The Analysis of the Effect of Covid 19 on Macroeconomic Indicators via MDS and Clustering Methods

pinar koc (✉ pinartorun@gumushane.edu.tr)

Gümüşhane Üniversitesi: Gumushane Universitesi <https://orcid.org/0000-0002-7843-1228>

Aziz KUTLAR

Sakarya University: Sakarya Universitesi

Ahmet GÜLMEZ

Sakarya University: Sakarya Universitesi

Abidin ÖNCEL

Sakarya University: Sakarya Universitesi

Research

Keywords: Covid 19, Macroeconomic effects, MDS, Clustering analysis

Posted Date: February 15th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-194221/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

TİTLE PAGE

Article Type: Research article

The Analysis of the effect of Covid 19 on macroeconomic indicators via MDS and Clustering Methods

Authors:

Aziz KUTLAR¹

Ahmet GÜLMEZ²

Pınar KOÇ³

Abidin ÖNCEL⁴

Corresponding Author: Pınar KOÇ

Institutional Address:

Assist Prof, Gümüşhane University, Faculty of Economics and Administrative Sciences, Department of Economics, Gümüşhane, Turkey

email:pinartorun@gumushane.edu.tr,

Phone: +905422261210

Institutional Addresses:

¹Prof., Dr., Sakarya University, Faculty of Political Sciences, Department of Economics, Sakarya, Turkey. email:akutlar@sakarya.edu.tr.

² Assoc Prof., Sakarya University, Faculty of Political Sciences, Department of Economics, Sakarya, Turkey email:agulmez@sakarya.edu.tr,.

³ Assist Prof, Gümüşhane University, Faculty of Economics and Administrative Sciences, Department of Economics, Gümüşhane, Turkey, email:pinartorun@gumushane.edu.tr,

⁴Assoc Prof., Sakarya University, Faculty of Economics and Administrative Sciences, Department of Economics, Sakarya, Turkey. email:aoncel@sakarya.edu.tr,

The Analysis of the effect of Covid 19 on macroeconomic indicators via MDS and Clustering Methods

Abstract

Background: Covid 19, which emerged in China in December 2019 and affected the whole world in a short period, caused serious contractions in the world economy. Analyzing these effects is important in terms of reducing economic losses and measuring the effectiveness of the measures taken.

Methods: The aim of this study, covering the period 2019: q1- 2020q3 is to analyze the volatility in macroeconomic indicators caused by the pandemic process, taking into account the % changes in macroeconomic indicators and whether OECD countries show similar tendencies in terms of volatilities during the pandemic process. The period 2019: q1-2019: q3 represents the pre-pandemic period, while the period 2019: q4-2020: q3 represents the pandemic process. By using cluster analysis and multidimensional scaling analysis, countries that have similar characteristics in terms of the change in macroeconomic indicators for each period were grouped, and it was investigated whether this grouping changed during the pandemic process. Clustering and multidimensional scaling analysis are the most appropriate methods for the purpose of the study. Exports, imports, inflation, unemployment, private consumption and economic growth are macroeconomic indicators used in the model.

Results: According to the results of the analysis, although most OECD countries showed similar characteristics in terms of economic impact before the pandemic, countries such as Turkey, Iceland, Ireland, New Zealand and Mexico differ significantly from other countries in terms of economic impact during the pandemic process. The separation in question continues throughout the period discussed for Turkey. In addition, it was concluded that Spain, Britain, Mexico and Colombia suffered the most economic losses due to COVID-19 in the second quarter of 2020, when the pandemic was felt the most.

Conclusion: The economic variable that has seen the most contraction is the volume of foreign trade. Unemployment rates have increased more slowly in countries where employment is sought to protect with employment packages, while unemployment rates have increased more in other countries. The contraction in the volume of production and consumption also negatively affected economic growth. Differences in economic impact have diversified the cluster between countries.

Key Words: Covid 19, Macroeconomic effects, MDS, Clustering analysis

Introduction

COVID-19 cases, which first appeared in Wuhan, China in December 2019, have profoundly affected social and economic life around the world due to high morbidity and mortality rates. Due to high morbidity rates, being a first-time case, taking time to detect infection channels, and having deadly effects, curfew restrictions imposed by governments have changed the consumption behavior of economic decision units, causing serious changes in total demand components and production volume [1, 2]. These changes in the volume of production and consumption also caused a deterioration in all macroeconomic indicators. According to OECD [3] statistics, GDP in OECD countries increased by 0.2% in the last quarter of 2019 compared to the previous quarter of the same year, while in the first quarter of 2020 there was a 1.9% contraction. The economic contraction in the second quarter of 2020 is 10.5%. In order to reduce the economic losses caused by COVID-19, the economy began to recover and grew by 9.2% as the restrictions imposed due to the disease began to be gradually lifted. In the last quarter of 2019, the average unemployment rate in OECD countries was 5.3%, rising to 5.4% in the first quarter of 2020 and 8.6% in the second quarter of 2020, and it declined to 7.7% with the economic recovery in the third quarter. When foreign trade statistics were examined, export volume in OECD countries contracted by 0.6% compared to the previous period. As of the quarter of 2020, the change in export volume is -2.6%, -22.0 and 24.8%, respectively. Upon examining the changes in the volume of imports, it is seen that the contraction in the volume of imports in OECD countries in the last quarter of 2019 was -1.8%. The contraction in import volume in the first quarter of 2020 is about twice that of the previous period, and the contraction in the second quarter is about five times that of the previous period. The economic recovery in the third quarter of 2020 also led to an improvement in import volume. In the third quarter of 2020, import volume increased by 18.5% compared to the previous period.

OECD countries are countries with different structures in terms of economic situation and population, located in different geographies. Therefore, it is expected that the economic repercussions of COVID-19 will also differ by country. In this context, in this study, how OECD countries face an economic table due to COVID-19 and whether they differ in terms of economic impact was examined using multidimensional scaling and cluster analysis. The study consists of three sections. In the first section, current studies investigating the economic effects of COVID-19 are examined. In the second part, information about the methodology is given and the results of the analysis are presented. In the third part, the findings were evaluated.

Literature Review

Channels of economic impact of diseases are studied in the literature on disease costs, and the economic costs incurred due to diseases are divided into three groups: direct costs, indirect costs, and immeasurable costs. Expenses for the diagnosis and treatment of diseases include direct costs, while indirect costs are formed by the disease that causes loss of income and production by reducing labour productivity and immeasurable costs are created by deterioration in the quality of life of individuals caused by the pain, stress, mental effects triggered by disease [4, 5, 6]. In the current literature, there are a limited number of studies analyzing the economic effects of COVID-19. In the studies in the literature, the economic effects of COVID-19 have also been analyzed based on simulations that examine the effects of economic crises. Mooney and Zegarra [7] analyzed the effects of COVID-19 on tourism mobility in 35 countries in Latin America and the Caribbean under three different scenarios. Tourism mobility is projected to decrease 43.8% in the first scenario, 56.3% in the second scenario, and tourism mobility is foreseen to decrease by 68.8% in the third scenario.

