, had a high GDP growth rate and a high value of Government Effectiveness is

Ireland. However, the case of Ireland is a very particular case. In fact, the high GDP growth rate of Ireland is due to the favorable tax policies granted to the big corporations in the IT sector. Therefore, with the exception of Ireland whose economic growth is more fictitious than real, it should be emphasized that generally a high GDP growth rate is associated with a low level of Government Effects. Countries that growth more in terms of GDP have government with low credibility and scarce domestic and international reputation.

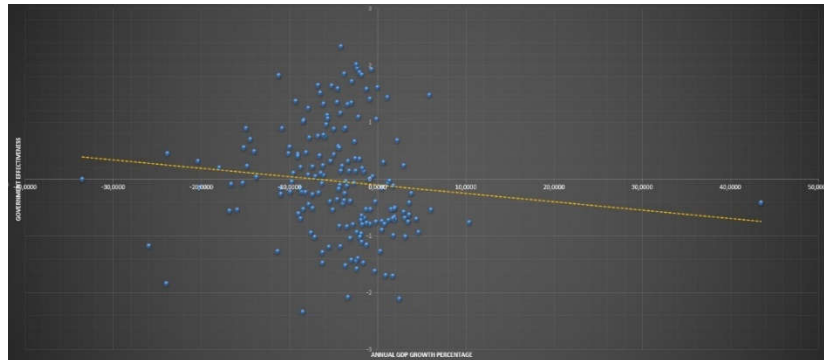


Figure 5. Relationship between Government Effectiveness and Annual Percentage GDP growth Rate for the 2020. Source: World Bank.

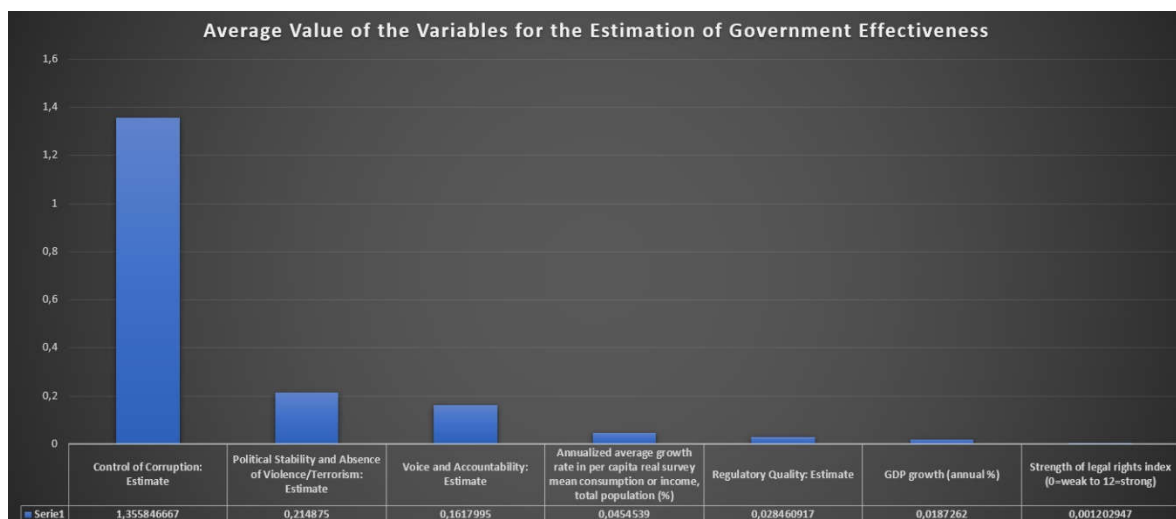


Figure 6. Average Value of the Variables for the Estimation of Government Effectiveness.

4. Clusterization with k-Means Algorithm Optimized with the Elbow Method

In the following analysis, a clustering is performed with the k-Means algorithm. Since the k-Means algorithm is unsupervised, the optimal number of k must be set by the researcher. However, to find the optimal number of clusters it is necessary to use methods. There are several methods that can be used. In this case the Elbow method was used, i.e. a graphical method. Through the use of Elbow's method it was possible to identify the optimal number of clusters with k=4. The clusters obtained are indicated below:

- *Cluster 1:* Albania, Antigua and Barbuda, Argentina, The Bahamas, Bahrain, Bhutan, Botswana, Bulgaria, Cabo Verde, China, Colombia, Costa Rica, Croatia, Dominica, Georgia, Greece, Grenada, Hungary, India, Indonesia, Italy, Jamaica, Jordan, Kuwait, Mexico, Montenegro, Namibia, North Macedonia, Oman, Panama, Philippines, Poland, Qatar, Romania, Rwanda, Samoa, Saudi Arabia, Serbia, Seychelles, Slovak Republic, South Africa,

Sri Lanka, St Kittis and Nevis, St Lucia, St Vincent and the Grenadines, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay, Vietnam;

- *Cluster 2:* Afghanistan, Angola, Burundi, Central African Republic, Chad, Comoros, Congo Dem. Rep., Congo Rep., Djibouti, Equatorial Guinea, Eritrea, Guinea, Guinea-Bissau, Haiti, Iraq, Korea Dem People's Rep., Liberia, Libya, Madagascar, Mali, Marshall Islands, Myanmar, Nigeria, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Syrian Arab Republic, Tajikistan, Timor-Leste, Togo, Turkmenistan, Venezuela RB, Yemen Rep., Zimbabwe;
- *Cluster 3:* Algeria, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Benin, Bolivia, Bosnia and Herzegovina, Brazil, Burkina Faso, Cambodia, Cameroon, Cote d'Ivoire, Cuba, Dominican Republic, Ecuador, Egypt Arab Rep, El Salvador, Eswatini, Ethiopia, Fiji, Gabon, The Gambia, Ghana, Guatemala, Guyana, Honduras, Iran Islamic Rep., Kazakhstan, Kenya, Kiribati, Kyrgyz Republic, Lao PDR, Lebanon, Lesotho, Malawi, Maldives, Mauritania, Micronesia Fed Sts, Moldova, Mongolia, Morocco, Mozambique, Nauru, Nepal, Nicaragua, Niger, Pakistan, Palau, Papua New guinea, Paraguay, Peru, Russian Federation, Sao Tome and Principe, Senegal, Suriname, Tanzania, Tonga, Tuvalu, Uganda, Ukraine, Uzbekistan, Vanuatu, Zambia;
- *Cluster 4:* Andorra, Australia, Austria, Barbados, Belgium Brunei Darussalam, Canada, Chile, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Japan, Korea Rep, Latvia, Liechtenstein, Lithuania, Luxembourg, Malaysia, Malta, Mauritius, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States.

From the median point of view it is possible to identify the following ranking of the Clusters or: Cluster 4-C4 with a value of 1.368 units, followed by 1-C1 clusters with a value of 0.226906, followed by 3-C3 clusters With an amount equal to -0.53814, followed by the 2 -C2 cluster with a value equal to an amount of -1.41996 units. It therefore derives the following system or: $C4 > C1 > C3 > C2$.

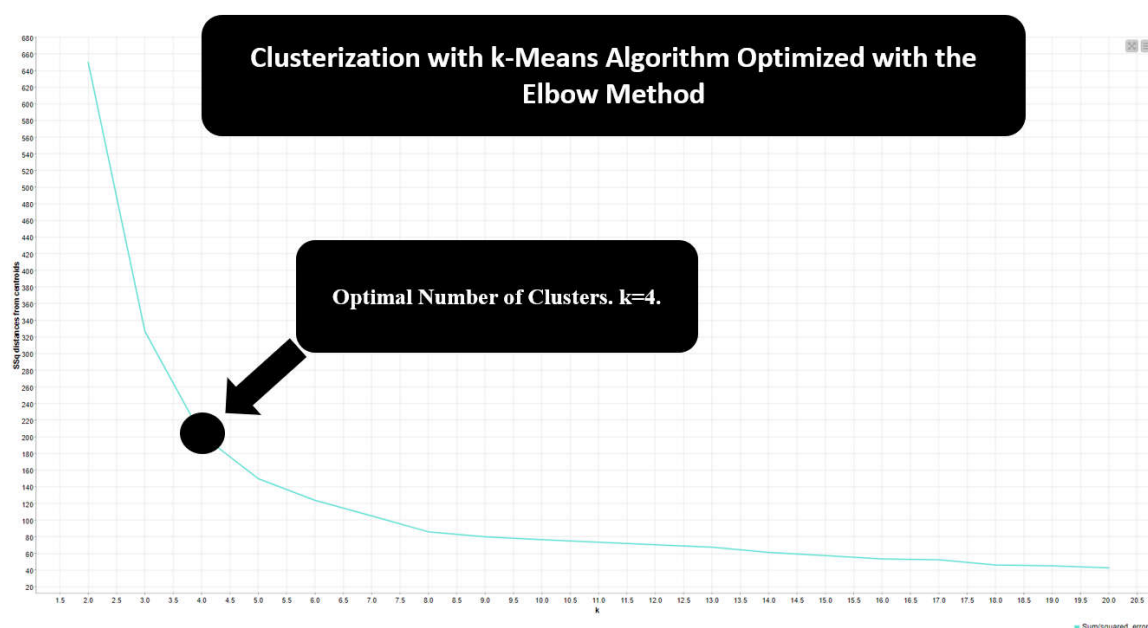


Figure 7. A graphical representation of the Elbow Method.

Considering the Cluster four-C4 or the cluster that has the highest levels of "Government Effectiveness" it appears that Singapore, Switzerland, and Finland are the countries with the highest values within the cluster with values corresponding to 2,3249, 2,0103 and 1,9392. The countries of the Cluster Quattro are above all the high-capita western countries high which also have a high standard in terms of Human Development Index-HDI. Among these, the majority are European and Anglo-Saxon countries. There is also five Asian countries or Singapore, Japan, South Korea, Malaysia, and Brunei, 2 countries of the Middle East or Israel and United Arab Emirates, a Southern America country or Chile, and some Tax Haven or Andorra, Barbados, and Mauritius. However, in the list of countries that can be considered as Tax Haven must also be considered Liechtenstein, Singapore, Switzerland, Luxembourg, United Arab Emirates and Malta. The economy of the Netherlands is also developing tax economic policies that are very favorable compared to the domiciliation of multinationals. It follows that these countries that directly or indirectly use economic policies in a very similar way to the functioning of a tax paradise should be excluded from the ranks of the most efficient countries in terms of "Government Effectiveness". In fact, in the countries operating as tax as the presence of quality public services, civil service, policy formulation, policy implementation and government reputation, they are made with the almost exclusive purpose of attracting foreign capital. In fact, the influx of foreign capital requires a regulatory framework that is based on government stability, on the ability to respect the rights of ownership of people and organization, the presence of political, civil, and democratic freedoms. Therefore, in these cases there is the doubt that the high level of "Government Effectiveness" is only a way to allow the allocation of foreign capital in an international market context.

However, for those countries that are not Tax Haven is evident the positive correlation between "Government Effectiveness" and the performance of the economy from the point of view of the pro-capita gross domestic product. In fact, the countries of the 4-C4 cluster are the countries that have very high levels of income-pro-items. It therefore follows that, contrary to what was once considered, there is no longer a contradiction between the effectiveness of the government, or of public spending policies, and the market. Indeed, the countries that are most efficient in the market economy also have a greater level of "Government Effectiveness". There is therefore no longer a contrast between state and market, a debate that very passionate the economists and political scientists of the 60-70s, as regards the contrary there is a positive sum between state and market, that is, the effectiveness of the economy It publishes in producing goods and services for citizens and the efficiency of the private economy in producing income, wealth, and heritage, they grow together.

