The Employment Impact of Innovation in Europe

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It grew by 10% between 2014 and 2021

The European Innovation Scoreboard calculates the value of the impact of innovation on employment through the sum of two sub-indicators, i.e. employment in knowledge-intensive activities and employment in innovative companies.

Ranking of European countries by value of the impact of innovation on employment in 2021. Israel ranks first by value of the employment impact of innovation with a value of 207.88, with Norway in second place with a value equal to 175.58 followed by Switzerland with an amount equal to 173.29. In the middle of the table there are Montenegro with an amount equal to 116.45 units, followed by Ireland with an amount equal to 114.70 units, and by France with a value equal to 111.56 units. Poland closes the ranking with an amount equal to 31.93, followed by Turkey with an amount of 26.35 and Romania with an amount equal to 10.50 units.

Ranking of European countries by value of the percentage change in the impact of innovation on employment between 2014 and 2021. Romania is in first place by percentage value of the change in the impact of innovation on employment with an amount equal to 137.5 units equal to a value of 6.08%, followed by Lithuania with a value equal to 111.04% equal to an amount of 48.2 units and by Norway with an amount equal to 87.03% equal to a amount of 81.7 units. In the middle of the table there are Sweden with an amount equal to a value of 13.15% equal to an amount of 17.88 units, followed by Montenegro with a variation equal to a value of 8.78% equal to a value of 9 , 4 units, and from the United Kingdom with an amount equal to 7.31% equal to an amount of 10.4 units. Portugal closes the ranking with an amount of -18.74% equal to a value of -15.32 units, followed by Ireland with an amount equal to -28.56% equal to a value of -45.85 units and from Turkey with a value of -48.55% equal to a value of -24.86 units.

Clustering with the k-Means algorithm. Clustering is proposed below to verify the presence of groupings within the countries considered. The algorithm used for clustering is called k-Means. K-Means is a supervised algorithm or it is necessary for the observatory to decide the number of clusters before carrying out the analysis. It follows that the Silhouette coefficient is used to reduce discretion in choosing the optimal number of clusters. The Silhouette coefficient varies between -1 and 1 and tends to improve as it approaches 1. Specifically, the following values were obtained in terms of the Silhouette coefficient, that is: Cluster 2 with a value equal to 0.518, cluster 3 with a value equal to 0.478, cluster 4 with a value of 0.439, cluster 5 with a value of 0.434, cluster 6 with a value of 0.386, cluster 7 with a value of 0.383, cluster 8 with a value of 0.340. Therefore, the number of clusters associated with the highest Silhouette coefficient was chosen, ie cluster 2. Through the application of cluster 2 it was possible to obtain the following cluster groupings:

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- Cluster 1: Sweden, Germany, Holland, United Kingdom, Belgium, Iceland, Finland, Ireland, Austria, Luxembourg, Switzerland, France, Montenegro, Norway, Malta, Israel, Italy, Denmark, Cyprus, Slovenia, Greece, Portugal;
- Cluster 2: Slovakia, Latvia, Turkey, Bulgaria, Hungary, North Macedonia, Poland, Serbia, Spain, Croatia, Romania, Lithuania, Ukraine, Estonia, Czech Republic, Bosnia.

Considering the value of the median of the variable constituted by the employment impact of innovation, it appears that the median value of cluster 1 is equal to 130.6385 and the median value of cluster 2 is equal to a value of 54.44 units. It follows that cluster 1 is greater than cluster 2. As is evident from the analysis of the clusters, it appears that Europe is divided into two parts, namely Western Europe - except for Spain - where the value of the employment impact of innovation is high and Eastern Europe with a lower employment impact of innovation. This dichotomy is also due to the delay of the institutions and productive organizations in Eastern Europe. It is therefore necessary that policy makers intervene to create greater convergence between Western Europe and Eastern Europe in the sense of the employment effects of innovation.

Machine Learning and prediction. Subsequently, a prediction activity was carried out using seven different machine learning algorithms. The algorithms were organized according to their ability to maximize the MSE; the RMSE, the EAW and the R2. The following algorithm ordering was obtained, that is:

- Gradient Boosting with a value of 5;
- AdaBoost with a value of 7;
- Tree with a value of 12;
- Random Forest with a value of 16;
- Linear Regression with a value of 20;
- kNN with a value equal to 24;
- Neural Network with a value of 28.

