

THE EFFECTS OF THE CORONAVIRUS ON EUROPEAN COUNTRIES ECONOMIES

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Abstract: *The analysis of impact of sanitary crisis for European countries is nowadays one of the most discussed subjects. In this research, 19 European countries are analyzed in order to identify and compare the effect of pandemic measures for the economy. Principal components analysis is used to reduce the number of variables from 19 indicators (about labor, trade, GDP, consumption and others) to 7 new variables, while K-means algorithm is used to group the countries in 3 major classes. The results are compared taking into account the first 2 quarters from 2020 and the number of cases registered in each country and the main conclusion is that the impact of the sanitary crisis is visible, more or less, in each economy.*

Keywords: sanitary crisis, employment, European countries, K-means

JEL classification: C38, I10

1. Introduction and literature review

The sanitary crisis caused by Covid-19 pandemic is considered one of the biggest crises for the last period of time. That gets unprepared the entire world, not only the European countries. In Europe, the measures adopted by countries governments to fight against the virus put pressure on the economies.

Entire economic activities were stopped for months and the effect is visible both on short term and long term. On short term, the employment decreased (especially on activities like restaurants, hotels, entertainment) and many unemployed persons put pressure on public expenditures and government budgets, while on long term, many of small and medium businesses declared insolvency and many of them will never recover.

On the other side, the entire economic system of a country could be considered as a complex adaptive system where small initial changes could lead to major final changes, although these systems evolve and have the self-organizing characteristic. Therefore, a sanitary crisis could have a major impact in many different areas, industries and activities from an economy.

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The main purpose of this article is to identify the impact that the beginning of the sanitary crisis had for European countries in terms of employment, GDP, consumption, trade, unemployment, house prices or gross capital formation. Some countries were highly affected since the beginning of 2020 year, while for others and the impact was delayed for a few months. Therefore, two quarters (first 2 quarters from 2020) analysis and comparison is required.

The research and the interest for this subject is widely spread among the researchers, most of relevant studies are recent, in 2020. An analysis³ of the Covid-19 impact on economy show that countries that already had economic problems before the crisis are now the most affected economies, while the telework helped the labor market, but there are sectors where working remotely is not an option. Solutions³ to reduce the impact of sanitary crisis are already discusses by the European Commission and take into consideration the EU budget in order to help workers affected by pandemic conditions. Another analysis (Ashraf, 2020) show that governments announcements regarding the protection measures against covid-19 have on stock markets.

Using about 77 countries stock market indicators and econometric models, the author concludes that the announcements about social distancing have a direct impact on stock market returns, while announcements about other measures (like “testing and quarantining policies”) have a positive impact. Another study (Ozili, Peterson & Arun, Thankom, 2020) regarding the impact of pandemic on stock market indicators show that the economic activities were not influenced by the number of confirmed cases, but were influenced by the restrictions imposed by each country.

The idea that the pandemic might lead to a global recession is presented in a study (Açikgöz, Günay, 2020) where the authors estimate the cost of pandemic for the global economy, as well as for Turkish economy. On the other side, another study (Sumner, Hoy, Ortiz-Juarez, 2020) show the impact of pandemic situation on poverty for developing countries and concludes that “the real outcomes will be dramatic” and it depends on the pandemic duration.

This research is divided in sections like: introduction and literature review, where the latest research related papers are presented, methodologies present the main data analysis methods applied for research, the dataset and results section show the main results and comments regarding the achievement of the proposed objective, while the conclusions present the final ideas and further research.

³ <https://ec.europa.eu/jrc/en/news/jrc-analyses-covid-19-impact-economy-and-labour-markets-help-guide-eu-response>

2. Methodologies

In order to analyze the impact of the Covid-19 crisis in economy, the multidimensional data analysis methods are likely to provide relevant information. The principal components analysis is the most used method to reduce the dimensionality of the dataset. The maximization problem to be solved for extracting the principal components from a dataset generates new variables that are uncorrelated. Using certain criteria, the number of principal components is determined. Based on the factor matrix, the correlations between original variables and principal components, each new variable (named principal component) is named.

On the other side, the unsupervised pattern recognition methods are used to group a set of observations into homogeneous classes. The main idea used for grouping the observations is to minimize the variability within classes (high homogeneity in each class) and to maximize the variability between classes. The K-means algorithm is one of the most used methods to group observations in classes according to the above rule.