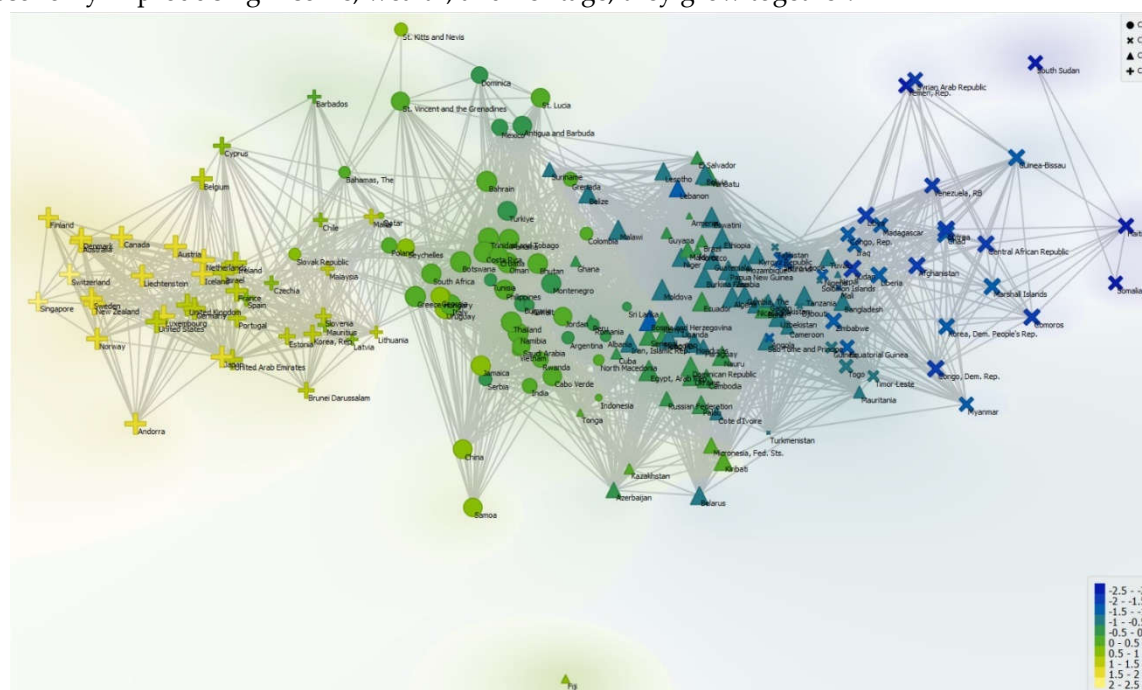


Figure 8. Clusterization with k-Means algorithm optimized with the Elbow Method.

If we consider the value of the average of the countries analyzed, it is also possible to verify that the value of Government Effectiveness tends to decrease. In fact, in the transition between 2011 and 2020 the value of Government Effectiveness calculated as average of the countries went from -0.07435 up to -0.07966 or equal to a value of -0.00531 equal to an amount of -7.13%.

5. Machine Learning Algorithms for the Prediction of Government Effectiveness

Eight different Machine Learning algorithms are compared for the prediction of the future value of the Government Effectiveness variable. The algorithms were trained with 70% of the data while the remaining 30% was used for the prediction. The algorithms were classified according to their ability to maximize the R-Squared and to minimize the statistical errors MAE, MSE, RMSE. Specifically we have applied the following formulas:

- $R^2 = 1 - \frac{\text{SumSquaredRegression}}{\text{TotalSumOfSquares}} = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y})(y_i - \bar{y})}$
- $MAE = \frac{\sum_{i=1}^n |y_i - x_i|}{n} = \frac{\sum_{i=1}^n |e_i|}{n}$
- $MSE = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)(Y_i - \hat{Y}_i)$
- $RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (\hat{y}_i - y_i)(\hat{y}_i - y_i)}$

A ranking has been identified for each statistical indicator. The ranking of each indicator in the individual rankings has been added. The following ranking was therefore derived from this or:

- Polynomial Regression with a payoff value of 4;
- Random Forest Regression with a payoff value of 9;
- Linear Regression with a payoff value of 11;
- Gradient Boosted Trees Regression with a payoff value of 16;
- Ann-artificial neural network with a payoff value of 21;
- Tree Regression Ensemble with a payoff value of 23;
- PNN-Probabilistic neural Network with a payoff value of 28;
- Simple Regression Tree with a payoff value of 32.

Table.6.

| Ranking of algorithms based on predictive efficiency | | | | | | |
|--|-----------------------------------|----------------|-----|-----|------|-----|
| Rank | Algorithm | R ² | MAE | MSE | RMSE | Sum |
| 1 | Polynomial Regression | 1 | 1 | 1 | 1 | 4 |
| 2 | Random Forest Regression | 2 | 3 | 2 | 2 | 9 |
| 3 | Linear Regression | 3 | 2 | 3 | 3 | 11 |
| 4 | Gradient Boosted Trees Regression | 4 | 4 | 4 | 4 | 16 |
| 5 | ANN | 5 | 6 | 5 | 5 | 21 |
| 6 | Tree Ensemble Regression | 6 | 5 | 6 | 6 | 23 |
| 7 | PNN | 7 | 7 | 7 | 7 | 28 |
| 8 | Simple Regression Tree | 8 | 8 | 8 | 8 | 32 |

Therefore, using the Polynomial Regression algorithm, or the Best Predictor algorithm, the following predictions can be verified:

- Algeria with an increased variation from an amount of -0.54489 up to a value of -0.52778 or a variation of 0.02 unit equivalent to +3.14%;

- Armenia with an increased variation from an amount of -0.27448 up to a value of -0.16257 equal to a value of 0.11 unit equivalent to +40.77%;
- Azerbaijan with an increased variation from an amount of -0.11694 units up to a value of -0.09270 units or equal to an amount of 0.02 units equal to a value of 20.73%;
- The Bahamas with an increased variation from an amount of 0.44528 units up to a value of 0.46785 units or equal to a value of 0.02 units equal to a value of 5.07%;
- Belarus with an increased variation from an amount of -0.79850 to a value of -0.12660 or a variation equal to an amount of 0.67 units equal to an amount of 84.15%;
- Benin with a diminutive variation from an amount of -0.26054 units up to a value of -0.42962 units or equal to a value of -0.17 units equal to a value of -64.90%;
- Brazil with an increased variation from an amount of -0.43761 to a value of -0.22541 or a variation equal to an amount of 0.21 units equal to a value of 48.49%;
- Green Cabo with an increased variation from an amount of 0.22691 units up to a value of 0.30771 units or equal to a value of 0.08 unit equivalent to an amount of 35.61%;
- China with a diminutive variation from an amount of 0.67732 units up to a value of 0.56286 units or equal to a value of -0.11 units equal to a value of -16.90%;
- Colombia with a diminutive variation from an amount of 0.03801 units up to a value of 0.02744 units or equal to a value of -0.01 units equal to a value of -27.81%;
- Comoros with a diminutive variation from an amount of -1,62420 to a value of -1,71242 or a variation equal to an amount of -0.09 units equal to a value of -5.43%;

Table.7.

Statistical Results of Machine Learning Algorithms for the Prediction of Government Effectiveness

| Algorithms | R ² | MAE | MSE | RMSE |
|-----------------------------------|----------------|-------------|-------------|-------------|
| ANN | 0,90511157 | 0,058919429 | 0,004599017 | 0,067816055 |
| PNN | 0,865579442 | 0,065344224 | 0,006307214 | 0,079417968 |
| Gradient Boosted Trees Regression | 0,938974339 | 0,045888646 | 0,003447355 | 0,05871418 |
| Random Forest Regression | 0,969874181 | 0,037425111 | 0,002022447 | 0,044971625 |
| Tree Ensemble Regression | 0,894543458 | 0,058279607 | 0,004822111 | 0,06944142 |
| Linear Regression | 0,969339121 | 0,03266463 | 0,002032851 | 0,045087144 |
| Polynomial Regression | 0,976166447 | 0,027713004 | 0,001149582 | 0,033905481 |
| Simple Regression Tree | -9 | 0,622106961 | 0,41208641 | 0,641939569 |

- Congo Dem. Rep. With an increased variation from an amount of -1.71408 units up to a value of -1.511256 units or equal to a value of 0.20 units equal to an amount of 11.76%;
- Djibouti with an increased variation from an amount of -0.728089 units up to a value of -0.71961 units or equal to a value of 0.01 units equal to an amount of 1.16%;
- Ecuador with an increased variation from an amount of -0.44603 units up to a value of -0.33272 units or equal to a value of 0.11 units equal to an amount of 25.40%;
- Egypt Arab Rep. With an increased variation from an amount of -0.42018 units up to a value of -0,20150 units or equal to a value of 0.22 units equal to an amount of 52.04%;
- Eritrea with a variation from an amount of -1,62418 units up to a value of -1.74437 units or equal to a value of -0.12 units equal to a value of -7.40%;
- Estonia with a diminutive variation from an amount of 1,33477 units up to a value of 1,14083 units or equal to an amount of -0.19 units equal to a value of -14.53%;

- Eswatini with an increased variation from an amount of -0.72636 units up to a value of -0.60688 units equal to a value of 16.45%;
- Fiji with an increased variation from an amount of 0.54531 units up to a value of 0.93694 units or equal to a value of 0.39 units equal to an amount of 71.82%;
- France with an increased variation from an amount of 1,23942 units up to a value of 1,30131 units or equal to a value of 0.06 units equal to an amount of 4.99%;
- Gabon with an increased variation from a value of -0.96759 units up to a value of -0.87708 units or equal to a value of 0.09 units equal to a value of 9.35%;
- The Gambia with an increased variation from an amount equal to -0.75450 up to a value equal to -0.71104 or a variation equivalent to 0.04 units equal to an amount of 5.76%;
- Ghana with a diminutive variation from an amount of -0.16559 units up to a value of -0.26543 units or equal to a value of -0.10 units equal to a value of -60.30%;
- Greece with a diminutive variation from an amount of 0.43761 units up to a value of 0.39888 units or equal to an amount of -0.04 units equal to a value of -8.85%;
- Guinea with an increased variation from an amount of -0.94121 units up to a value of -0.77026 units or equal to a value of 0.17 units equal to an amount of 18.16%;
- Guyana with an increased variation from a value of -0.41697 units up to a value of -0.34507 units or equal to a value of 0.07 units equal to a value of 17.24%;
- India with a diminutive variation from an amount of 0.40551 units up to a value of 0.14861 units or equal to a value of -0.26 units equal to an amount of -63.35%;
- Iraq with an increased variation from an amount of -1,28008 units up to a value of -1,26321 units or equal to an amount of 0.02 units equal to a value of 1.32%;
- Israel with an increased variation from an amount of 1,08804 units up to a value of 1,26519 units or equal to a value of 0.18 unit equivalent to a value of 16.28%;
- Japan with a diminutive variation from an amount of 1,58712 units up to a value of 1,36998 units or equal to a value of -0.22 units equal to a value of -13.68%;