Through the application of Gradient Boosting, it is possible to calculate the difference between the predicted value and the value of the historical series for the 38 countries considered. The analysis shows a reduction in the value of the employment impact of innovation for an amount equal to a value of -0.4%.

Conclusion. The employment impact of technological innovation in Europe has grown by an amount equal to a value of 10.64% between 2014 and 2021 or a change equal to an amount of 10.17 units. However, in the face of this generalized growth, the cluster analysis highlighted the presence of a contrast between Western Europe, which has a high level of the employment impact of innovation, and more backward Eastern Europe. It follows that the economic policies of the European Union should invest significantly to reduce the gap between Western and Eastern Europe by facilitating convergence. Europe lags behind the US and China in terms of technological innovation, research and development and the knowledge economy. Reducing the gap between Eastern Europe and Western Europe could make it possible to increase the number of companies and employees in the technological innovation sector, also increasing the impact in terms of production of added value.

Reference:

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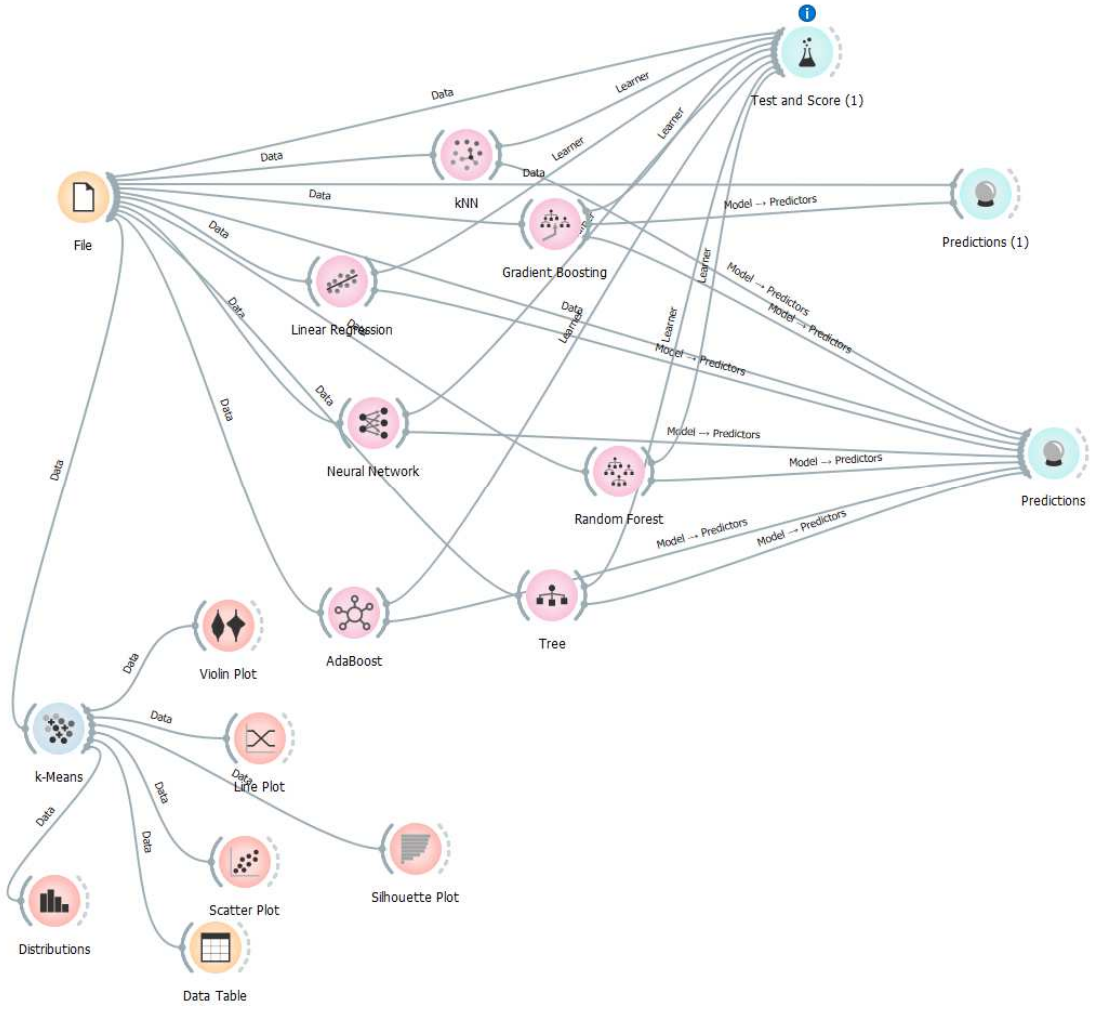
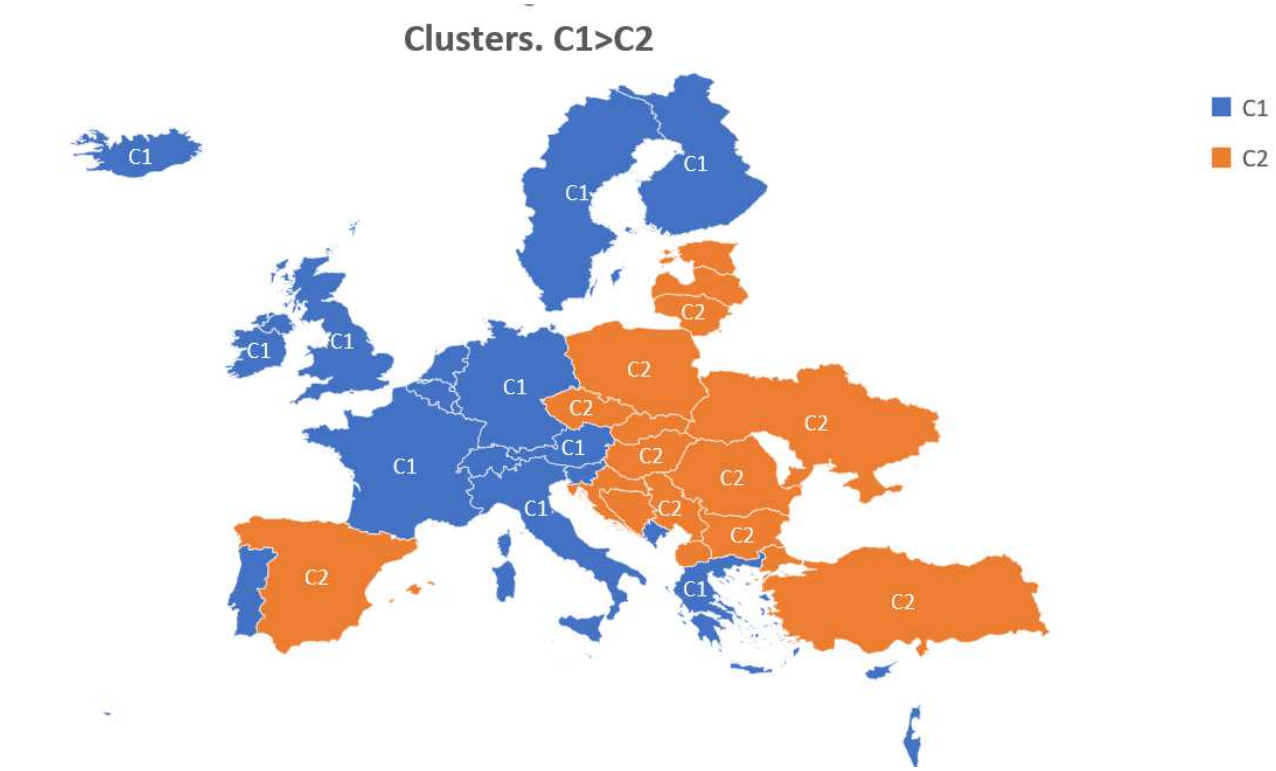
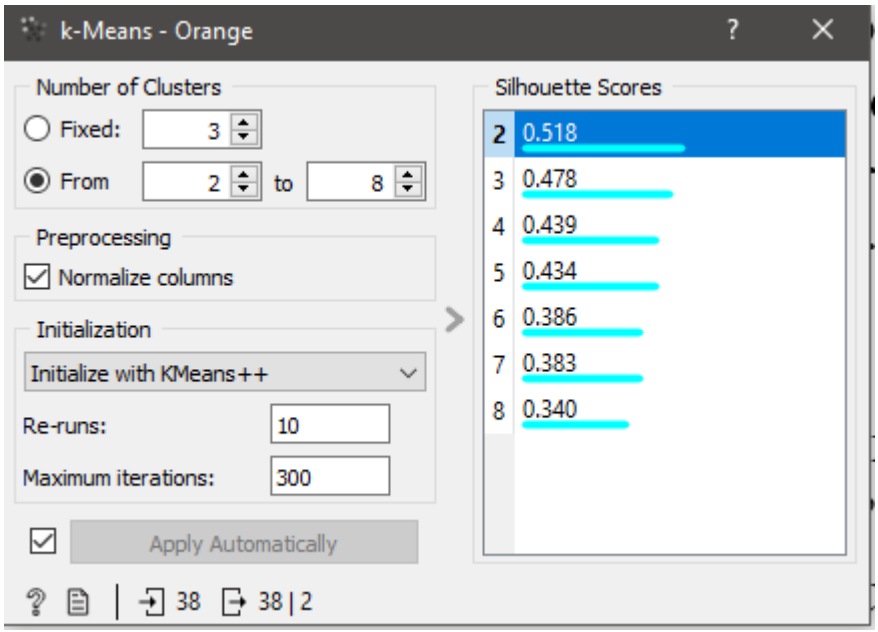
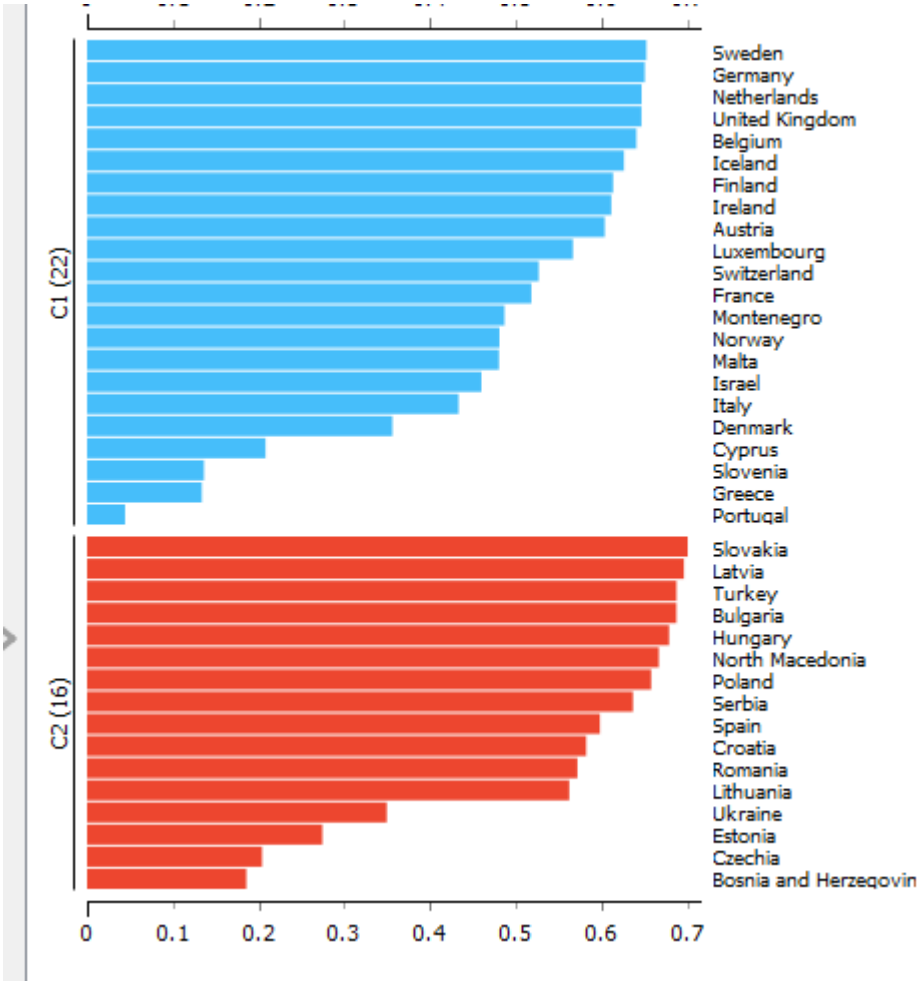
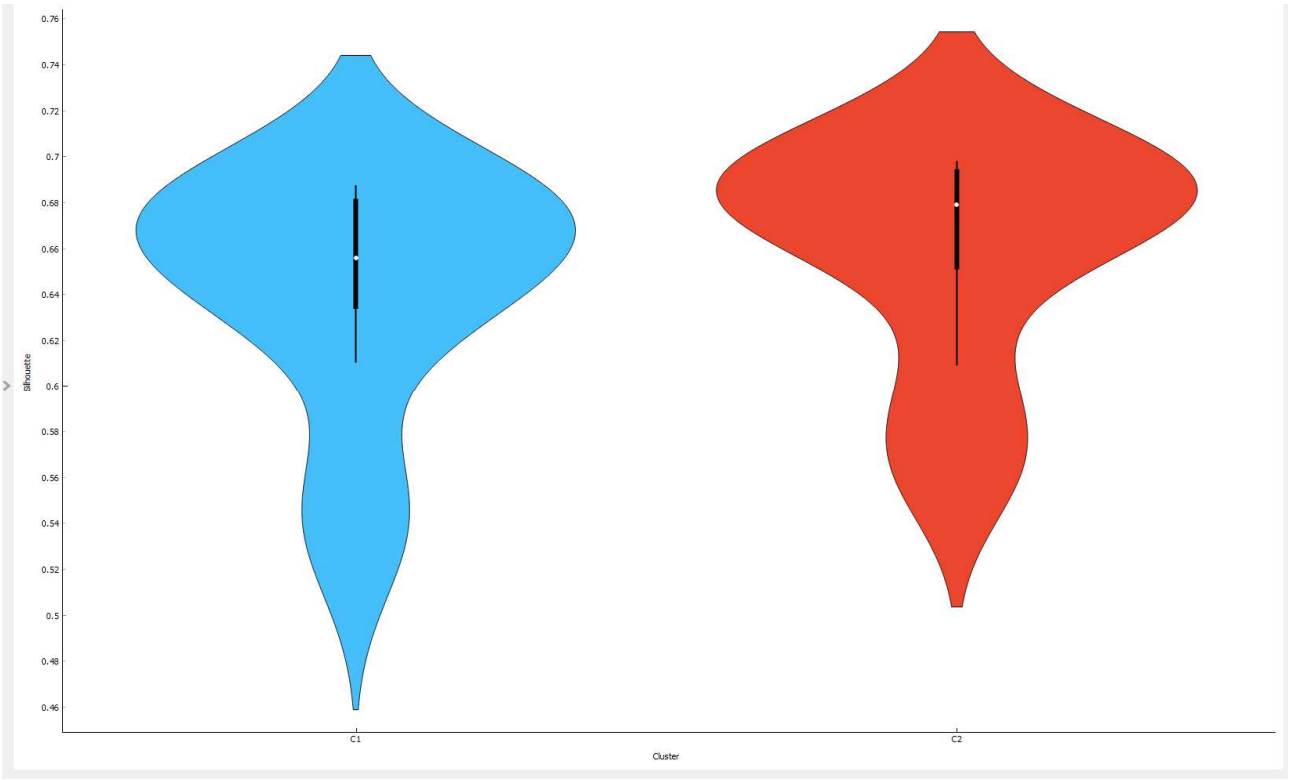