Dijofack et al. [8] in Sub-Saharan African countries; Mckibbin and Fernando [9], G20 countries and different groups of countries; Malliet et al. [10] are studies in France that use the computable general equilibrium model to analyze the economic effects of COVID-19. Dijofack et al. [8] predicted a loss of regional output of 5.7% in the most optimistic scenario; 7.65% in the most pessimistic table. Mckibbin and Fernando [9] argue that expansionary monetary policies based on lowering interest rates are

necessary to prevent contraction in demand but not sufficient. They stressed that we face a multifaceted crisis that would require interventions in money, finance, and health policy. Malliet et al. [10] analyzed the economic effects of the COVID-19 process for the period of 2020-2010. The study predicted that in 2020, GDP will decrease by 5.1%, investment by 11% and unemployment by 2.9%. However, the contraction in the volume of economic activity is expected to reduce CO2 emissions by 6.6%, indicating that negative demand shocks are temporary and will return to the basic trajectory of the economy over the next 10 years.

De Vito and Gomez [11] simulated how the COVID-19 pandemic crisis would change the liquidity of companies if sales revenues of 14245 companies operating in 25 OECD countries and China decreased by 50% and 75%. The study emphasized that the government should intervene with tools such as tax deduction, bridge loans, to avoid possible cash crunch. Bridge loans, in particular, are argued to be more advantageous to avoid a liquidity crunch that may occur after six months.

Fernandes [12] analyzed national revenue losses from COVID-19 in 30 different countries, Banco [13] in Spain using simulation method. In the study by Fernandes [12], the projected economic contraction under the moderate scenario is expected to range from 3-6%. It has been emphasized that under other scenarios, the output loss can exceed 10%, or even 15%. It is argued that output loss will be higher in countries that are more dependent on foreign trade. Banco [13], unlike other studies, analyzed the output losses that will occur in the economy under 3 different scenarios that take into account the processes of restraint and normalization applied by governments. In the first two scenarios, the restrictions will last 8 weeks, and in the third scenario the restrictions will last 12 weeks. The expected output loss for the first two scenarios is 6.6% and 8.7%. The expected output loss for the third scenario is 13.6%.

Apart from the simulation technique, studies using different analysis techniques are also available for different country groups. Konig and Winkler [14] analyzed the effects of Pandemic on growth in OECD countries using regression analysis. The pandemic negatively affected economic growth. However, measures taken by governments reduce the narrowing effect of the pandemic. It has been concluded that for only a few countries, the impact of the pandemic is very strong, and that measures taken by local governments have failed to achieve successful results in reducing the impact of economic contraction.

In their study covering the period of 2001q1:-2020:q2, Luga and Mihalciuc [15], analyzed the effects of changes in macroeconomic variables on economic growth due to major economic crises that occurred in the EU countries in central and Eastern Europe during the 21. century using the empirical regression model. The study concluded that COVID-19 measures negatively affect macro-economic variables and slow economic growth.

Oravsky et al [16] seeks to establish appropriate policies to eliminate the negative effects of the current recession on economic growth using a linear panel regression model by focusing on the impact of the selected indicators on national income of European countries. European countries are classified according to the measures they took in the financial consolidation of the 2008 economic crisis. Analysis in the study was conducted based on these groups of countries. According to the results obtained, the type of tax that shows the most decrease among tax revenues is corporate tax. While the countries that are most at risk increase interest rates, the group of the least risky countries has a decrease in interest rates. The Consumer Confidence Index fell sharply in the group of countries affected only minimally by the 2008 crisis. When economic indicators are examined, we face the biggest recession since World War II. in the first half of 2020. COVID-19 reduces GDP by reducing tax revenues due to the contraction in activity volume.

Ashraf [17], has analyzed the impact of policies such as social distance, curfew restrictions, social support packages in 77 countries to reduce the negative effects of COVID-19 on the volume of economic

activity and stock market returns by using daily stock market values in the period of 22.01.2020-14.04.2020. Pooled panel regression model was used in the study. According to the results of the study, initially social distance measures had negative effects on stock market returns, and with the decrease in the number of cases, improvements in stock market returns began to be seen.

Milani [18] emphasized that COVID-19 spreads not only within the country but also between the countries due to the presence of interdependence and also stressed that the social distance measures and perception differences about the risk of coronavirus plays a role in determining the differences in economic impact between the countries and has analyzed the social and economic effects of COVID-19 in 41 OECD countries through the GVAR model. COVID-19 affected unemployment rates differently in each country. For example, in the United States and Spain, unemployment rates have risen very rapidly, while in countries where government policies to protect employment have been implemented, the increase in the unemployment rate has remained lower.

Mohapatra [19] stressed the economic contraction caused by the negative effects of COVID-19 on labor markets through household income in 11 South East Asia, and in 5 West African countries, and also emphasized that women are the ones that would be affected more from the process of COVID-19 and argued that government policies to reduce the negative effects of COVID-19 should be organized based on gender equality.

Contributions of the Study

In studies in the current literature, the economic effects of COVID-19 have been studied using simulations and regression analysis, but it has not been mentioned whether countries have similar characteristics in terms of economic impact. It is an organization in which OECD countries participate in different socio-economic countries. Therefore, the economic effects of COVID-19 are expected to vary by country. In this study, differences in social and economic structure between countries were taken into account, and whether countries showed similar characteristics in terms of economic impact was analyzed using MDS and cluster analyses.

Methodology

In this study covering the period 2019:q1-2020:q3, the economic effects of COVID-19 in OECD countries and whether countries show similarities in terms of economic impact were analyzed. The OECD is an organization consisting of countries with different social and economic characteristics. Therefore, the economic repercussions of the pandemic are expected to change from country to country. In this context, in this study, taking into account the economic effects of the pandemic, it was tested by multidimensional scaling and cluster analysis whether countries showed similar characteristics in terms of economic impact. The economic effects of corona virus on important macroeconomic indicators on a country-by-country basis were examined by taking into account % changes in variables as of quarter periods and the economic impact was analyzed by multidimensional scaling and clustering method. The variables and data sources used in the study are shown in Table 1.

Table 1.

Data source and description.