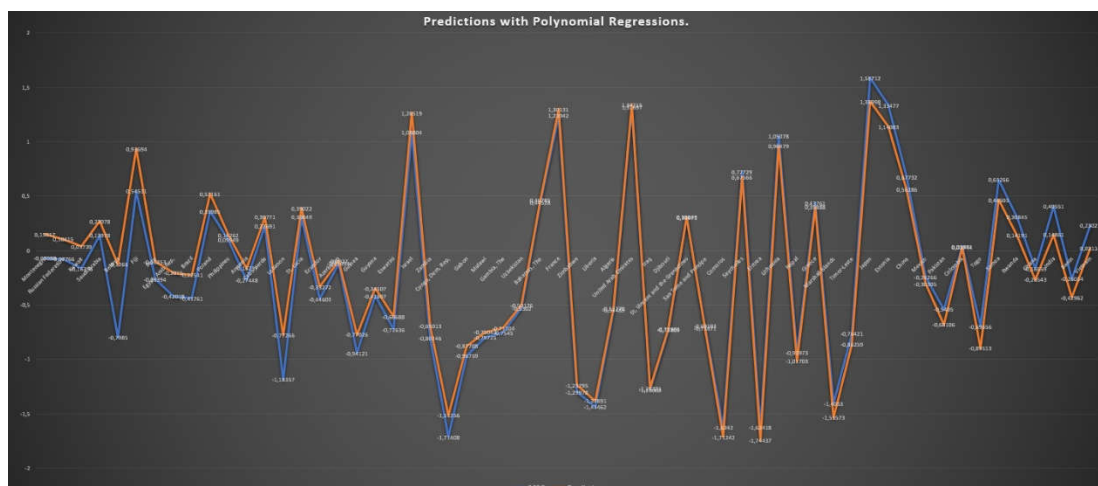


Figure 9. 2020 Values and Prediction with the application of Polynomial Regression.

- Kuwait with an increased variation from an amount of -0.16396 units up to a value of 0.03739 units or equal to a value of 0.20 units equal to an amount of 122.80%;
- Lebanon with an increased variation from an amount of -1,18357 units up to a value of -0.77266 units or equal to a value of 0.41 units equal to an amount of 34.72%;

- Liberia with an increased variation from an amount of -1,43462 units up to a value of -1,37891 units or equal to a value of 0.06 units equal to an amount of 3.88%;
- Lithuania with a diminutive variation from an amount of 1,050078 units up to a value of 0.96479 units or equal to an amount of -0.09 units equal to a variation of -8.18%;
- Malawi with a variation from an amount of -0.79725 units up to a value of -0.75043 units or equal to a value of 0.05 units equal to an amount of 5.87%;
- Marshall Islands with a diminutive variation from an amount of -1,40530 units up to a value of -1.53573 units equal to a value of -0.13 units equal to a value of -9.28%;
- Mexico with a diminutive variation from an amount of -0.24266 units up to a value of -0.30305 units or equal to a value of -0.06 units equal to an amount of -24.88%;
- Montenegro with an increased variation from an amount of -0.07089 units up to a value of 0.15017 units or equal to a value of 0.22 units equal to an amount of 311.84%;
- Nepal with a diminutive variation from an amount of -0.93972 units up to a value of -1.01703 units or equal to a value of -0.08 units equal to an amount of -8.23%;
- Pakistan with a diminutive variation from an amount of -0.54050 units up to a value of -0.68106 units or equal to a value of -0.14 units equal to a value of -26.00%;
- Peru with an increased variation from an amount of -0.26394 units up to a value of -0.10253 units or equal to a value of 0.16 units equal to a value of 61.15%;
- Philippines with a variation from an amount of 0.09949 units up to an amount of 0.14262 units or equal to a value of 0.04 units equal to a value of 43.34%;
- Poland with an increased variation from a value of 0.35985 units up to a value of 0.52161 units or equal to a value of 0.16 units equal to a value of 44.95%;
- Russian Federation with an increased variation from a value of -0.07766 units up to a value of 0.10415 units or equal to a value of 0.18 units equal to a value of 234.12%;
- Rwanda with a variation from an amount of 0.30845 units up to a value of 0.14191 units or equal to a value of -0.17 units equal to a value of -53.99%;
- Samoa with a diminutive variation from an amount of 0.65266 units up to a value of 0.46503 units or equal to a variation of -0.19 units equal to a value of -28.75%;
- Sao Tome and Principe with a diminutive variation from an amount of -0.69193 units up to a value of -0.71071 units or equal to an amount of -0.02 unit equivalent to a value of -2.71%;
- Saudi Arabia with an increased variation from an amount of 0.13978 units up to a value of 0.27078 units or equal to an amount of 0.13 units equal to a value of 93.72%;
- Seychelles with a diminutive variation from an amount of 0.72729 units up to a value of 0.67566 units or equal to an amount of -0.05 units equal to a value of -7.10%;
- St Lucia with an increased variation from an amount of 0.30849 units up to a value of 0.39022 units or equal to a value of 0.08 units equal to a value of 26.49%;
- ST, Vincent and the Grenadines with a diminutive marginal variation from an amount of 0.30849 units up to a value of 0.30671 units or equal to a value of 0.00 units equal to a value of -0.58%;
- Timor -lilte with a diminutive variation from an amount of -0.76421 units up to a value of -0.86259 units or equal to a value of -0.10 units equal to a value of -12.87%;
- Togo with a diminutive variation from an amount of -0.69656 units up to a value of -0.89513 units or equal to a variation of -0.20 units equal to a value of -28.51%;

- United Arab Emirates with an increased variation from an amount of 1,31697 units up to a value of 1,34215 units equal to an amount of 0.03 units equal to a value of 1.91%;
- Uzbekistan with an increased variation from an amount of -0.53020 units up to a value of -0.50126 units or equal to a value of 0.03 units equal to an amount of 5.46%;
- Vietnam with a diminutive variation from an amount of 0.23021 units up to a value of 0.02114 units or equal to a value of -0.21 units equal to a value of 90.82%;
- Zambia with an increased variation from an amount of -0.80246 units up to a value of -0.69013 units or equal to a value of 0.11 units equal to a value of 14.00%;
- Zimbabwe with an increased variation from an amount of -1,29978 units up to a value of -1,23795 units equal to a value of 0.06 units equal to a value of 4.76%.

Table.8.

| Prediction with Polynomial Regression | | | | | | | | | |
|---------------------------------------|----------|------------|---------|--------|---------------------------------------|----------|------------|---------|--------|
| Country | 2020 | Prediction | Abs Var | % Var | Country | 2020 | Prediction | Abs Var | % Var |
| <i>Algeria</i> | -0,54489 | -0,52778 | 0,02 | 3,14 | <i>Japan</i> | 1,58712 | 1,36998 | -0,22 | -13,68 |
| <i>Armenia</i> | -0,27448 | -0,16257 | 0,11 | 40,77 | <i>Kuwait</i> | -0,16396 | 0,03739 | 0,20 | 122,80 |
| <i>Azerbaijan</i> | -0,11694 | -0,09270 | 0,02 | 20,73 | <i>Lebanon</i> | -1,18357 | -0,77266 | 0,41 | 34,72 |
| <i>Bahamas, The</i> | 0,44528 | 0,46785 | 0,02 | 5,07 | <i>Liberia</i> | -1,43462 | -1,37891 | 0,06 | 3,88 |
| <i>Belarus</i> | -0,79850 | -0,12660 | 0,67 | 84,15 | <i>Lithuania</i> | 1,05078 | 0,96479 | -0,09 | -8,18 |
| <i>Benin</i> | -0,26054 | -0,42962 | -0,17 | -64,90 | <i>Malawi</i> | -0,79725 | -0,75043 | 0,05 | 5,87 |
| <i>Brazil</i> | -0,43761 | -0,22541 | 0,21 | 48,49 | <i>Marshall Islands</i> | -1,40530 | -1,53573 | -0,13 | -9,28 |
| <i>Cabo Verde</i> | 0,22691 | 0,30771 | 0,08 | 35,61 | <i>Mexico</i> | -0,24266 | -0,30305 | -0,06 | -24,88 |
| <i>China</i> | 0,67732 | 0,56286 | -0,11 | -16,90 | <i>Montenegro</i> | -0,07089 | 0,15017 | 0,22 | 311,84 |
| <i>Colombia</i> | 0,03801 | 0,02744 | -0,01 | -27,81 | <i>Nepal</i> | -0,93973 | -1,01703 | -0,08 | -8,23 |
| <i>Comoros</i> | -1,62420 | -1,71242 | -0,09 | -5,43 | <i>Pakistan</i> | -0,54050 | -0,68106 | -0,14 | -26,00 |
| <i>Congo, Dem, Rep,</i> | -1,71408 | -1,51256 | 0,20 | 11,76 | <i>Peru</i> | -0,26394 | -0,10253 | 0,16 | 61,15 |
| <i>Djibouti</i> | -0,72809 | -0,71961 | 0,01 | 1,16 | <i>Philippines</i> | 0,09949 | 0,14262 | 0,04 | 43,34 |
| <i>Ecuador</i> | -0,44603 | -0,33272 | 0,11 | 25,40 | <i>Poland</i> | 0,35985 | 0,52161 | 0,16 | 44,95 |
| <i>Egypt, Arab Rep,</i> | -0,42018 | -0,20150 | 0,22 | 52,04 | <i>Russian Federation</i> | -0,07766 | 0,10415 | 0,18 | 234,12 |
| <i>Eritrea</i> | -1,62418 | -1,74437 | -0,12 | -7,40 | <i>Rwanda</i> | 0,30845 | 0,14191 | -0,17 | -53,99 |
| <i>Estonia</i> | 1,33477 | 1,14083 | -0,19 | -14,53 | <i>Samoa</i> | 0,65266 | 0,46503 | -0,19 | -28,75 |
| <i>Eswatini</i> | -0,72636 | -0,60688 | 0,12 | 16,45 | <i>Sao Tome and Principe</i> | -0,69193 | -0,71071 | -0,02 | -2,71 |
| <i>Fiji</i> | 0,54531 | 0,93694 | 0,39 | 71,82 | <i>Saudi Arabia</i> | 0,13978 | 0,27078 | 0,13 | 93,72 |
| <i>France</i> | 1,23942 | 1,30131 | 0,06 | 4,99 | <i>Seychelles</i> | 0,72729 | 0,67566 | -0,05 | -7,10 |
| <i>Gabon</i> | -0,96759 | -0,87708 | 0,09 | 9,35 | <i>St, Lucia</i> | 0,30849 | 0,39022 | 0,08 | 26,49 |
| <i>Gambia, The</i> | -0,75450 | -0,71104 | 0,04 | 5,76 | <i>St, Vincent and the Grenadines</i> | 0,30849 | 0,30671 | 0,00 | -0,58 |
| <i>Ghana</i> | -0,16559 | -0,26543 | -0,10 | -60,30 | <i>Timor-Leste</i> | -0,76421 | -0,86259 | -0,10 | -12,87 |
| <i>Greece</i> | 0,43761 | 0,39888 | -0,04 | -8,85 | <i>Togo</i> | -0,69656 | -0,89513 | -0,20 | -28,51 |
| <i>Guinea</i> | -0,94121 | -0,77026 | 0,17 | 18,16 | <i>United Arab Emirates</i> | 1,31697 | 1,34215 | 0,03 | 1,91 |
| <i>Guyana</i> | -0,41697 | -0,34507 | 0,07 | 17,24 | <i>Uzbekistan</i> | -0,53020 | -0,50126 | 0,03 | 5,46 |
| <i>India</i> | 0,40551 | 0,14861 | -0,26 | -63,35 | <i>Vietnam</i> | 0,23021 | 0,02114 | -0,21 | -90,82 |
| <i>Iraq</i> | -1,28008 | -1,26321 | 0,02 | 1,32 | <i>Zambia</i> | -0,80246 | -0,69013 | 0,11 | 14,00 |
| <i>Israel</i> | 1,08804 | 1,26519 | 0,18 | 16,28 | <i>Zimbabwe</i> | -1,29978 | -1,23795 | 0,06 | 4,76 |

Based on the analysis made, it appears that the value of "Government Effectiveness" is predicted growing, for the countries analyzed only, from an amount of -0.22015 units up to a value of -0.18867 units or equal to a value of 0.03148 units equal to a value of 14.30%. Specifically, there are countries that are top performers or countries for which the algorithm predicts a significant growth in the value of "Government Effectiveness" and these countries are Montenegro with a percentage value equal to

+311.84%, Russian Federation with A value equal to +234.12, and Kuwait with a variation equal to a value of 122.8%. However, there are also countries for which the algorithm predicts a significant reduction in the value of "Government Effectiveness" such as Vietnam with a value equal to -90.82%, Benin with -64.9%, and India with a value equal to -63.35%.