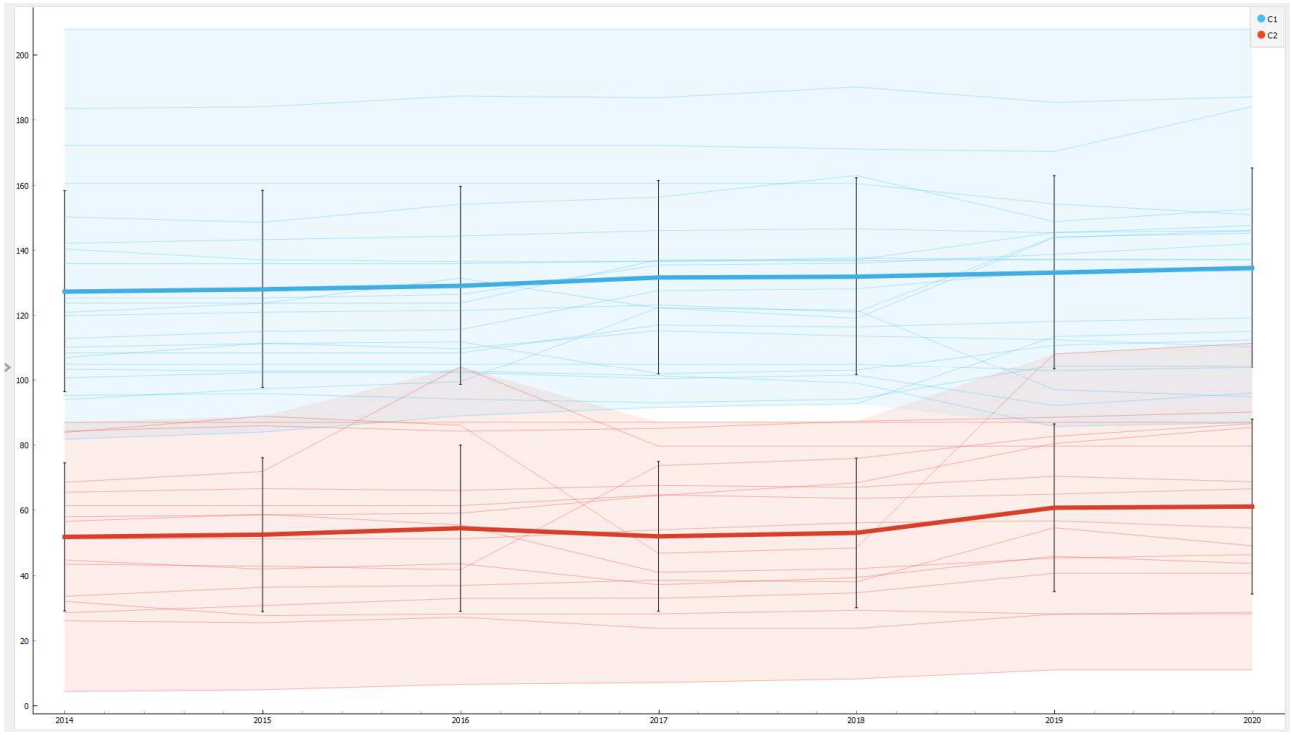
Model	MSE	RMSE	MAE	R2
Neural Network	9773.717	98.862	87.895	-3.499
kNN	398.147	19.954	14.908	0.817
Linear Regression	346.435	18.613	13.791	0.841
Random Forest	131.778	11.479	8.920	0.939
Tree	80.097	8.950	7.389	0.963
AdaBoost	3.742	1.935	0.613	0.998
Gradient Boosting	1.517	1.232	0.964	0.999

