**Evaluating countries’ performances against COVID-19 concerning their structural characteristics via DEA and MCDM Models**

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**Abstract**

**The Problem and Scope**

The coronavirus, also known as COVID-19, which first confirmed in Wuhan, China on December 8, 2019, has spread rapidly all over the world and deteriorated the health, socio-economic and environmental conditions of countries. Then, the World Health Organization declared it as a pandemic on March 11, 2020. In order to decrease its spreading rate and negative effects on health of the people, a struggle against it was implemented via some preventions, restrictive policies and extraordinary efforts of the health systems. However, due to the economic, socio-cultural, etc. differences, some countries had better performance, others not. Therefore, to determine which countries show better performance and its reasons is a very important question to answer.

In this context, this study evaluates the management efficiencies and performances against Pandemic between the periods of March 2020 – July 2021 (before spread of vaccination). At the same time, the linkage between the performances and the structural characteristics (culture and socio-economic properties) of the countries tried to be find out. Up to our knowledge, this is the first study which investigates all these aspects at the same time in a performance evaluation against Covid-19, in the post-disease era.

**Methodology**

Efficiency analysis conducted has two-stage. First, static efficiency measurement is implemented via Data Envelopment Analysis (DEA) method, which is a multi-factor productivity analysis model for measuring the relative efficiencies of a homogenous set of decision making units (DMUs, here, countries). This analysis is conducted on the average values in the whole analysis period. Besides in order to determine the key factors of the efficiency, and peer countries for inefficient ones, are also determined.

Second, dynamic efficiencies on the weekly data which shows the policy efficiency variations of the struggle against Covid-19, and their stability are shown. In this stage the DEA Windows model which is a time dependent version /an extension of the original form is used. This model assesses the performance of a DMU over time by choosing a “window” of w observations for each DMU, and treating these as if they represented *w* “different” DMUs. It works on the principle of moving averages. This results in increasing the number of data points in the analysis, which can be useful when dealing with small sample sizes. Since in our study, the initial sample is divided into small groups and small set of alternatives versus many variables efficiencies lose their discrimination power, windows analysis is beneficiary. Besides as a sensitivity analysis classical MCDM (SAW, TOPSIS, BORDA) methods also used on the same criteria, since these methods are also similar to DEA, as they consider multi-dimensional and conflicting aspects at the same time.

Last but not the least, in order to observe the links between efficiency trends and structural characteristics of the countries more accurately, suitable non-parametric statistical tests are used.

**Data: Sample and Variables**

The data for the initial sample consists of 39 countries. These countries are among the ones which has all available data planned to be used in the study, accounting for a significant percentage of total global cases (with more than 3 Million cumulative cases or more at individual country level) up to date. They accounted for 88% of the global cumulative cases as of November 2022 (source: ourworldindata.org).

These countries are (in the descending order of total cumulative cases): United States, India, France, Germany, Brazil, South Korea, United Kingdom, Italy, Japan, Russia, Turkey, Spain, Vietnam, Australia, Argentina, Netherlands, Taiwan, Iran, Mexico, Indonesia, Poland, Colombia, Ukraine, Portugal, Austria, Greece, Malaysia, Chile, Israel, Thailand, Belgium, Canada, Switzerland, Peru, Czechia, South Africa, Philippines, Denmark, and Romania.

A wide range of criteria that account for political, demographic, capacity, and Covid-19 indicators widely used within the most recent literature were selected. The first category of data is on the performance measures against Covid-19, the other is that characterize the social and economic structures of the countries as listed in Table 1. with corresponding models used. The countries are divided into groups with respect to their GDP’s, development indices and cultural map scores. While defining the models some inputs and outputs are thought as negative-effect and positive-effect variables, respectively.

**Table 1. Models and Variables: Inputs and Outputs (Criteria)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model** | **Method** | **Inputs\*** | **Outputs\*** |
| Dynamic(on weekly data) | DEA WindowsAnalysis\*\*(w, window width of two weeks) | Government Response measuresStringency Index | Total Cases & Deaths /Population (undesirable\*\*\*) Total Tests / Pop.Total Recovered / Pop. |
| Static & Peer Analysis(on the mean values of the whole period) | DEA and MCDM Methods  | Government Response measuresStringency IndexCurrent Health ExpenditureHospital Beds Per ThousandPopulation densityPopulation ages 65 + (%)Cardiovascular Death RateDiabetes PrevalenceShare of adults who smokeExtreme Poverty | Total Cases & Deaths /Population (undesirable\*\*\*) Total Tests / Pop.Total Recovered / Pop. |
| Structural | Clustering, pre-determination of classes | GDP per Capita Human development indexCultural Map Scores |

(\*) Inputs stand for cost criteria, while outputs for benefit criteria, in corresponding MCDM Analysis.

(\*\*) The windows width of 2 weeks is selected since average quarantine time in this disease is assumed to be 14 days.

(\*\*\*) Undesirable inputs and output are included in the analysis by taking inverse of these variables.

Data were obtained from the data sources given below:

*The coronavirus and health system input / output data:* ourworldindata.org

*Cultural Variables:* The Inglehart-Welzel World Cultural Map - World Values Survey 7 (2022): www.worldvaluessurvey.org

*Government Policies / Measures:* Oxford COVID-19 Government Response Tracker,

www.bsg.ox.ac.uk

*Health System Data:* World Health Organisation, www.who.int

Global Health Security Index (2019-2021), www.ghsindex.org

**Main Results**

The first results reveal that countries with strong healthcare systems, successful government policy have higher efficiency while struggling against Covid-19. When compared the findings with classical MCDM methods for robustness, similar results are obtained. The initial results mainly show that the DEA Windows Analysis model is capable of identifying dynamic trends of efficiency clearly. Moreover, sources of inefficiency, thereby potentially yield managerial insights into organizational improvements are find out via classical DEA and MCDM analyses. The results also demonstrate the important differences that exist between the countries with respect to their structural characteristics.