6. Conclusions

Our analysis shows that some variables, i.e. Control of Corruption and Political Stability and Absence of Violence/Terrorism are positively associated with GE. On the contrary, the percentage GDP growth is negatively associated with GE. GE's value decreased between 2011 and 2020 in many Western countries. Specifically, it has decreased in the countries of Western Europe, the USA and in the UK. On the contrary, it has increased in many countries of Eastern Europe, the Baltic, India, and China. The reasons for these variations consist above all in the management of pandemic and in the ability of governments to offer better socio-economic conditions to their citizens. Furthermore, the credibility of governments towards the population is very relevant, and has relevant impact in determining the level of GE.

In this sense, the US, UK and many Western European countries have lost much credibility, for facts also connected to socio-economic phenomena i.e.: inequalities, gender and racial discriminations, corruption, lobbyism, lack of a real rotation in the ruling class. Western democracies, also having high levels in an absolute sense of GE, show a decreasing trend of GE in percentage terms. The inability of Western Democracies to guarantee a real change in the elite shows a dangerous parallelism with Eastern Autocracies, and in the absence of a real GDP growth, generate a percentage decrease in GE.

Funding: The authors received no financial support for the research, authorship, and/or publication of this article.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgements: We are grateful to the teaching staff of the LUM University Giuseppe Degennaro and to the management of the LUM Enterprise s.r.l. for the constant inspiration to continue our scientific research work undeterred.

Declaration of Competing Interest: The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication.

Software: The authors have used the following software: Gretl for the econometric models, Orange for clusterization and network analysis, and KNIME for machine learning and predictions. They are all free version without licenses.

References

- [1] WB, "Environment, Social and Governance-ESG," [Online]. Available: <https://esgdata.worldbank.org/?lang=en>. [Accessed 15 01 2023].
- [2] A. Case and A. Deaton, Deaths of Despair and the Future of Capitalism, Princeton University Press., 2020.
- [3] A. Oxford, "Qatargate'exposes EU transparency failures," Emerald Expert Briefings, 2022.
- [4] M. Haverland, R. van der Veer and M. Onderco, "Is this crisis different? Attitudes towards EU fiscal transfers in the wake of the COVID-19 pandemic," European Union Politics, vol. 23, no. 4, pp. 680-699, 2022.
- [5] D. Acemoglu and J. A. Robinson, Why nations fail: The origins of power, prosperity, and poverty, Currency, 2012.
- [6] D. Rodrik, The globalization paradox: Democracy and the future of the world economy, WW Norton & Company., 2011.
- [7] C. Chisadza, C. M. and R. Gupta, "Government effectiveness and the COVID-19 pandemic," Sustainability, vol. 6, no. 3042, p. 13, 2021.

- [8] L. L. Liang, C. H. Tseng, H. J. Ho and C. Y. Wu, "Covid-19 mortality is negatively associated with test number and government effectiveness," *Scientific reports*, vol. 1, no. 10, pp. 1-7, 2020.
- [9] M. Butkus and J. Seputiene, "Growth effect of public debt: The role of government effectiveness and trade balance," *Economies*, vol. 4, no. 62, p. 6, 2018.
- [10] E. F. Tanjung, "Impact of public wellness, competitiveness, and government effectiveness on quality of education in Asian countries," *Kıbrıslı Eğitim Bilimleri Dergisi*, vol. 15, no. 6, pp. 1720-1731, 2020.
- [11] S. P. Chainey, G. Croci and L. J. Rodriguez Forero, "The influence of government effectiveness and corruption on the high levels of homicide in Latin America," *Social Sciences*, vol. 172, no. 5, p. 10, 2021.
- [12] L. Yang, S. Bashiru Danwana and F. L. Y. Issahaku, "Achieving Environmental Sustainability in Africa: The Role of Renewable Energy Consumption, Natural Resources, and Government Effectiveness—Evidence from Symmetric and Asymmetric ARDL Models," *International Journal of Environmental Research and Public Health*, vol. 13, no. 8038, p. 19, 2022.
- [13] R. Santa, J. B. MacDonald and M. Ferrer, "The role of trust in e-Government effectiveness, operational effectiveness and user satisfaction: Lessons from Saudi Arabia in e-G2B," *Government Information Quarterly*, vol. 36, no. 1, pp. 39-50, 2019.
- [14] J. Wallis and F. Zhao, "e-Government development and government effectiveness: a reciprocal relationship," *International Journal of Public Administration*, vol. 41, no. 7, pp. 479-491, 2018.
- [15] G. C. Montes, J. C. A. Bastos and A. J. Oliveira, "Fiscal transparency, government effectiveness and government spending efficiency: Some international evidence based on panel data approach," *Economic Modelling*, vol. 79, pp. 211-225, 2019..
- [16] E. Tennant and E. A. Gilmore, "Government effectiveness and institutions as determinants of tropical cyclone mortality," *Proceedings of the National Academy of Sciences*, vol. 117, no. 46, pp. 28692-28699, 2020.
- [17] G. Grossman and A. Krueger, "Environmental Impacts of a North American Free Trade Agreement," *National Bureau of Economic Research, Inc.*, no. 3914, 1991.
- [18] H. F. G. e. S. A. S. U. Al-Mulali, "Investigating the environmental Kuznets curve (EKC) hypothesis: does government effectiveness matter? Evidence from 170 countries," *Environment, Development and Sustainability*, vol. 24, no. 11, pp. 12740-12755, 2022.
- [19] R. Yasmeen, R. Tao, W. U. H. Shah, I. U. H. Padda and C. Tang, "The nexuses between carbon emissions, agriculture production efficiency, research and development, and government effectiveness: evidence from major agriculture-producing countries," *Environmental Science and Pollution Research*, 2022.
- [20] A. Bunyaminu, I. Mohammed, I. N. Yakubu, B. Shani and A. L. Abukari, "The effect of health expenditure on average life expectancy: does government effectiveness play a moderating role?," *International Journal of Health Governance*, 2022.
- [21] Blom-Hansen, K. Houlberg and S. Serritzlew, "Jurisdiction size and local government effectiveness: Assessing the effects of municipal amalgamations on performance," *European Journal of Political Research*, vol. 60, no. 1, pp. 153-174, 2021.
- [22] O. Adabor, "Averting the "resource curse phenomenon" through government effectiveness. Evidence from Ghana's natural gas production," *Management of Environmental Quality: An International Journal*, 2022.
- [23] A. Nikzadian, "The effects of resource rent, human capital and government effectiveness on government health expenditure in organization of the petroleum exporting countries," *International Journal of Energy Economics and Policy*, vol. 9, no. 2, pp. 381-389, 2019.
- [24] K. N. Kalu, "The impact of ICT-diffusion on government effectiveness: what role for cultural practices?," *International Journal of Organization Theory & Behavior*, vol. 22, no. 2, pp. 123-154, 2019.
- [25] J. P. Cross and A. Vaznonytė, "Can we do what we say we will do? Issue salience, government effectiveness, and the legislative efficiency of Council Presidencies," *European Union Politics*, vol. 21, no. 4, pp. 657-679, 2020.
- [26] B. Bosco and A. Poggi, "Middle class, government effectiveness and poverty in the EU: A dynamic multilevel analysis," *Review of Income and Wealth*, vol. 1, no. 66, pp. 94-125, 2020.
- [27] H. Yanikkaya and T. Turan, "Tax structure and economic growth: Do differences in income level and government effectiveness matter?," *The Singapore Economic Review*, vol. 65, no. 01, pp. 217-237, 2020.
- [28] M. Ü. ŞAŞMAZ and E. N. SAĞDIÇ, "The effect of government effectiveness and rule of law on economic growth: the case of European union transition economies," *Dokuz Eylül Üniversitesi İşletme Fakültesi Dergisi*, vol. 21, no. 1, pp. 203-217, 2020.
- [29] A. A. Wandaogo, "Does digitalization improve government effectiveness? Evidence from developing and developed countries," *Applied Economics*, vol. 54, no. 33, pp. 3840-3860, 2022.
- [30] R. Al-Tal and A. Al-Tarawneh, "The Impact of Government Effectiveness and Political Stability on Energy Consumption in the Selected MENA Economies," *International Journal of Energy Economics and Policy*, vol. 11, no. 2, pp. 1-6, 2021.