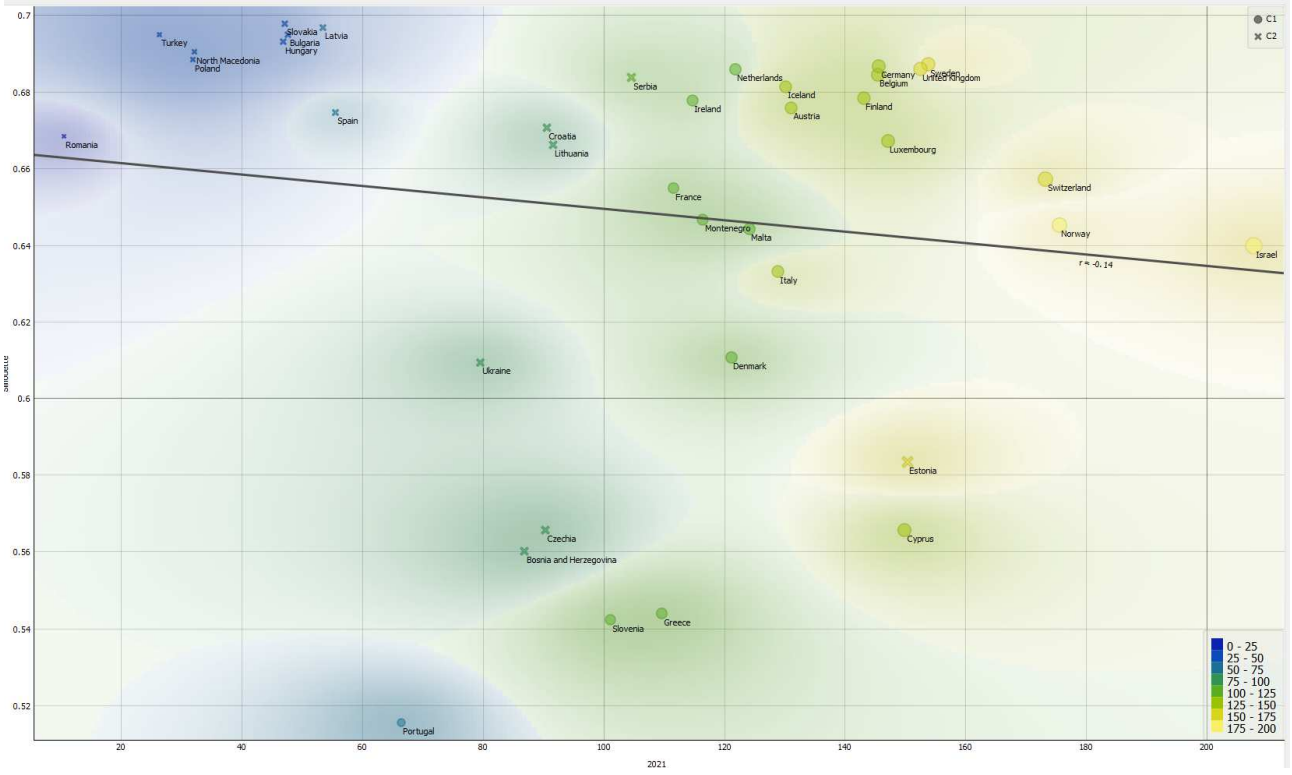


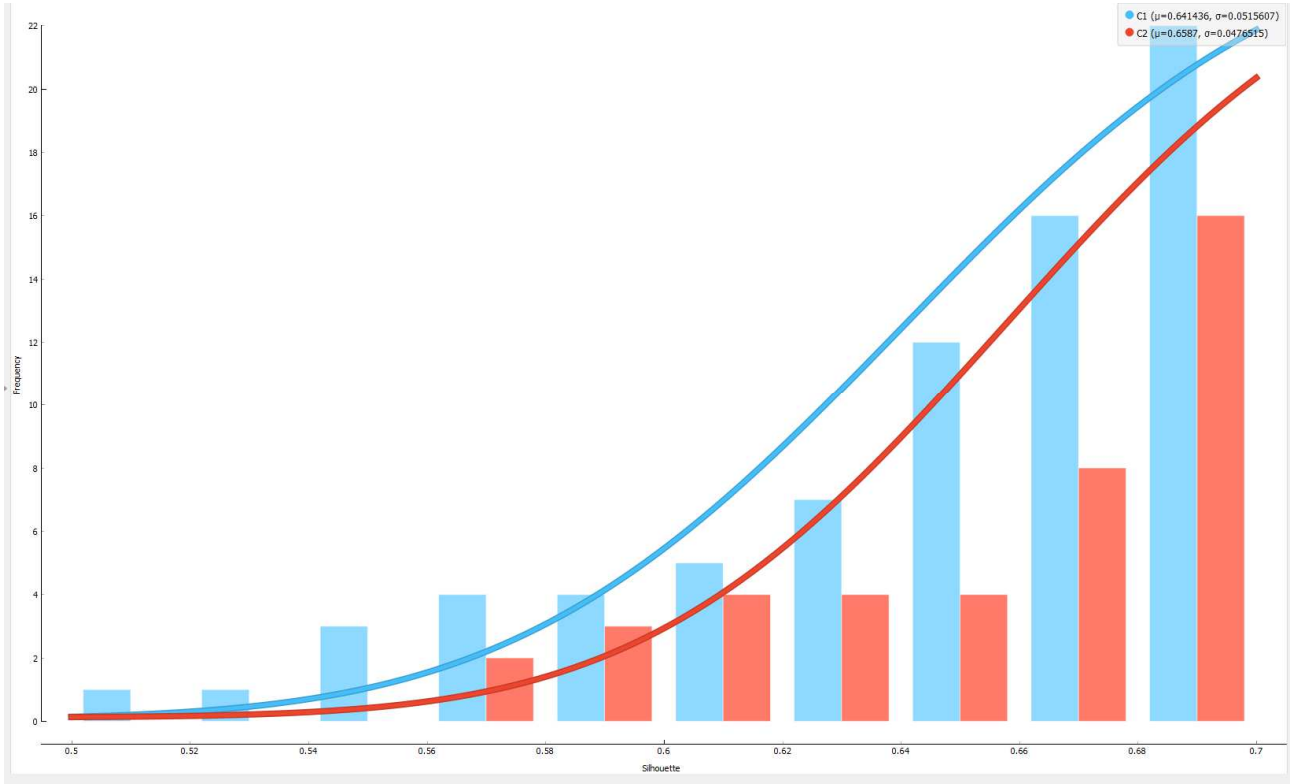



C1 (22)
C2 (16)
Sweden
Germany
Netherlands
United Kingdom
Belgium
Iceland
Finland
Ireland
Austria
Luxembourg
Switzerland
France
Montenegro
Norway
Malta
Israel
Italy
Denmark
Cyprus
Slovenia
Greece
Portugal
Slovakia
Latvia
Turkey
Bulgaria
Hungary
North Macedonia
Poland
Serbia
Spain
Croatia
Romania
Lithuania
Ukraine
Estonia
Czechia
Bosnia and Herzegovin
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7


Silhouette
0.76
0.74
0.72
0.7
0.68
0.66
0.64
0.62
0.6
0.58
0.56
0.54
0.52
0.5
0.48
0.46
C1
C2
Cluster


C1
C2
200
180
160
140
120
100
80
60
40
20
0
2014
2015
2016
2017
2018
2019
2020


C1
C2
0.7
0.68
0.66
0.64
0.62
0.6
0.58
0.56
0.54
0.52
20
40
60
80
100
120
140
160
180
200
2021
Turkey
Slovakia
Latvia
Bulgaria
Hungary
North Macedonia
Poland
Serbia
Netherlands
Germany
Belgium
Sweden
United Kingdom
Iceland
Ireland
Finland
Austria
Spain
Romania
Croatia
Lithuania
Luxembourg
Switzerland
France
Montenegro
Malta
Norway
Israel
r = -0.14
Italy
Ukraine
Denmark
Estonia
Czechia
Bosnia and Herzegovina
Cyprus
Slovenia
Greece
Portugal
0 - 25
25 - 50
50 - 75
75 - 100
100 - 125
125 - 150
150 - 175
175 - 200



Rank	Algorithm	MSE	RMSE	MAE	R2	Total
1	*Gradient Boosting*	1	1	2	1	5
2	*AdaBoost*	2	2	1	2	7
3	*Tree*	3	3	3	3	12
4	*Random Forest*	4	4	4	4	16
5	*Linear Regression*	5	5	5	5	20
6	*kNN*	6	6	6	6	24
7	*Neural Network*	7	7	7	7	28