Variables	Explanation	Source
EXPORT	Export Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/
IMPORT	Import Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/
INFLATION	Inflation Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/

UNEMP.	Unemployment Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/
PRIV. CONS.	Private Consumption Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/
GDP	GDP Growth on the same period of the previous year(%)	OECD.Stat https://stats.oecd.org/

In the study, export, import, inflation unemployment, private consumption, growth rate economic variables of 35 OECD countries were included in the analysis. All data are defined as a percentage change compared to the same quarter of the previous year

Multidimensional scaling analysis (MDS)

The MDS method is a numerical and visual method that reveals the similarity or difference in behavior of subjects with a common set of variables. While it was previously used in biological sciences, it has found a fairly wide range of uses in social sciences today. The main result of MDS analysis is a spatial map, and in this map, objects are shown with points. Distances between points give an idea of the similarities of objects. Points close to each other represent similar objects, while distant points represent different objects [20, 21,22, 23]. Multidimensional Scaling Analysis can be briefly called a dimension reduction and visualization technique. The distances between points in the MDS analysis are matched with the original measurements, observations in the multidimensional space are scaled on a lower dimension [20, 21, 23]. In most MDS applications, the similarity or difference of objects cannot be measured. Similarities or differences of objects are determined on the basis of variables determined by researchers [24, 25]

Multidimensional Scaling Analysis can be applied with two different approaches: classical and modern multidimensional Scaling Analysis according to the nature of the data set [23]. Classical multidimensional Scaling Analysis was used in this study.

4.2. Classical Multidimensional Scaling Analysis

The foundations of classical multidimensional Scaling Analysis were laid by Young and Householder [26] and Torgersen [27]. Classic MDS algorithm is based on the idea that the X coordinate matrix $B = XX'$ can be derived from the scalar product matrix by eigenvalue decomposition. The problem of how a b matrix can be obtained from a distance matrix is solved by multiplying the squares $J = I - n^{-1}II'$ of similarities by The Matrix. This process is called double centering [25].

The steps followed when analyzing with classic MDS algorithms can be sorted as follows Wickelmaier [28];

1. By creating a distance matrix D, The Matrix A obtained in the form of its elements $a_{ij} = -\frac{1}{2}d_{ij}^2$ is created. D various distance measures can be used when creating a distance matrix. But the most commonly used measure of distance is the Euclidean distance. The Euclidean distance for Dimension d can be formulated as follows.

$$d_{ij} = \sum_{k=1}^d \left[(X_{ik} - X_{jk})^2 \right]^{1/2} \quad (1)$$

2. Using the elements of Matrix a, double centering is applied to represent the number of objects n, and Matrix B is obtained. And it can be formulated as follows;

$$B = -\frac{1}{2}Jd_{ij}^2J \text{ and } J = I - n^{-1}II'$$

3. The eigenvalues Λ_i of Matrix B are estimated by $|A - \Lambda I| = 0$.

4. The eigenvectors of Matrix B are estimated based on $|A - \Lambda|t = 0$ the number of dimensions using the eigenvalues found.

5. The values taken by the eigenvectors are placed in the coordinate system and graphical drawings are obtained. it is derived from the X coordinate Matrix, defined as an M-dimensional spatial configuration $X = E_m \Lambda_m^{1/2}$ of N-numbered objects. E_m represents the eigenvectors Matrix corresponding to the largest eigenvalue m of Matrix B, $\Lambda_m^{1/2}$ represents the diagonal matrix consisting of the square root of the largest eigenvalue m of Matrix B.

In MDS analysis, the number of N-dimensional objects that have a nxn-dimensional data matrix must be shown in a space can be determined by the goodness of fit statistic proposed by Mardia [29]. The goodness-of-fit statistics proposed by Mardia [29] is formulated as follows.

$$Mardia_1 = \frac{\sum_{i=1}^p |\lambda_i|}{\sum_{i=1}^n |\lambda_i|} \quad (3)$$

$$Mardia_2 = \frac{\sum_{i=1}^p |\lambda_i^2|}{\sum_{i=1}^n |\lambda_i^2|} \quad (4)$$

Metric DBS analyses accept the input matrix with the $\frac{n*(n-1)}{2}$ distance value as data and usually give a two-or three-dimensional map depending on its suitability. In the analysis, it is aimed that the difference between the input and output matrices takes the minimum value. when deciding how many units of N with a nxn-dimensional data matrix can be represented in a space, the compatibility between the configuration distances obtained for the desired dimension and the distances obtained from the original data is taken into account. Kruskal's stress measure is used for compliance [25, 30, 31]. The measurement value is formulated as follows.

$$Kruskal(\hat{D}, E) = \left(\frac{\sum (E_{ij} - \hat{D}_{ij})}{\sum E_{ij}^2} \right)^{1/2} \quad (5)$$

In the equation;

E_{ij} : i. and j. represent data distance between objects,

D_{ij} : $\hat{D}$ and j. represent configuration distance values between objects

represents their values. If the resulting stress value is greater than 0.20, there is a mismatch, a low fit is between 0.10 and 0.20, a good fit is between 0.05 and 0.10, a perfect fit is between 0.025 and 0.05, and an excellent match is between 0.00 and 0.025. As the Kruskal stress value approaches zero, the goodness of fit increases.

Cluster analysis

In addition to the results obtained by multidimensional Scaling Analysis, cluster analysis was also used to test whether the study supported the results obtained by MDS analysis. Cluster analysis measures the tendency of observation values in groups to cluster. Although cluster analysis was initially used in biology and ecology [32], it has also recently been used in the social sciences, but its use in the Social Sciences has not become as widespread as in the Natural Sciences. In cluster analysis, objects that make

up clusters form clusters according to the degree of proximity to each other. Distant objects come together in higher clusters. Cluster analysis can be applied with two different approaches: hierarchical methods and non-hierarchical methods. Hierarchical cluster analyses are suitable for situations where the number of observations is below 250 and are used when the researcher does not know how many groups are in the dataset they are studying. Hierarchical cluster analysis is the process of successively combining homogeneous clusters [33, 34]. Non-hierarchical cluster analysis can be used when the number of observations is more than 1000 and the number of clusters can be determined in advance. In hierarchical cluster analysis, the averages of clusters are taken as starting points and the values closest to the cluster average are grouped in the same cluster [35].

This study focused on hierarchical clustering. But both clustering methods aim to increase homogeneity for the group, or in other words, heterogeneity between groups. At each stage of hierarchical clustering, either a new cluster is created, or the object being addressed is included in a previously created cluster. An object included in a set is not then included in a different set. Hierarchy clustering methods are divided into agglomerative methods and divisive methods. In associative hierarchical clustering, each object is initially treated as an independent set, and these values are combined with various algorithms to create a parent set at each stage. In parser clustering, all values are evaluated as a set at the beginning and subsets are obtained by various parsing algorithms. At the end of the process, a tree structure is formed that shows the relationships of all objects, called a dendrogram.

The literature often uses unifying methods. In unifying methods, cluster creation operations are performed using one of the single-link, complete link, and average link methods, depending on the distances between objects. In the single connection method, clustering operations are performed using objects with the smallest distance value, while in the full connection method, clustering operations are performed using objects with the largest distance value. In this context, how the distances between objects are measured is also an important question. In the literature, different distance correlations are used, such as Euclidean distance, Manhattan distance, and Minkowski distance. But the most commonly used distance correlation in practice is the Euclidean distance [34, 36, 37, 38, 39, 40,41]. In this study, an analysis of the unifying clustering method was performed using the full connection method based on the Euclidean distance correlation, and the results obtained were presented in the form of dendograms.