- [31] C. Sulaiman and A. S. Abdul-Rahim, "Relationship between wood fuel energy consumption and forest degradation at regional and sub-regional levels of sub-Saharan Africa: the role of control of corruption and government effectiveness," *Environmental Science and Pollution Research*, pp. 1-14, 2022.
- [32] S. Albreiki and A. D. Bhaumik, "The influence of knowledge management on the smart government effectiveness: An empirical study in UAE," *Dimension*, vol. 11, no. 12, 2019.
- [33] L. Nzama, T. Sithole and S. B. Kahyaoglu, "The Impact of Government Effectiveness on Trade and Financial Openness: The Generalized Quantile Panel Regression Approach," *Journal of Risk and Financial Management*, vol. 1, no. 14, p. 16, 2023.
- [34] T. Paientko and V. Fedosov, "Can Information Technology Increase Government Effectiveness?," *ICTERI Workshops*, pp. 393-405, 2019.
- [35] A. Bohigues and X. Fernández-i-Marín, "Drug Legalization, Elite Support, and Government Effectiveness in Latin America," *Journal of Drug Issues*, vol. 52, no. 2, pp. 250-267, 2022.
- [36] I. O. Adam and M. D. Alhassan, "The linkages between ICT access, e-government and government effectiveness and its effect on corruption," *International Journal of Technology, Policy and Management*, vol. 21, no. 4, pp. 344-362, 2021.
- [37] E. Agbozo and B. K. Asamoah, "The role of e-government systems in ensuring government effectiveness and control of corruption," *R-Economy*, vol. 5, no. 2, pp. 53-60, 2019.
- [38] S. E. Ştefoni and A. Draghia, "Impact of education and government effectiveness on the shadow economy," *Theoretical and Applied Economics*, vol. 22, no. 3, pp. 75-84, 2020.
- [39] T. Nam, "Does e-Government raise effectiveness and efficiency?: Examining the cross-national effect," *Journal of Global Information Management (JGIM)*, vol. 27, no. 3, pp. 120-138, 2019.
- [40] J. Chen, L. Gong and S. Xie, "Psychological Distress in Urbanizing China: How Does Local Government Effectiveness Matter?," *International Journal of Environmental Research and Public Health*, vol. 4, no. 2042, p. 18, 2021.
- [41] M. Djayasinga and T. J. Prasetyo, "The effect of government effectiveness, rule of law and control of corruption toward tax obedience," *Religación: Revista De Ciencias Sociales Y Humanidades*, vol. 41, no. 6, pp. 136-143, 2019.
- [42] G. Hofstede, *Culture's consequences: International differences in work-related values*, vol. 5, Sage, 1984.
- [43] P. Kim, R. Kim and T. Im, "Which Combinations of Human Resource Management and National Culture Optimize Government Effectiveness?," *Journal of Policy Studies*, vol. 37, no. 1, pp. 27-43, 2022.
- [44] S. O. Akinbode, J. Olabisi, R. R. Adegbite, T. A. Aderemi and A. M. Alawode, "Corruption, Government Effectiveness and Human Development in Sub-Saharan Africa," *Journal for the Advancement of Developing Economies*, vol. 9, no. 1, pp. 16-34, 2020.
- [45] M. M. Ahmed, "Government Effectiveness and Development: South Asian Perspective," *Asian Social Science*, vol. 18, no. 8, pp. 1911-2017, 2022.
- [46] L. Zang and F. Xiong, "How (when) does technological innovation improve government effectiveness? An empirical investigation with cross-national evidence," *Science and Public Policy*, vol. 47, no. 1, pp. 103-113, 2020.
- [47] L. Laureti, A. Costantiello and A. Leogrande, "The Fight Against Corruption at Global Level. A Metric Approach," *SSRN*, 2022.
- [48] WB, "Annualized average growth rate in per capita real survey mean consumption or income, bottom 40% of population (%)," *World Bank*, [Online]. Available: <https://data.worldbank.org/indicator/SI.SPR.PC40.ZG>. [Accessed 2023 01 15].
- [49] WB, "Control of Corruption," *World Bank*, [Online]. Available: <https://databank.worldbank.org/metadataglossary/worldwide-governance-indicators/series/CC.EST#:~:text=Control%20of%20Corruption%20captures%20perceptions,by%20elites%20and%20private%20interests..> [Accessed 15 01 2023].
- [50] WB, "Political Stability and Absence of Violence/Terrorism: Estimate," *World Bank*, [Online]. Available: <https://databank.worldbank.org/metadataglossary/1181/series/PV.EST#:~:text=Political%20Stability%20and%20Absence%20of%20Violence%20Terrorism%20measures%20perceptions%20of,%20Dmotivated%20violence%2C%20including%20terrorism..> [Accessed 15 01 2023].
- [51] WB, "Regulatory Quality," *World Bank*, [Online]. Available: <https://databank.worldbank.org/metadataglossary/worldwide-governance-indicators/series/RQ.PER.RNK.LOWER#:~:text=Regulatory%20Quality%20captures%20perceptions%20of,%20and%20promote%20private%20sector%20development..> [Accessed 15 01 2023].
- [52] WB, "Strength of legal rights index (0=weak to 12=strong)," [Online]. Available: <https://data.worldbank.org/indicator/IC.LGL.CRED.XQ>. [Accessed 15 01 2023].
- [53] WB, "Voice and Accountability," *World Bank*, [Online]. Available: <https://databank.worldbank.org/metadataglossary/worldwide-governance-indicators/series/VA.STD.ERR#:~:text=Voice%20and%20Accountability%20captures%20perceptions,association%2C%20and%20a%20free%20media..> [Accessed 15 01 2023].

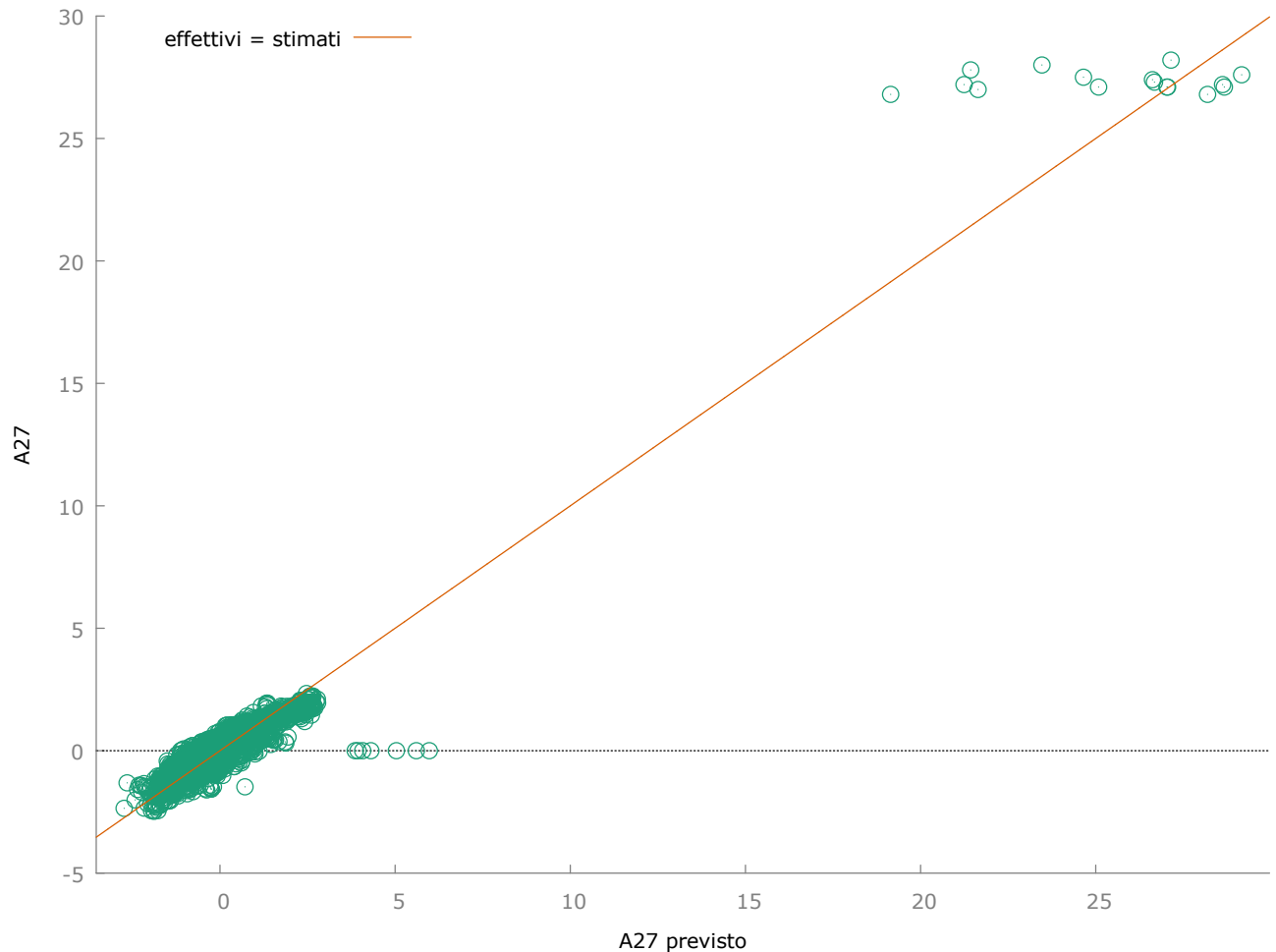
[54] WB, "Gdp Growth %," World Bank, [Online]. Available: <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG>. [Accessed 15 01 2023].

Appendix

11.1 Regression Analysis

Modello 1: Pooled OLS, usando 1930 osservazioni
 Include 193 unità cross section
 Lunghezza serie storiche = 10
 Variabile dipendente: A27

| | <i>Coefficiente</i> | <i>Errore Std.</i> | <i>rapporto t</i> | <i>p-value</i> | |
|-----------------------|---------------------|------------------------|-------------------|----------------|-----|
| const | -0,0456923 | 0,0155350 | -2,941 | 0,0033 | *** |
| A8 | 0,0914567 | 0,0112693 | 8,116 | <0,0001 | *** |
| A12 | 1,19682 | 0,0209605 | 57,10 | <0,0001 | *** |
| A24 | 0,0187262 | 0,00209310 | 8,947 | <0,0001 | *** |
| A47 | -0,0845504 | 0,0158718 | -5,327 | <0,0001 | *** |
| A55 | 0,0680405 | 0,00287561 | 23,66 | <0,0001 | *** |
| A63 | 0,00104518 | 3,03373e-05 | 34,45 | <0,0001 | *** |
| A67 | -0,0704004 | 0,0192960 | -3,648 | 0,0003 | *** |
| Media var. dipendente | 0,147729 | SQM var. dipendente | 2,666454 | | |
| Somma quadr. residui | 767,5978 | E.S. della regressione | 0,631961 | | |
| R-quadro | 0,944033 | R-quadro corretto | 0,943829 | | |
| F(7, 1922) | 4631,368 | P-value(F) | 0,000000 | | |
| Log-verosimiglianza | -1848,812 | Criterio di Akaike | 3713,625 | | |
| Criterio di Schwarz | 3758,147 | Hannan-Quinn | 3730,002 | | |
| rho | 0,675207 | Durbin-Watson | 0,578750 | | |



Modello 2: Effetti fissi, usando 1930 osservazioni
 Include 193 unità cross section
 Lunghezza serie storiche = 10
 Variabile dipendente: A27

| | <i>Coefficiente</i> | <i>Errore Std.</i> | <i>rapporto t</i> | <i>p-value</i> | |
|-----------------------|---------------------|------------------------|-------------------|----------------|-----|
| const | 0,0527053 | 0,00696538 | 7,567 | <0,0001 | *** |
| A8 | 0,0222450 | 0,00502731 | 4,425 | <0,0001 | *** |
| A12 | 1,44191 | 0,0248193 | 58,10 | <0,0001 | *** |
| A24 | -0,00300977 | 0,000989395 | -3,042 | 0,0024 | *** |
| A47 | 0,223079 | 0,0175891 | 12,68 | <0,0001 | *** |
| A55 | 0,00817326 | 0,00184350 | 4,434 | <0,0001 | *** |
| A63 | 0,00127469 | 2,45817e-05 | 51,86 | <0,0001 | *** |
| A67 | 0,172528 | 0,0163470 | 10,55 | <0,0001 | *** |
| Media var. dipendente | 0,147729 | SQM var. dipendente | 2,666454 | | |
| Somma quadr. residui | 121,5441 | E.S. della regressione | 0,265060 | | |
| R-quadro LSDV | 0,991138 | R-quadro intra-gruppi | 0,950076 | | |
| LSDV F(199, 1730) | 972,2854 | P-value(F) | 0,000000 | | |

| | | | |
|---------------------|-----------|--------------------|----------|
| Log-verosimiglianza | -70,32828 | Criterio di Akaike | 540,6566 |
| Criterio di Schwarz | 1653,712 | Hannan-Quinn | 950,0841 |
| rho | 0,381173 | Durbin-Watson | 1,046314 |