3. Dataset and results

The dataset considered have 19 indicators and 19 European countries that have available data for the first two quarters of 2020. The main sources for data are the Eurostat and the European Centre for Disease Prevention and Control websites. For both analyzed quarters (Q1 and Q2), the analyzed indicators are: the employment (as % change on previous period) for all activities and for 10 detailed main activities (indicators i1 to i11), the unemployment rate (i12, as % of total population from 15 to 74 years), the price index for existing and new dwellings, GDP (as % change on previous period) and consumption, export, import and gross capital formation (all as % of GDP). The table from below shows the indicators names and the used indicator code.

Table 1. The details about indicators

Indicator	Indicator code
Total - all NACE activities	I1
Agriculture, forestry and fishing	I2
Industry (except construction)	I3
Manufacturing	I4
Construction	I5
Wholesale and retail trade, transport, accommodation and food service activities	I6
Information and communication	I7

Financial and insurance activities	I8
Real estate activities	I9
Professional, scientific and technical activities; administrative and support service activities	I10
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	I11
Unemployment (% of total population from 15 to 74 years)	I12
House price index - purchases of new dwellings (annual rate of change)	I13
House price index - purchases of existing dwellings (annual rate of change)	I14
Final consumption expenditure (% of GDP)	I15
Gross capital formation (% of GDP)	I16
Exports of goods and services (% of GDP)	I17
Imports of goods and services (% of GDP)	I18
Gross domestic product at market prices (% change on previous period)	I19

Another dataset was considered from ECDC website and presents the number of Covid-19 infected persons each day. The summarized variables (for Q1 and Q2) show the number of Covid-19 infected people in each country and each quarter. These variables are used to compare the macroeconomic analysis with the number of cases in each quarter.

	lq1	pq1	pcq1
Comp.1	3.67118	19.32198	19.32198
Comp.2	3.20709	16.87940	36.20138
Comp.3	2.57458	13.55040	49.75178
Comp.4	2.43198	12.79988	62.55166
Comp.5	2.06361	10.86109	73.41274
Comp.6	1.45623	7.66437	81.07711
Comp.7	1.18289	6.22571	87.30282
Comp.8	0.66244	3.48650	90.78932
Comp.9	0.60379	3.17787	93.96719
Comp.10	0.42524	2.23812	96.20531
Comp.11	0.32484	1.70968	97.91500
Comp.12	0.16711	0.87952	98.79452
Comp.13	0.10912	0.57434	99.36886
Comp.14	0.07040	0.37054	99.73940
Comp.15	0.02161	0.11376	99.85315
Comp.16	0.01783	0.09383	99.94698
Comp.17	0.00966	0.05087	99.99785
Comp.18	0.00041	0.00215	100.00000
Comp.19	0.00000	0.00000	100.00000

	lq2	pq2	pcq2
Comp.1	4.38803	23.09488	23.09488
Comp.2	3.40183	17.90435	40.99922
Comp.3	2.41629	12.71730	53.71652
Comp.4	1.97963	10.41912	64.13564
Comp.5	1.81122	9.53273	73.66837
Comp.6	1.76836	9.30718	82.97556
Comp.7	1.18114	6.21653	89.19209
Comp.8	0.81987	4.31509	93.50718
Comp.9	0.48616	2.55873	96.06591
Comp.10	0.29609	1.55835	97.62426
Comp.11	0.15971	0.84057	98.46484
Comp.12	0.10140	0.53370	98.99854
Comp.13	0.08151	0.42899	99.42752
Comp.14	0.06572	0.34592	99.77344
Comp.15	0.03668	0.19304	99.96648
Comp.16	0.00364	0.01918	99.98566
Comp.17	0.00158	0.00829	99.99395
Comp.18	0.00115	0.00605	100.00000
Comp.19	0.00000	0.00000	100.00000

Figure 2. PCA results for both datasets

The figure from above (figure 1) shows the principal components results in terms of variance for each principal component, the percent of total information from all original variables that is considered in each component, as well as the cumulative percent of information. For 2020-Q1 dataset, the Kaiser criteria shows that from 19 variables, 7 principal components have the variance above the unit, and take about 87.3% of total information. For 2020-Q2 dataset, the first 7 principal components summarize 89.19% of total information.