5. Results

In the study, descriptive statistics of variables were examined first. Descriptive statistical information is included in Table 2. Negative marked values mean that the corresponding variable decreased at the given rate compared to the same period of the previous year

Table 2.
Descriptive statistics of OECD country data

Descriptive Statistics		2019: Q1			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-8,1	17,4	-1,094	4,7421
IMPORT	35	-21	11,2	-2,23	5,5769
INFLATION	35	0,3	19,9	2,252	3,1976
UNEMPLOYMENT	35	2,1	18,3	5,916	3,5711
PRIVATE CONSUMPTION	35	-3,9	5,6	1,957	1,7275
GDP	35	-2,4	5,6	2,137	1,5725
Descriptive Statistics		2019: Q2			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-15,7	9,7	-2,393	4,6478

IMPORT	35	-17,7	5,1	-3,655	4,3286
INFLATION	35	0,3	18	2,328	2,8833
UNEMPLOYMENT	35	2	17,3	5,831	3,4802
PRIVATE CONSUMPTION	35	0,3	6,2	2,027	1,4354
GDP	35	-0,9	6,1	2,108	1,4595

Descriptive Statistics		2019: Q3			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-27	7,6	-3,372	6,3014
IMPORT	35	-13	5	-3,2	4,0133
INFLATION	35	-0,2	13,5	1,902	2,2863
UNEMPLOYMENT	35	2	17	5,817	3,4808
PRIVATE CONSUMPTION	35	0,5	5,6	2,182	1,2049
GDP	35	-0,3	6,2	2,078	1,3802

Descriptive Statistics		2019: Q4			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-13,1	3,8	-3,273	4,5148
IMPORT	35	-18,7	13,8	-4,701	5,3914
INFLATION	35	-0,1	10,3	1,808	1,8098
UNEMPLOYMENT	35	2	16,6	5,741	3,3776
PRIVATE CONSUMPTION	35	-3,7	8,5	1,904	1,9959
GDP	35	-2,4	7,9	1,968	1,9122

Descriptive Statistics		2020: Q1			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-32,2	9,5	-6,257	7,241
IMPORT	35	-25,9	8,5	-7,03	5,5094
INFLATION	35	-0,1	12,1	2,013	2,1375
UNEMPLOYMENT	35	2	15,9	5,805	3,269
PRIVATE CONSUMPTION	35	-6,6	4,5	-1,57	2,8889
GDP	35	-5,7	4,7	-0,759	2,5169

Descriptive Statistics		2020: Q2			
Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-40,4	-2	-22,706	9,2915
IMPORT	35	-35,4	-10,8	-23,128	6,4815
INFLATION	35	-1,4	11,7	0,979	2,2921
UNEMPLOYMENT	35	2,4	20,7	7,257	4,3818
PRIVATE CONSUMPTION	35	-26,2	-4	-13,535	5,5337
GDP	35	-21,5	-2,8	-11,331	4,8845

Descriptive Statistics 2020: Q3

Variables	N	Minimum	Maximum	Mean	Std. Deviation
EXPORT	35	-23,1082	12	-3,94309	7,7594
IMPORT	35	-23,8023	10,3	-6,52864	7,5378
INFLATION	35	-1,9	11,8	1,18	2,3184
UNEMPLOYMENT	35	2,8	17,8	7,374286	3,9502

PRIVCONSUMPTION	35	-20,6236	8,8	-5,25294	5,5149
GDP	35	-12,3993	8,1	-4,35024	4,1624

According to Table 2, exports and imports are the variables with the most variability. In OECD countries before the quarter of 2020, the unemployment rate was around 2% on average, while during the pandemic it rose to 7%. The second quarter of 2020 is the period in which private consumption expenditures saw the greatest decline and the greatest loss of output. The partial lifting of restrictions in the third quarter of 2020 also led to an improvement in economic indicators. Although vaccination efforts have begun, the pandemic still continues to have its impact, and restrictions continue to be applied at rates that vary by country depending on the number of cases. So it is still unclear whether economic problems will deepen in the long run.

Multidimensional scaling estimation results

In the study, an analysis of the unifying clustering method was performed using the full connection method based on the Euclidean distance correlation, and the results obtained were presented in the form of denograms. Classical multidimensional Scaling Analysis was performed in the study. To assess the goodness of fit, two test statistics proposed by Mardia et al [29]. were used, and the statistics were obtained using the double-centered distance matrix. The results of classical multidimensional Scaling Analysis are included in Table 3. Looking at Table 3, it is seen that all eigenvalues are positive. The fact that all eigenvalues are positive means that the number of dimensions determined based on the Euclidean distance correlation is appropriate to explain the uniqueness between export, import, inflation, private consumption and GDP. The appropriate size number was determined to be 2. According to Mardia goodness of fit statistics, 91% of the economic impact differences in the 1. quarter of 2019 can be explained by two dimensions, while for the second quarter of 2019, the rate is 88%. It is 90% for the third quarter of 2019 and 93% for the final quarter of 2019. In December 2019, cases began to spread worldwide in the first quarter of 2020, and restrictions imposed due to high morbidity and mortality rates deeply affected social and economic life. The second quarter of 2020 is the period in which negative effects are most observed in economic terms.

Table 3.
Classical multidimensional scaling analysis results

2019: Q1						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7503
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9147
Abs (Eigenvalue)				Eigenvalue^2		
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	1291.1747	46.30	46.30	66.04	66.04	
2	801.18992	28.73	75.03	25.43	91.47	
2019: Q2						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7114
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.8807
Abs (Eigenvalue)				Eigenvalue^2		
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	838.5561	37.97	37.97	49.95	49.95	
2	732.6209	33.17	71.14	38.12	88.07	
2019: Q3						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7362
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9092
Abs (Eigenvalue)				Eigenvalue^2		
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	838.5561	37.97	37.97	49.95	49.95	

2	732.6209	33.17	71.14	38.12	88.07	
2019: Q4						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7651
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9390
Abs (Eigenvalue)			Eigenvalue^2			
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	1358.98	55.69	55.69	82.38	82.38	
2	508.19	20.82	76.51	93.90	93.90	
2020: Q1						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7820
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9390
Abs (Eigenvalue)			Eigenvalue^2			
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	2380.76	62.12	62.12	90.26	90.26	
2	616.32	16.08	78.20	6.05	96.31	
2020: Q2						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.8000
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9693
Abs (Eigenvalue)			Eigenvalue^2			
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	4172.29	59.20	59.20	86.28	86.28	
2	1465.94	20.80	80.00	10.65	96.93	
2020: Q3						
Eigenvalues	> 0	=	6	Mardia fit	measure 1=	0.7629
Retained	Dimensions	=	2	Mardia fit	measure 2=	0.9520
Abs (Eigenvalue)			Eigenvalue^2			
Dimension	Eigenvalue	Percent	Fri. per	Percent	Fri. per	
1	3495.17	55.34	55.34	83.28	83.28	
2	1322.85	20.95	76.29	11.93	95.20	