Test congiunto sui regressori -

Statistica test: $F(7, 1730) = 4703,27$

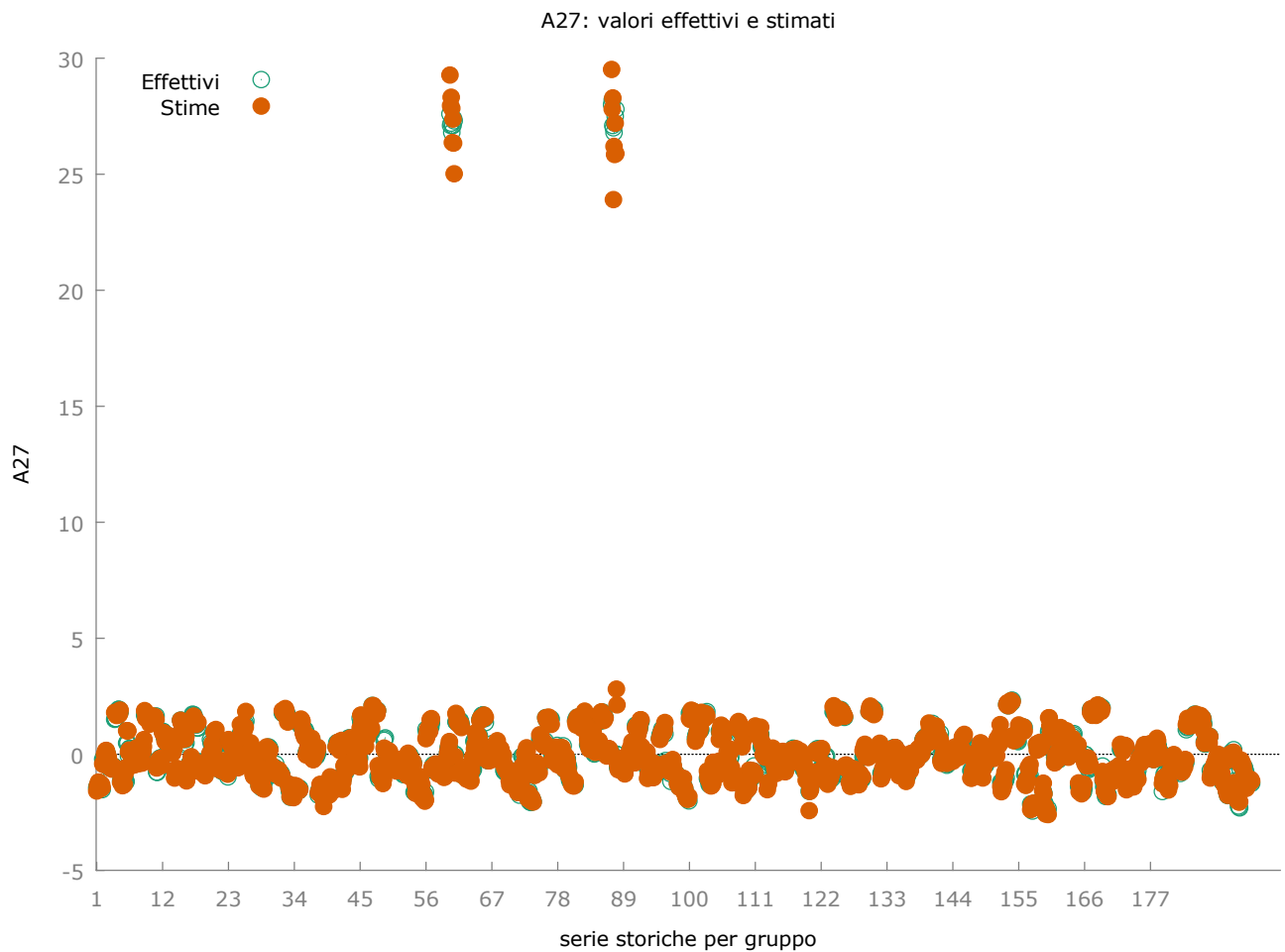
con p-value = $P(F(7, 1730) > 4703,27) = 0$

Test per la differenza delle intercette di gruppo -

Ipotesi nulla: i gruppi hanno un'intercetta comune

Statistica test: $F(192, 1730) = 47,8938$

con p-value = $P(F(192, 1730) > 47,8938) = 0$



Modello 3: Effetti casuali (GLS), usando 1930 osservazioni

Con trasformazione di Nerlove

Incluse 193 unità cross section

Lunghezza serie storiche = 10

Variabile dipendente: A27

| | <i>Coefficiente</i> | <i>Errore Std.</i> | <i>z</i> | <i>p-value</i> | |
|-----------------------|---------------------|------------------------|----------|----------------|-----|
| const | 0,0497381 | 0,0712704 | 0,6979 | 0,4853 | |
| A8 | 0,0226600 | 0,00498577 | 4,545 | <0,0001 | *** |
| A12 | 1,42881 | 0,0239766 | 59,59 | <0,0001 | *** |
| A24 | -0,00232263 | 0,000979637 | -2,371 | 0,0177 | ** |
| A47 | 0,206671 | 0,0169841 | 12,17 | <0,0001 | *** |
| A55 | 0,00916899 | 0,00181323 | 5,057 | <0,0001 | *** |
| A63 | 0,00128897 | 2,40100e-05 | 53,68 | <0,0001 | *** |
| A67 | 0,151071 | 0,0159317 | 9,482 | <0,0001 | *** |
| Media var. dipendente | 0,147729 | SQM var. dipendente | 2,666454 | | |
| Somma quadr. residui | 1689,264 | E.S. della regressione | 0,937258 | | |
| Log-verosimiglianza | -2609,987 | Criterio di Akaike | 5235,974 | | |
| Criterio di Schwarz | 5280,497 | Hannan-Quinn | 5252,351 | | |
| rho | 0,381173 | Durbin-Watson | 1,046314 | | |