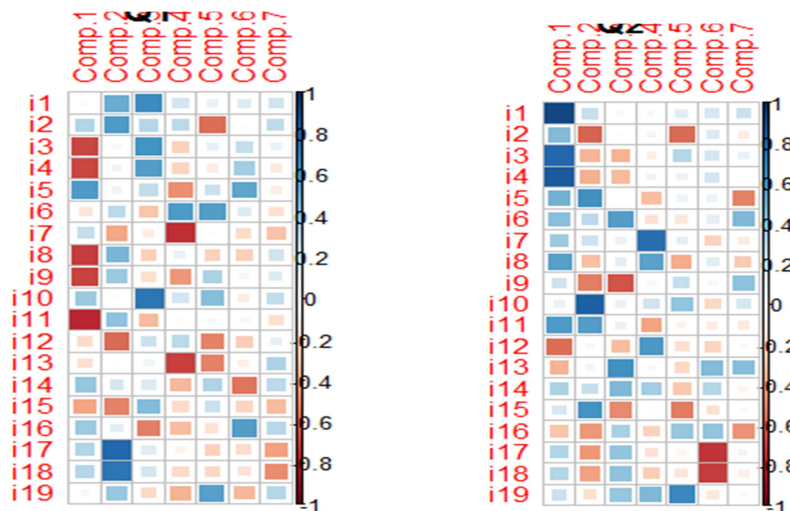


Figure 3. Factor matrix for both datasets

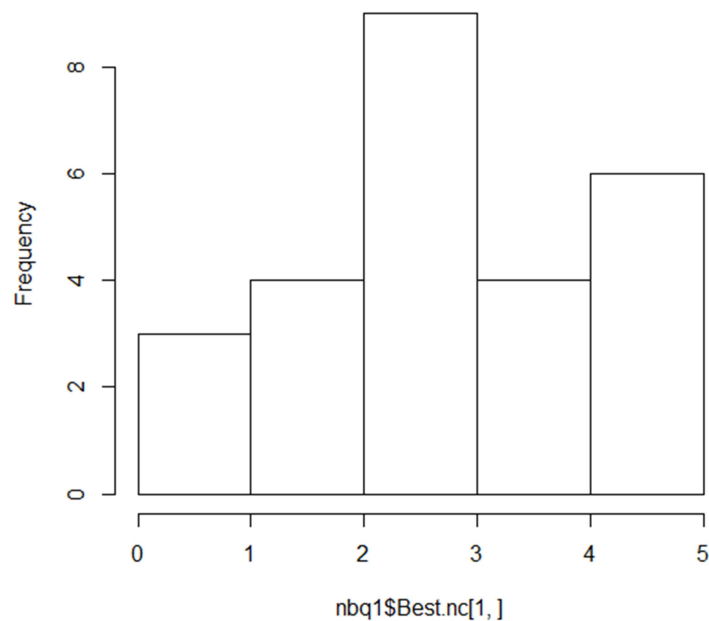
The correlation matrix between principal components and original variables is named factor matrix and, using these correlations, the new variables can be interpreted as (Q2 dataset):

- one principal component is highly correlated with import and export of goods and services and can be interpreted as trade component; another component is highly (negatively) correlated with the unemployment rate and with the employment (positive correlation) change for all NACE activities and different sectors (industry, manufacturing, financial activities), having the significance of main labor component, while another component have more information from the other activities (indicators like i10, i11 and i5) being another employment component;

- another component is significantly correlated with the house price index (positive correlation), real estate activities (negative correlation) and wholesale and retail trade;

- another component is correlated with agriculture employment, GDP and final consumption expenditures; another represents the gross capital formation, while another component is highly correlated with the employment change in information and communication.

Histogram of nbq1\$Best.nc[1,]