As a matter of fact, in the second quarter of 2020, the Mardia goodness of fit benefit value increased from 0.93 to 0.96. And in the second quarter of 2020, 96% of the economic impact differences in the quarter can be explained by two dimensions. And in 2. and 3. quarter of 2020, this ratio is 0.95. The results can be interpreted as diverging between countries in terms of the economic effects of the pandemic process. After examining the compatibility statistics, the coordinates obtained were transferred to the two-dimensional space map and the countries that differ the most economically were evaluated. Figure 1 gives the space map of the MDS analysis results, in other words, the MDS configuration results. According to figure 1, in the first quarter of 2019, Turkey, Iceland and Australia in the upper-right coordinate; Greece and South Korea in the lower-right coordinate; Luxembourg in the upper-left coordinate and Colombia and Portugal in the lower-left coordinate follow a different course from OECD countries in economic terms. In OECD countries in the first quarter of 2019, GDP increased by 1.6% compared to the same period of the previous year, imports decreased by 2.1%, exports decreased by 2.3%, average inflation increased by 2.2% and consumption expenditures increased by 1.5%. During this period, the unemployment rate in OECD countries was 5.5%. Considering the current economic indicators, it can be said that these countries follow a different trend in terms of foreign trade, especially when these countries follow a different trend from OECD countries in economic terms. During this period, the volume of foreign trade in OECD countries decreased by about 2%, while the volume of imports in Turkey, Iceland, Australia decreased by 21%, 12.5% and 5.1%, respectively. In Colombia, Luxembourg and Portugal, the volume of imports has increased, unlike other OECD countries. The import growth rate is 9.5% for Colombia, 11.5% for Luxembourg and 1.6% for Portugal. Export volumes in Australia, Turkey, Iceland and Luxembourg have increased in contrast to the overall trend in OECD countries. Unemployment rates in Colombia, Greece and Turkey are well above the OECD average. Turkey follows a different course from OECD countries in terms of all economic indicators. Inflation and unemployment rates in Turkey are well above the OECD average. In addition,

OECD countries saw an average growth of 1.6% and an increase in private consumption expenditures during this period, while consumption expenditures in Turkey decreased by 3.9% and GDP by 2.4%.

In the second quarter of 2019, Turkey and Iceland moved to the lower right coordinate, while Australia remained in the same coordinate, but the distance between the OECD countries increased. Slovenia, Chile and Norway were among the countries that differed. In the third quarter of 2019, it can be said that the similarities between countries increased slightly in terms of OECD economic indicators. It can be said that the uncertainties created by trade wars between the United States and China, Brexit uncertainty, contraction in production volume, and increases in exchange rate volatility increase the similarities between countries in terms of economic indicators. In the last quarter of 2019, countries are concentrated in positive coordinates.

In December 2019, the pandemic, which occurred in Wuhan, China and affected the whole world in the short term, increased the divergence between countries in terms of economic indicators. While the negative effects of the pandemic process began to be felt in the first quarter of 2020, these negative effects continued to deepen in the second quarter. In the second quarter of 2020 Denmark, Ireland and Colombia, in the third quarter, Turkey, Ireland, Belgium, Colombia, New Zealand and Mexico are the countries that shows the most divergence in terms of economic impact.

Fig. 1. Two-Dimensional MDS configuration results

Kruskal's stress loss function

In multidimensional scaling analyses, the sum of squares of raw residues is not minimized (Mardia et al, 1979, 406-408). Differences between objects can be converted to distances based on the euclidean distance approach. In the classical MDS approach, using the least squares method, distances between objects are regressed with distances based on the euclidean correlation. The compatibility between the distances between the original objects and the distances based on the euclidean correlation is measured by Kruskal's stress loss function. Table 4 gives the stress values calculated as of the periods covered. A stress value above 0.20 means that there is a mismatch between distances, while a stress value close to zero means that there is a perfect fit between distances. In the first quarter of 2019, the stress compliance value is 0.18, while the calculated values for the second and third quarters of 2019 are 0.22 and 0.27. The decrease in stress compliance values from the first quarter of 2020 can be explained by the differentiation of countries in terms of economic impact due to COVID-19. As of the fourth quarter of 2019, the Kruskal stress value is between 0.10 and 0.20. This means that there is a low fit between the distances.

Table 4.

Kruskal stress value

	2019: Q1	2019: Q2	2019: Q3	2019: Q4	2020: Q1	2020: Q2	2020: Q3
Australia	0.1325	0.1350	0.1758	0.1517	0.2201	0.0853	0.1678
Austria	0.2152	0.2558	0.3616	0.1608	0.1811	0.1482	0.1418
Belgium	0.2391	0.2087	0.2550	0.1552	0.2077	0.1742	0.0855
Canada	0.1724	0.2585	0.2845	0.1378	0.1593	0.0889	0.1630
Chile	0.1325	0.1381	0.2680	0.1047	0.2347	0.0386	0.1533
Columbia	0.1929	0.2353	0.0661	0.1514	0.1068	0.0914	0.0816
Czech Rep	0.2645	0.3689	0.2977	0.2555	0.2823	0.1701	0.1401
Denmark	0.2090	0.2473	0.2093	0.1134	0.1538	0.0588	0.1158
Estonia	0.2787	0.2814	0.2467	0.1794	0.2470	0.1043	0.1038
Finland	0.1490	0.2031	0.3026	0.1516	0.1157	0.1590	0.1809
France	0.1889	0.2304	0.2766	0.1660	0.1122	0.1034	0.1559
Germany	0.2435	0.2031	0.3980	0.1998	0.2545	0.1898	0.1490
Greece	0.5566	0.8527	0.8346	0.2700	0.4281	0.2473	0.4730
Hungary	0.1771	0.2656	0.2149	0.1631	0.2291	0.1690	0.1100
Iceland	0.1154	0.1232	0.1387	0.0707	0.0893	0.2105	0.2248
Ireland	0.1446	0.2613	0.1613	0.3192	0.0624	0.0586	0.0855
Israel	0.1628	0.1643	0.1913	0.3038	0.2070	0.0968	0.2212
Italy	0.1543	0.2357	0.2667	0.3023	0.2286	0.1046	0.1489
Japan	0.2615	0.1981	0.3831	0.1690	0.2426	0.1699	0.1394
Korea	0.2446	0.1594	0.1798	0.1335	0.1675	0.0952	0.2218
Luxembourg	0.0710	0.2459	0.3265	0.1273	0.0244	0.1762	0.3443
Mexico	0.1659	0.1903	0.2984	0.1727	0.1778	0.0902	0.0791
Netherlands	0.2302	0.2349	0.3554	0.1488	0.2543	0.1095	0.1682
NewZealand	0.1568	0.3176	0.3357	0.1520	0.2733	0.0964	0.1193
Norway	0.1947	0.1135	0.1200	0.2223	0.0925	0.2004	0.1961
Poland	0.1722	0.2421	0.2710	0.1182	0.1851	0.1137	0.1055
Portugal	0.1444	0.1537	0.2172	0.1063	0.1766	0.1007	0.1815
Slovak_Republic	0.1478	0.1674	0.2348	0.1899	0.1608	0.2219	0.1009
Slovenia	0.1390	0.1141	0.1504	0.0985	0.1121	0.1389	0.1364
Spain	0.2496	0.4097	0.5596	0.3851	0.5725	0.0673	0.2526