Varianza 'between' = 0,883311

Varianza 'within' = 0,0629762

Theta usato per la trasformazione = 0,915863

Test congiunto sui regressori -

Statistica test asintotica: Chi-quadro(7) = 34393,4

con p-value = 0

Test Breusch-Pagan -

Ipotesi nulla: varianza dell'errore specifico all'unità = 0

Statistica test asintotica: Chi-quadro(1) = 2575,25

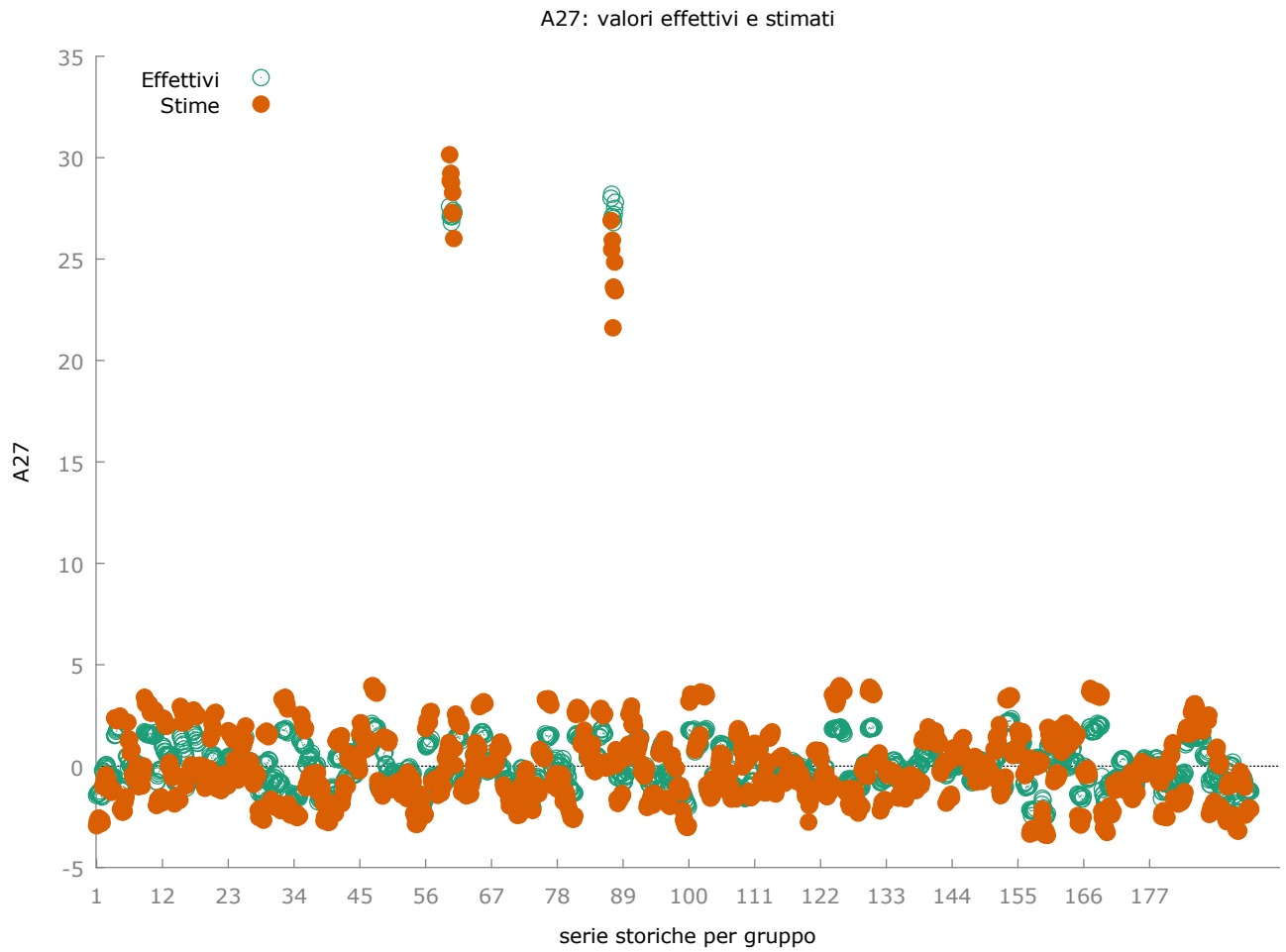
con p-value = 0

Test di Hausman -

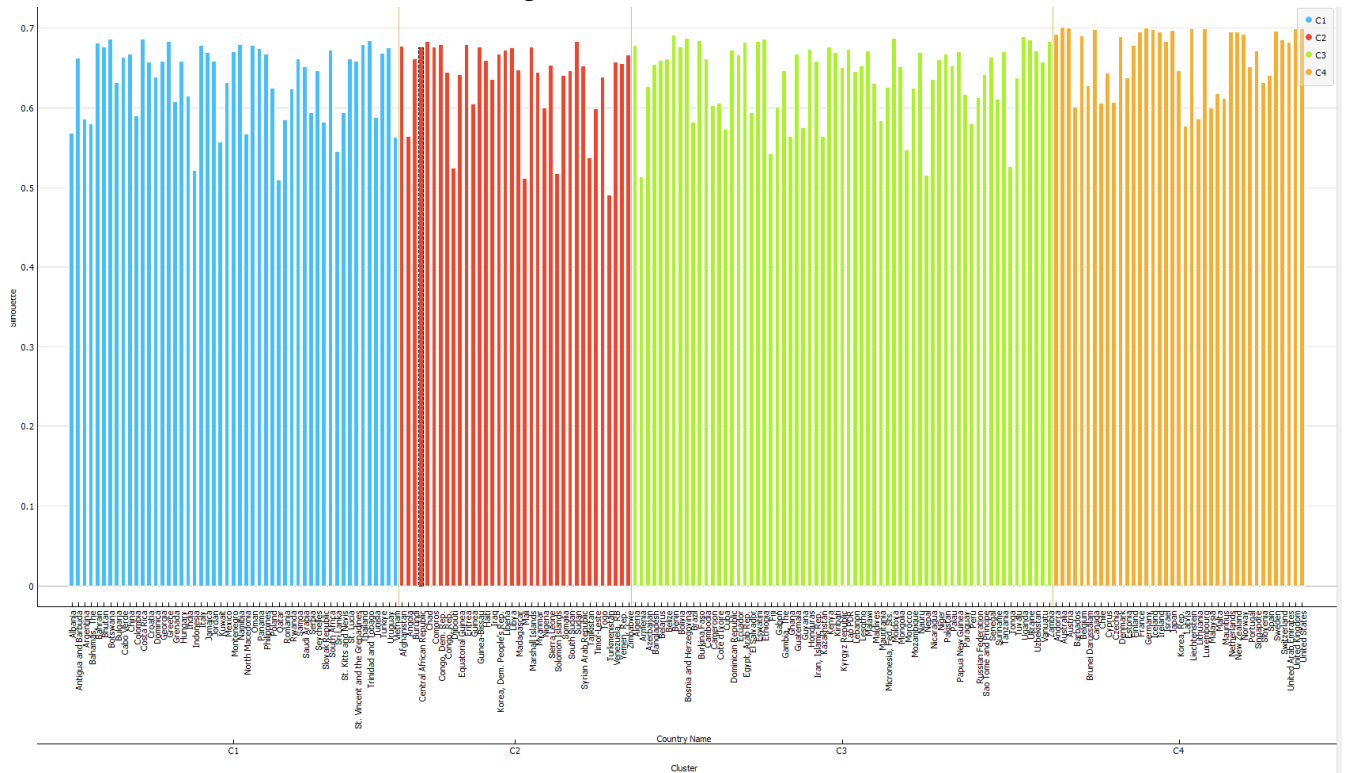
Ipotesi nulla: le stime GLS sono consistenti

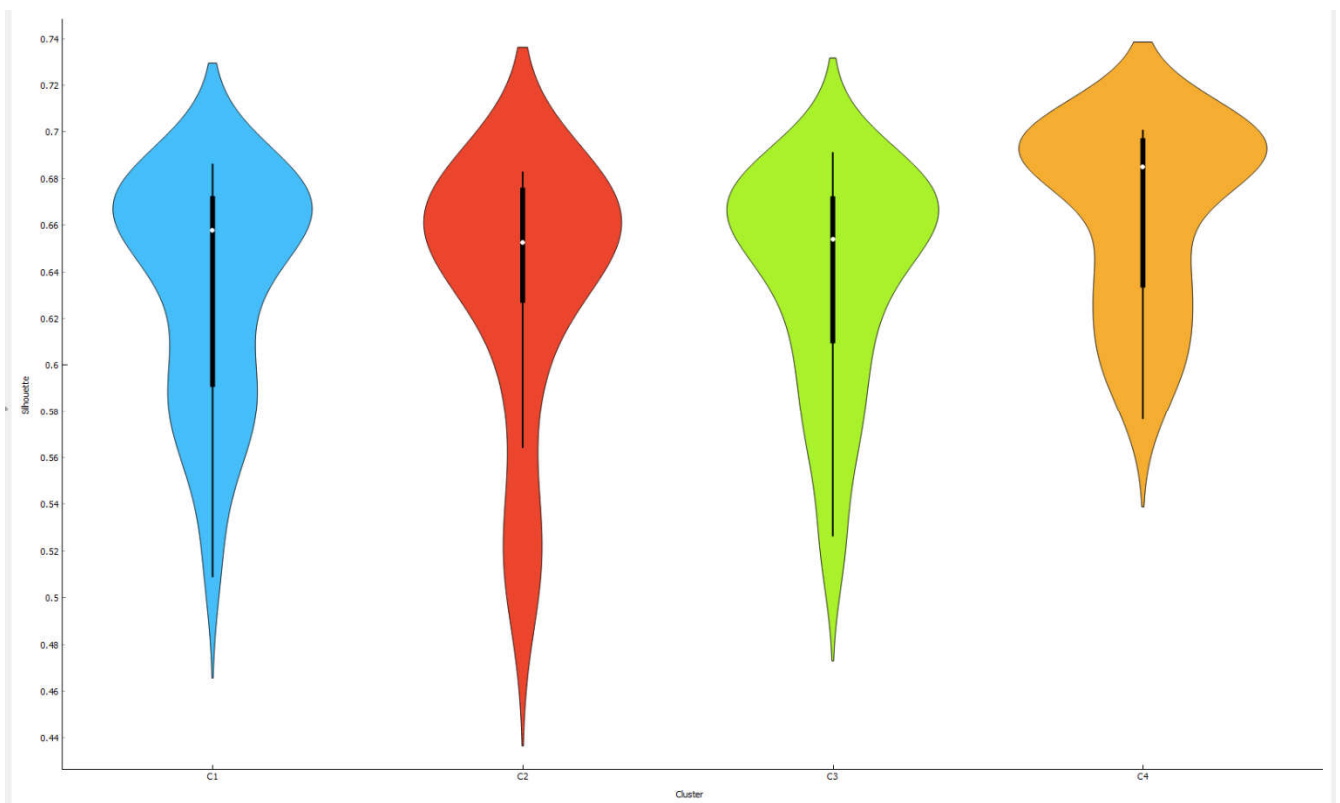
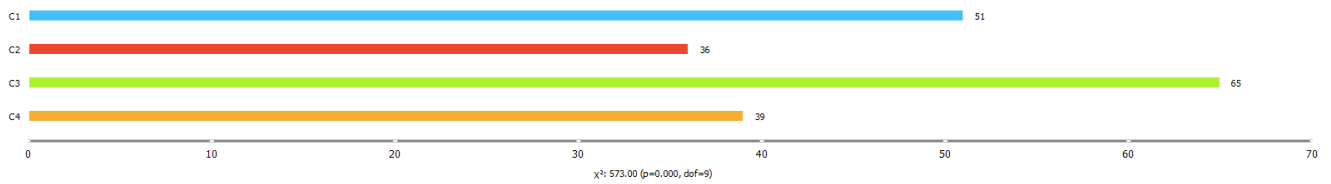
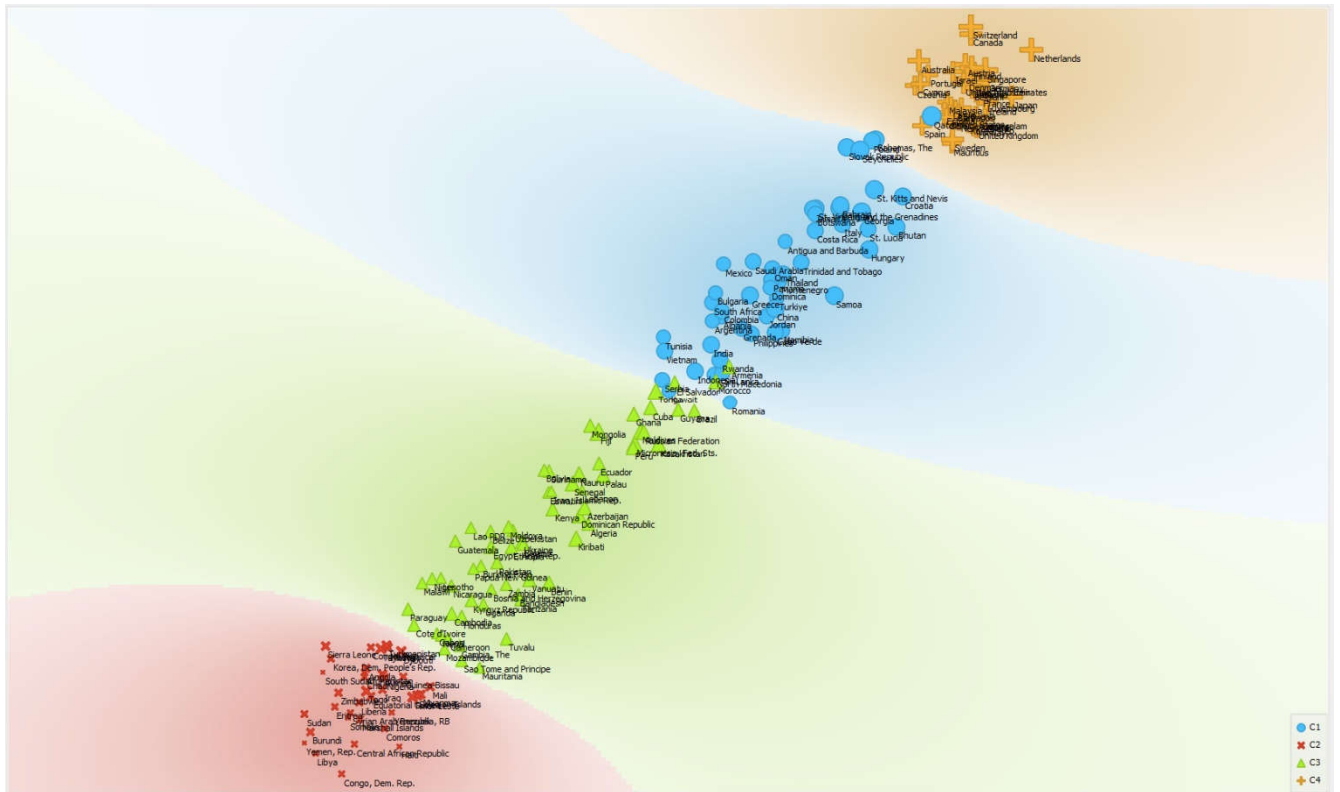
Statistica test asintotica: Chi-quadro(7) = 147,795