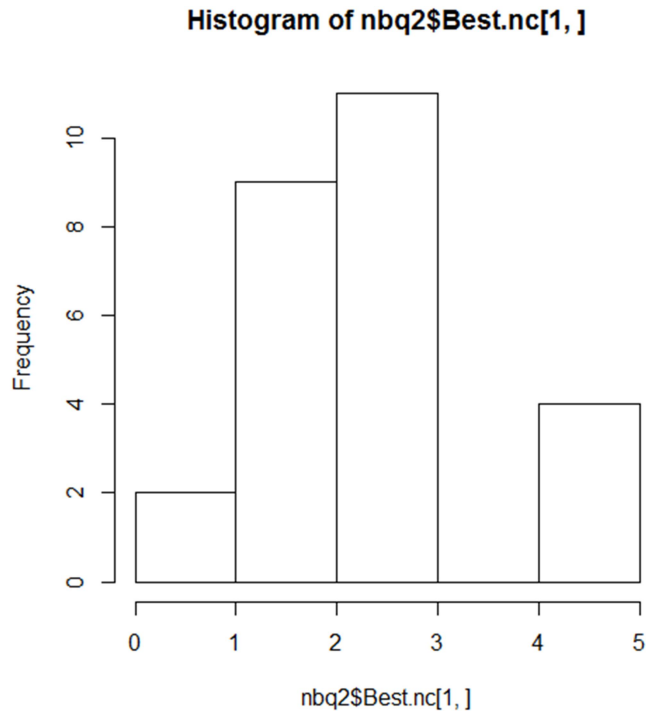


Figure 4. The best number of classes

The nbclust package in R (applied with parameters Euclidian for distance and k-means for method) provide information about the best number of classes to be considered for analysis, taking into account indices like D index or Cubic Clustering Criterion.

The figure from above show, for each dataset, the histogram of the best number of clusters: for 2020-Q1 dataset, the best number of classes is 3 (9 indices proposed 3 as the best number), as well as for 2020-Q2 dataset, for which 11 indices proposed 3 as the best number of groups.

```
> round(k1q1$centers,2)
  Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7
1 -2.19  0.00  0.82 -0.65  0.96  0.17 -0.25
2  0.71  0.92 -0.95  0.26 -0.10  0.09  0.03
3  0.95 -2.31  1.36  0.16 -0.95 -0.45  0.23
> round(k1q2$centers,2)
  Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7
1  0.44  2.58 -0.87 -0.83 -0.42  0.00  0.52
2  0.97 -0.46  0.33  0.45  0.35  0.15 -0.21
3 -3.12 -1.31 -0.03 -0.42 -0.53 -0.41  0.06
```

Figure 5. Classes centers for both datasets

After identifying the best number of clusters, K-means algorithm was applied on principal components in order to group the selected European countries in homogeneous classes. The average values for variables in both datasets are presented in the above figure. It is noticeable that the classes differ significantly.

For 2020-Q1 dataset, one class (class1) have the lowest average value for the first principal component, being a class with the highest increase of employment (in average) from previous period, in activities like real estate (especially Romania and Lithuania), arts, entertainment, industry and manufacturing. This class is characterized also by the highest decrease of agriculture employment (from the previous period), an average level of export and a high GDP change.

The second class have (in average) the highest level for export, an average value for GDP change, real estate activities employment and high change in agriculture employment change.

The third class have in 2020-Q1 the highest indexes for house price, high unemployment rate and a high decrease of employment in real estate activities. Among the countries from the third class, Italy and Spain show the first signs of economic impact of sanitary crisis in Q1, having the highest decrease of GDP from the last period.

For 2020-Q2 dataset, the first class is the most affected in terms of employment in agriculture, real estate activities and arts, entertainment and recreation activities. High impact of sanitary crisis is visible also for the first class in final consumption expenditure (the highest percentages in GDP, over 84%, in average) and the lowest gross capital formation, import and export levels and GDP change from the previous period. Romania is part of this class, with the highest impact in employment in real estate activities in Q2.

The second class have the majority of European countries and have a moderate impact of sanitary crisis in labor market or economy, while the third class have countries that are strongly affected by the pandemic situation: decrease of employment in all activities, increase of unemployment, decrease of GDP, high imports.

In the above figure (figure 5), each class in each dataset is represented with a different color.

In Q1, some countries are more affected by the sanitary crisis than others, while in Q2, there are signs that some highly affected countries from Q1 try to restart the activities. For example: Cyprus, Romania and United Kingdom were moderately affected in Q1, but highly affected in Q2, while Italy was highly affected since the beginning of the pandemic in Europe.