Sweden	0.1801	0.2435	0.3059	0.1612	0.1950	0.1098	0.1329
Switzerland	0.2111	0.2405	0.1476	0.1240	0.1162	0.1060	0.1505
Turkey	0.0576	0.0745	0.8289	0.0498	0.0439	0.3065	0.0357
United_Kingdom	0.1629	0.2905	0.3737	0.1589	0.1044	0.1038	0.1800
United_States	0.1674	0.1818	0.3476	0.1755	0.2367	0.1624	0.1449
Total	0.1800	0.2210	0.2748	0.1625	0.1685	0.1283	0.1524

Cluster analysis results

Figure 2 gives dendrogram of cluster analysis as of the period 2019:q1-2020:q4. On the vertical axis are the distances between clusters, and on the horizontal axis are the countries included in the analysis. Clustering is performed from the nearest countries to the farthest countries. Upon examining the results of for the quarter of 2019, it is seen that Ireland and New Zealand, as well as Austria and the Netherlands, are the most similar countries in terms of % changes in economic indicators. Australia and Estonia form a cluster among themselves. Luxembourg and Turkey follow a very different course from other countries in terms of economic indicators. Turkey has not been included in any main cluster, it has been included in all countries at a farthest point. Australia and countries other than Estonia, Luxembourg and Turkey form three main clusters among themselves. Ireland, New Zealand, Poland, Slovenia, Slovakia and the United States form a separate cluster; Austria, Netherlands, Switzerland, France, Denmark, Sweden, Finland, Belgium, Korea, Czech Republic, Germany, Japan, and Iceland create a different cluster, and lastly, Canada, Portugal, Israel, Great Britain, Hungary, Chile, Norway, Mexico, Colombia, Greece, Italy and Spain constitute a different cluster. In OECD countries, the volume of imports and exports in the first quarter of 2019 decreased by about 2% compared to the same period of the previous year, while private consumption expenditures and GDP increased by 1.6%. The unemployment rate is 5.5%. Turkey follows a different course from other OECD countries in terms of economic indicators during the period covered. In Turkey, the volume of imports increased by 21%, the volume of exports by 4.5%, and inflation by 19.9%. The unemployment rate is 13.6%. During the same period, growth and private consumption expenditures in OECD countries were increased, while economic contraction was observed in Turkey.

In the second quarter of 2019, Australia and Denmark were in the same cluster, while Turkey again did not participate in any cluster, at a distant point it was included in all countries. Other countries are divided into three clusters. Belgium, Finland, Slovakia, Portugal, Japan, the Netherlands, the USA, Hungary, Luxembourg, Poland, France, Italy and Sweden fall into a cluster, while Canada, Switzerland, Czech Republic, New Zealand, Mexico, Colombia, Slovakia, Greece, Spain and Ireland take part in a different cluster and Austria, England, Germany, Estonia, Chile, Israel, Korea, Iceland, and Norway are located in other cluster.

In the third quarter of 2019, divergence between countries is observed to be increasing due to increased uncertainties due to trade wars between the United States and China. In this period, in addition to Turkey, Norway and Colombia are not included in any clusters. During this period, Norway suffered a serious loss of exports and witnessed an economic growth close to zero. In the last quarter of 2019, Turkey follows a different course from other OECD countries in terms of economic indicators, Chile and Iceland are in a separate cluster, and other countries constitute three clusters within themselves.

In the first quarter of 2020, there is a very similar cluster to the previous quarter. In addition to Turkey, Luxembourg is in a separate cluster from other countries. Australia is the other country at the extreme. Luxembourg is the country with the most contraction in the volume of foreign trade. During this period, the volume of imports in Luxembourg decreased by 25.9% and the volume of exports by 32.2%.

In the second quarter of 2020, the negative effects of COVID-19 on the economy were seriously felt. While there were five main clusters at a distance of 10 units, the number of clusters at a distance of 20 units decreased to three and the number of clusters at a distance of 30 units decreased to two. In this period, Turkey, unlike other periods, is included in cluster. Australia, the Netherlands, Switzerland, Israel, Denmark, New Zealand, Ireland and Chile are the countries in the first cluster. Austria, Slovenia, Belgium, Iceland, Greece, the United States and Luxembourg are in the second cluster. Czech Republic, Hungary, Germany, Japan, Estonia, Spain, Finland, Korea and Turkey are the countries in the third cluster. Canada, France, Italy, Portugal, Slovakia and Norway are in the fourth cluster, while Colombia, Mexico, the United Kingdom and Spain are in the fifth cluster. The fact that the economic effects of COVID-19 differ from country to country has significantly affected the clustering between countries. Countries on the far right of the dendrogram are the countries that have suffered the most economic losses. In this context, it can be said that Spain, Britain, Mexico and Colombia are the countries that have suffered the most economic losses due to COVID-19.

With the increase in normalisation trends in the third quarter of 2020, the negative economic effects of the pandemic decreased, but curfew restrictions were reintroduced when morbidity rates increased. In this context, the third quarter of 2020 is a period in which the negative effects have partially decreased. Support packages prepared to reduce the negative effects of the negative supply and demand shocks due to pandemic, measures to prevent the loss of employment, income support to reduce revenue losses and interest rates to reassure markets has been effective in reducing economic losses. As of the indicators studied, the economic variable that has seen the most contraction is the volume of foreign trade. In the third quarter of 2020, Australia is on the far left and Turkey is on the far right. Differences in economic impact have diversified the cluster between countries, and the distance between countries has increased. There are 7 different clusters at a distance of 10 units. Australia, Norway, Canada, Finland, France, the United States are in the first cluster. Iceland, Japan and the United Kingdom form a separate cluster at a distance of 10 units, while the first cluster at a distance of 20 units is merged. Austria, Czech Republic, Germany, Netherlands, Slovenia, Switzerland, Denmark, Sweden, Israel, Korea, Italy, Portugal constitute the third cluster at a distance of 10 units. Greece and Spain form a separate cluster at a distance of 10 units, while the third cluster is merged at a distance of 20 units. Chile and New Zealand formed a separate cluster at a distance of 10 units, while Mexico and Luxembourg were included in this cluster at a distance of 20 units. Belgium and Colombia form a cluster among themselves, while Estonia, Hungary, Poland, Slovakia, Ireland and Turkey form a separate cluster.