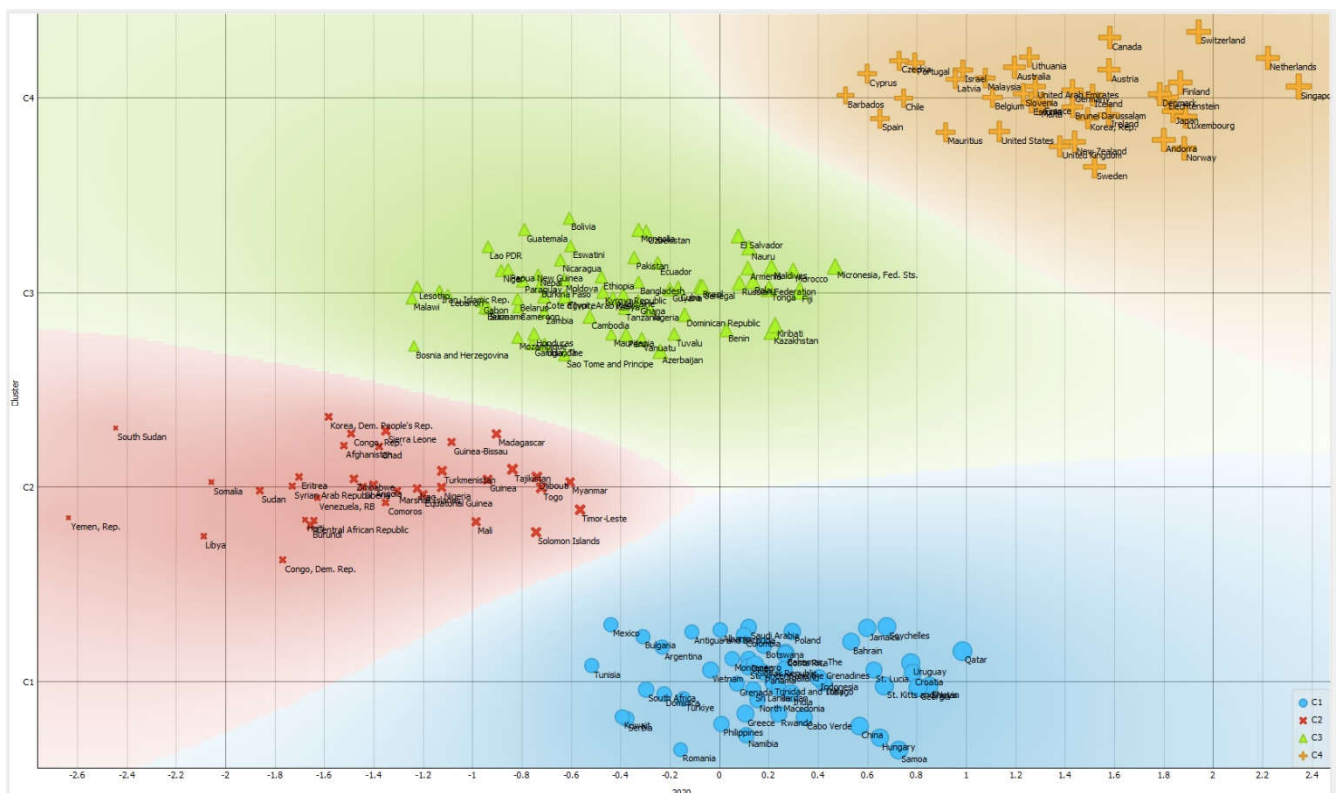
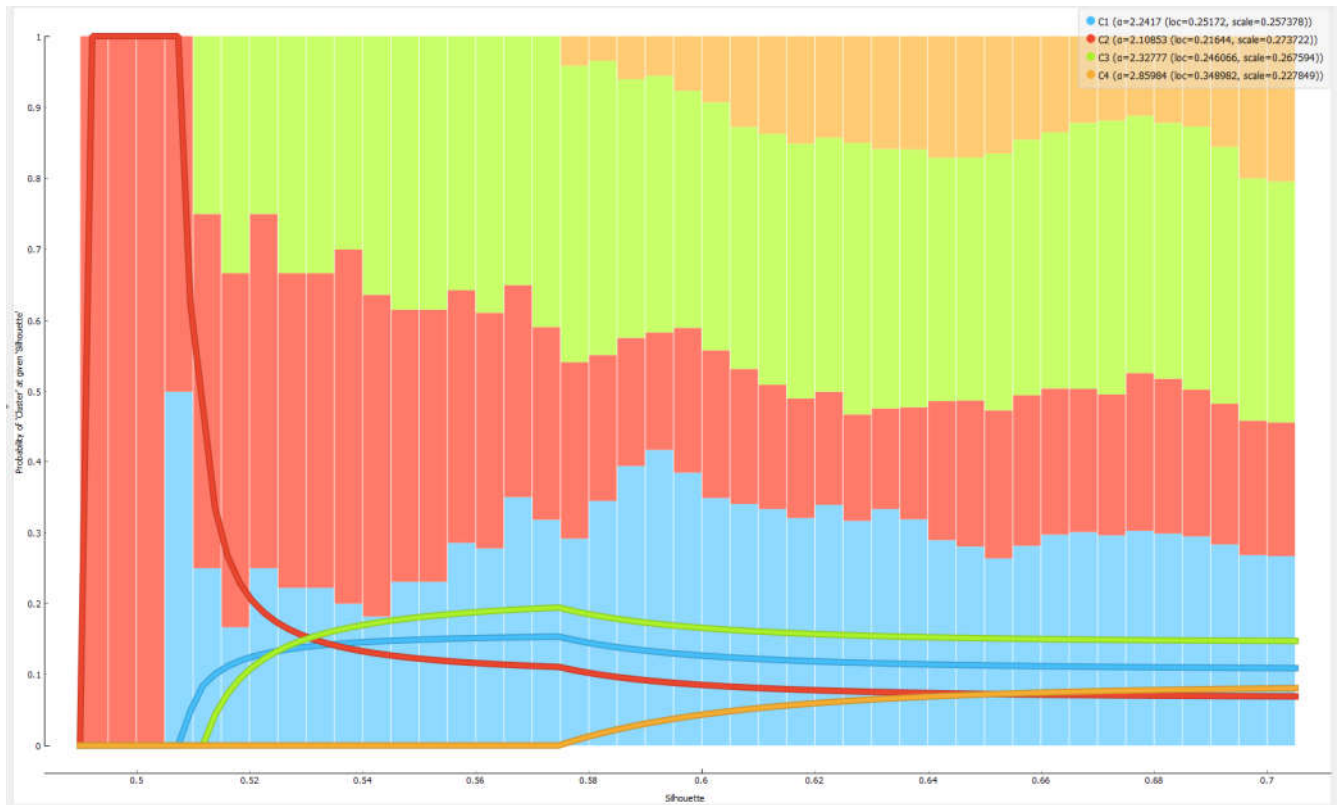
con p-value = 1,1789e-028

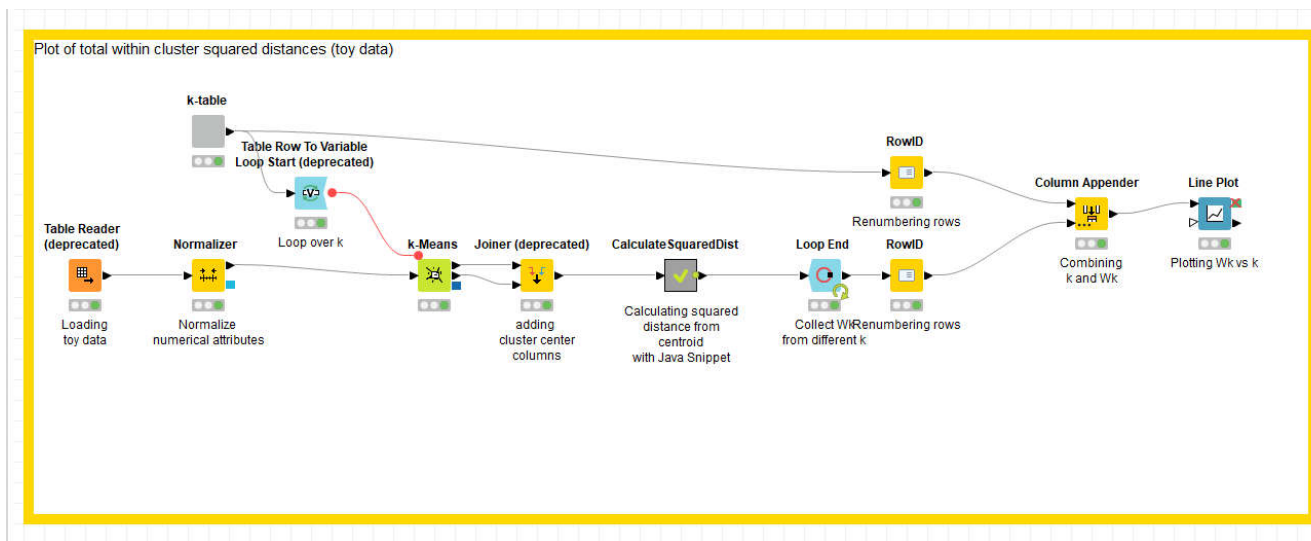
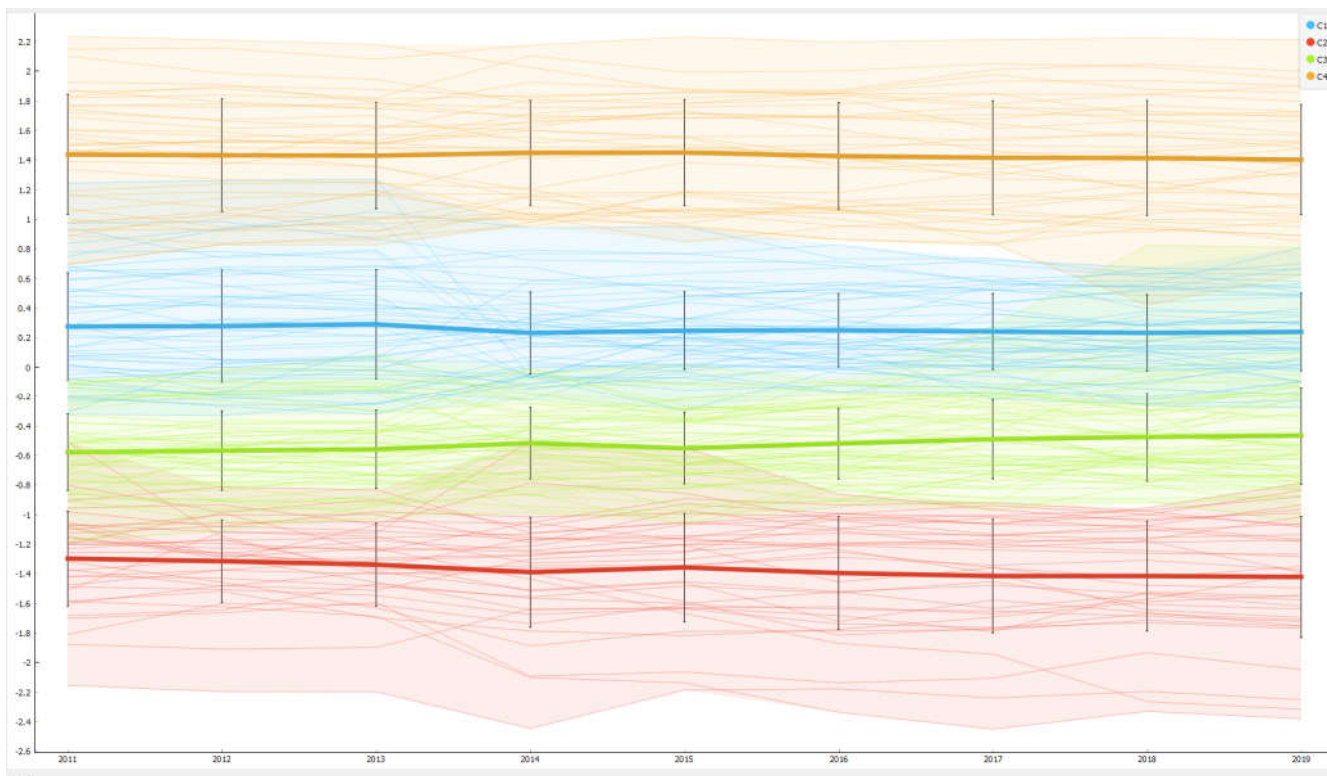


10.2 Clusterization with k-Means Algorithm









10.3 Machine Learning