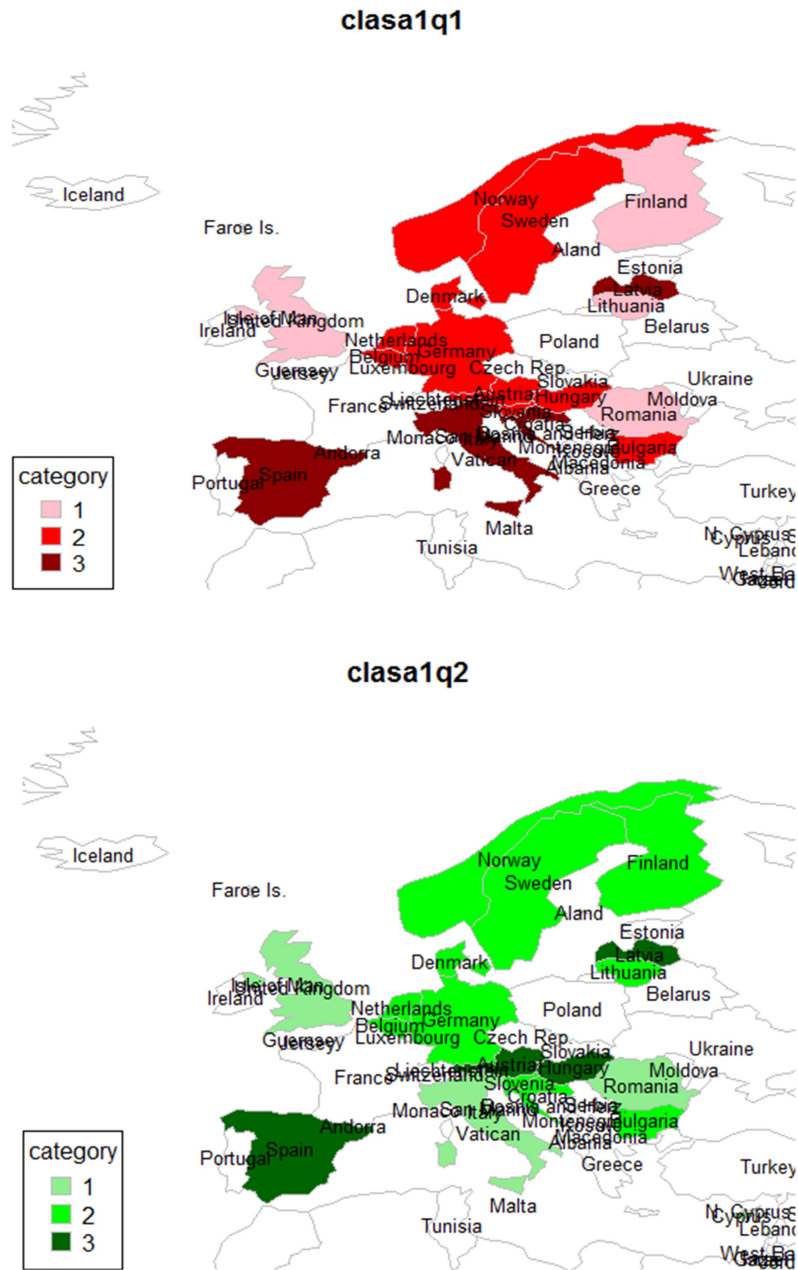


Figure 6. Classes graphically representation

Another country that “changed” the class from Q1 to Q2 is Finland that is moderately affected by sanitary crisis in both analyzed quarters.

	clasa1q1	1	2	3
[1000;10000)		2	4	0
<1000		2	3	2
>10000		1	3	2

	clasa1q2	1	2	3
[10000;100000)		1	4	0
<10000		1	6	3
>100000		2	1	1

Figure 7. Classes and Covid-19 cases in Q1 and Q2

The figure (Figure 6) from above shows a frequency between the number of Covid-19 cases⁴ (cumulated for Q1 and Q2) and the classes presented above. In Q1, most studied countries have fewer than 1000 cases, included countries that have a high and moderately impact.

In the second quarter, most countries that have fewer than 10000 cases (only in Q2) are not very affected (these countries are from the second class).

The main conclusion here is that there is not a direct and strong connection between the number of cases and the impact of sanitary crisis in economy.

4. Conclusions and discussions

The impact of pandemic on labor market and economy in general was visible (more or less) in most European countries since the beginning of the sanitary crisis. The crisis situation cannot be ended suddenly, and its effects will be visible for long term.

Many companies that were closed due to sanitary crisis in Europe already faced insolvency issues and some may never return to initial state. Considering the economic system as a complex adaptive system, these companies that closed the activity can cause a major imbalance on other interconnected systems (like labor market) in such a way that a chain reaction could lead to potential economic crisis. Therefore, economic measures should be considered in order to reduce the impact of sanitary crisis in the entire economy.

⁴ data source: <https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>

For further research, the main idea to be studied is the connection between the distressed companies (as a result of pandemic situation) and the economic indicators.

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