Dendrogram for(Q1-19) cluster analysis

Dendrogram for (Q2-19) cluster analysis

Dendrogram for (Q3-19) cluster analysis

Dendrogram for (Q4-19) cluster analysis

Fig. 2. 2019:Q1-2020: Q3 period dendrogram for cluster analysis

Discussion

In this study, the economic effects of COVID-19 were taken into account and the similarity of countries in terms of economic impact was analyzed using multidimensional scaling and cluster analyses. The analysis was conducted to cover the period 2019:Q1-2020:Q3 to test for variability in the trend of pre-pandemic and post-pandemic clustering. The analysis was based on the change in export, import, inflation, unemployment, private consumption and GDP data in the same period of the previous year. In the studies in the literature, economic losses caused by the pandemic were mentioned, however; it has not been analyzed which countries show similar trends in terms of economic losses. OECD countries consist of many countries with different socio-economic characteristics. Therefore, economic losses caused by covid 19 are expected to differ according to countries. Identifying countries that are similar or divergent in terms of economic losses is important for the effectiveness of policies to be implemented to reduce economic losses. The results of the study indicated that OECD countries are largely similar in terms of change in macroeconomic indicators before the pandemic, but; the differentiation between countries has increased during the pandemic process. During the pandemic process, countries that implement policies to protect employment and reduce income losses continue the pandemic process with less economic loss.

Conclusion

Increasing uncertainty in global markets and a decline in global growth trend, trade wars between the United States and China, economic effects caused by Brexit uncertainties have left their mark on the global economy, while the COVID-19 epidemic in the global economy from the last quarter of 2019 and the economic costs incurred due to the epidemic have left their mark on the economic agenda. In this context, depending on the economic structures of countries, the degree of external openness of countries, the shares they receive from the world economy, the level of development and the differences in the economic system, there are also differences in the tendency of countries to cluster according to periods. In the first quarter of 2019, Australia, Turkey, Iceland and Luxembourg are the most divergent countries from other OECD countries. Australia is the closest country to the OECD average among divergent countries. Turkey follows a different course from OECD countries in terms of all economic indicators. In the second quarter of 2019, Turkey and Iceland were replaced on the space map, with Slovenia, Chile and Norway joining the countries that are not divergent with OECD countries. In the third quarter of 2019, the disparities between countries in terms of OECD economic indicators increased slightly. It can be said that the uncertainties created by trade wars between the United States and China, Brexit uncertainty, contraction in production volume, and increases in exchange rate volatility increase the similarities between countries in terms of economic indicators. In the last quarter of 2019, countries concentrated mostly in positive coordinates.

The pandemic process has increased divergence between countries in terms of economic indicators. While the negative effects of the pandemic process began to be felt in the first quarter of 2020, it continued to deepen in the second quarter. In the second quarter of 2020, Denmark, Ireland and Colombia, in the third quarter, Turkey, Ireland, Belgium, Colombia, New Zealand and Mexico are the countries that shows the most divergence in terms of economic impact.

According to the results obtained in clustering analyses, it was observed that Turkey followed a different course from other OECD countries in terms of economic indicator in the period 2019:q1:2020 q1. In the second quarter of 2020, Turkey is in the same cluster with the Czech Republic, Hungary, Germany, Japan, Estonia, Spain, Finland, Korea; and in the third quarter, it was in the same cluster with Estonia, Hungary, Poland, Slovakia, Ireland. In the second quarter of 2020, the negative effects of COVID-19 on the economy were seriously felt. During this period, Australia, Netherlands, Switzerland, Israel, Denmark, New Zealand, Ireland and Chile are in a cluster, Austria, Slovenia, Belgium, Iceland,

Greece, the United States and Luxembourg fall into a separate cluster. And Czech Republic, Hungary, Germany, Japan, Estonia, Spain, Finland, Korea and Turkey take part in a different set of cluster, while Canada, France, Italy, Portugal, Slovakia and Norway fall within a different cluster, Colombia, Mexico, Great Britain and Spain have been involved in a different cluster. Countries on the far right of the dendrogram are the countries that have suffered the most economic losses. In this context, it was concluded that Spain, Great Britain, Mexico and Colombia were the countries that suffered the most economic losses due to COVID-19.

With the increase in normalization trends in the third quarter of 2020, the negative economic effects of the pandemic decreased, but curfew restrictions were reintroduced when morbidity rates increased. In this context, the third quarter of 2020 is a period in which the negative effects have partially decreased. Support packages prepared to reduce the negative effects of negative supply and demand shocks caused by the pandemic, income support to prevent the revenue losses and interest rates to reassure markets have been effective in reducing the economic losses. As of the indicators studied, the economic variable that has seen the most contraction is the volume of foreign trade. Unemployment rates have increased more slowly in countries where employment is sought to protect with employment packages, while unemployment rates have increased more in other countries. The contraction in the volume of production and consumption also negatively affected economic growth. Differences in economic impact have diversified the cluster between countries, and divergence between countries in terms of economic indicators has increased.

Authors' Contributions

AK, AG, PK, AÖ conceptualized the commentary. AK, AG, PK lead its writing. All authors contributed to the writing of the manuscript and read and approved its final version.

Acknowledgement

Not Applicable

Funding

No funding was received.

Availability of data and materials

The dataset obtained from the OECD database were used.

Ethics Approval and consent to participate

Not applicable. The dataset obtained from the OECD database were used.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests

References

- [1] Rio-Chanona, R. M., Mealy, P., Pichler, A., Lafond, F., Farmer, J. D. Supply and demand shocks in the covid-19 pandemic: an industry and occupation perspective. *Oxford Review of Economic Policy*. 2020; 36(1), 94-137.
- [2] Guerrieri, V., Lorenzoni, G., Straup, L., Werning, I. macroeconomic implications of covid-19: can negative supply shocks cause demand shortages?. *NBER Working Paper Series* 26918, 2020.
- [3] OECD. Quarterly National Accounts: GDP Per Capita. https://stats.oecd.org/Index.aspx?DatasetCode=SNA_TABLE1.

- [4] Jo, C. Cost-of-illness studies: concepts, scopes, and methods. *Clinical and Molecular Hepatology*. 2014; 20(4), 327-337.
- [5] Papadakaki, M., Stamoulli, M., Ferraro, O.E., Orsi, C., Otte, D., Tzamalouka, G., Geest, M.T., Lajunen, T., Özkan, T., Marondi, A., Kotsyfos, V., Chliaoutakis, J. Hospitalization costs and estimates of direct and indirect economic losses due to injury sustained in road traffic crashes: results from a one-year cohort study in three European countries. *Trauma*. 2016;19(4), 264-276.
- [6] Mutyambizi, C., Pavlova, M., Chola, L., Hongoro, C., Groot, W. Cost of diabetes mellitus in africa: a systematic review of existing literature. *Globalization and Health*. 2018; 14(3). DOI 10.1186/s12992-017-0318-5.
- [7] Mooney, H., Zegarra, M.A. The pandemic's unpredictable shock to tourism Latin America and The Caribbean, Edited by Simeon Djankov and Ugo Panizza, *COVID-19 in Developing Economies*. UK: CEPR Press, 2020; 112-126.
- [8] Djiofack, C. Z., H. Dudu, H., Zeufack, A.G. Assessing covid-19's economic impact in Sub-saharan Africa: insights from a cge model. In *COVID-19 in developing economies*. Simeon Djankov and Ugo Panizza (Eds.) UK: CEPR Press. 2020; 53-68.
- [9] McKibbin, W., Fernando, R. The Global macroeconomics impacts of covid-19: seven scenarios. *CAMA Working Paper 19*; 2020.
- [10] Malliet P., Reynès, F., Gissela, L., Hamdi-Cherif, M., Saussay, A. 2020. Assessing Short-Term and Long-Term Economic and Environmental Effects Of The Covid-19 Crisis In France. *Environmental and Resource Economics* 76, 867-883.
- [11] De Vito, A., Gomez, J. Estimating the covid-19 cash crunch: global evidence and policy. *Journal of Accounting and Public Policy*. 2020; 39, 106741.
- [12] Fernandes, N. Economic effects of coronavirus outbreak (covid-19) on the world economy. IESE Business School Working Paper no. WP-1240-E, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3557504. 2020.
- [13] Banco, D. Macroeconomics scenarios for the spanish economy after covid-19. *Economic Bulletin*. 2020; 2, 1-30.
- [14] König, M., Winkler, A. Covid-19 and economic growth: does good government performance pay off?. *Intereconomics*. 2020; 55, 224-231.
- [15] Luga, L. C., Mihalciuc, A. Major crises of the XXIst century and impact on economic growth. *Sustainability*. 2020; 12, 9373, 1-20.
- [16] Oravský, R., Tóth, P., Bánociová, A. The Ability of Selected European Countries to Face The Impending Economic Crisis Caused By Covid-19 In The Context Of The Global Economic Crisis Of 2008. *Journal of Risk Financial Management*. 2020; 13 179: 1-17.
- [17] Ashraf, B.N. Economic impact of government interventions during the covid-19 pandemic: international evidence from financial markets. *Journal of Behavioral and Experimental Finance*. 2020; 27 100371.
- [18] Milani, F. Covid-19 outbreak, social response, and early economic effects: a global analysis of cross-country interdependencies. *Journal of Population Economics*, 2021; 34, 223-252.
- [19] Mohapatra, S. Gender diverse economic responses to crises in developing countries: insights for covid-19 recovery policies. *Review of Economics of the Household*. 2020; <https://doi.org/10.1007/s11150-020-09512-z>
- [20] Kruskal, J. B., Wish, M. *Multidimensional scaling*. SAGE, Newbury Park; 1978.
- [21] Young, F. W., Hamer, R.M. *Multidimensional scaling: history, theory, and applications*. NJ: Erlbaum Associates, Hillsdale; 1987.
- [22] Hair, J. F., Babin, B., Black, W.C., Rolph, A.E. *Multivariate data analysis*. 8th Edition, Cengage, India; 2018.
- [23] Borg, I., Groenen. P. *Modern Multidimensional Scaling: Theory And Applications*. Springer, New York; 2005.
- [24] Mardia, K. V., Kent, J.T. Bibby, J. *Multivariate analysis*. Academic Press, London; 1979.
- [25] Cox, M.A.A., Cox, T. F *Multidimensional scalling*. In *Handbook of Data Visualization* Edt. Chun-houh Chen, Wolfgang Härdle, Antony Unwin.; 2008. 315.347.
- [26] Young, G., Householder, A.S. Discussion of a set of points in terms of their mutual distances. *Psychometrika*. 1938; 3, 19-22.

- [27] Torgerson, W.S. Multidimensional scaling: i. theory and method. *Psychometrika* 1952; 17, 401-419.
- [28] Wickelmaier, F. An Introduction to MDS. <https://www.hongfeili.com/files/paper100/paper4.pdf>, 2003.
- [29] Mardia, K. V. Some properties of classical multidimensional scaling. *Communications in Statistics—Theory and Methods*. 1978; 7 1233-1241.
- [30] Kruskal, J. B.. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika*. 1964; 29: 1-27.
- [31] Kruskal J. B. Nonmetric multidimensional scaling: a numerical method. *Psychometrika*. 1964; 29, 115-129.
- [32] Sokal, R.R., Sneath, P. H. A. *Principles of numerical taxonomy*. W.H. Freeman & Co, New York; 1963.
- [33] Anderberg, M.R. *Cluster analysis for applications*. Academic Press, New York; 1973.
- [34] Lingoes, J. C. Some boundary conditions for a monotone analysis of symmetric matrices. *Psychometrika*. 1971; 36, 195-203.
- [35] Blei, D.M., Lafferty, J.D. Topic models. In *Mining: Classification, Clustering, and Applications*. A. Srivastava and M. Sahami (Eds.), Boca Raton, FL: Chapman & Hall/CRC; 2009, 71- 94.
- [36] Morissette, L., Chartier, S., 2013. The K- Means Clustering Technique: General Considerations And Implementation In Mathematics. *Tutorials in Quantitative Methods for Psychology* 9(1), 15-24.
- [37] Everitt B., Landau, S., Leese, M., Stahl, D. *Cluster Analysis*. 5th ed. Chichester, Wiley; 2011.
- [38] Jain A.. K., Dubes, R.C. *Algorithms for clustering data*. NJ: Prentice Hall, Englewood Cliffs; 1988.
- [39] Michael A. A., Cox, T.F. *Multidimensional Scaling*. Chapman & Hall/CRC, Boca Raton, FL; 2001.
- [40] Gordon, A. D. 1999. *Classification*. 2nd ed. Chapman & Hall/CRC, Boca Raton, FL.
- [41] Kaufman L., Rousseeuw, P.J., 1990. *Finding Groups In Data: An Introduction To Cluster Analysis*, Wiley, New York; 1990.
- [42] Rencher, A. C., Christensen, W.F. *Methods of multivariate analysis*. 3rd ed. Wiley, Hoboken, NJ; 2012.

Figures

Figure 1

Two-Dimensional MDS configuration results

Figure 2

2019:Q1-2020: Q3 period dendrogram for cluster analysis