

# Fighting COVID-19: Patterns in international data

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# Supporting Documents

- “Fighting COVID-19: Patterns in international data”. The Special Memorial Issue of the *Philippine Review of Economics* (December 2020) in honor of **Dr. Benito J. Legarda, Jr.**
- ***Fighting COVID-19: Patterns in International Data, Expanded***, University of Pennsylvania, Penn Institute for Economic Research(PIER) Working Paper No: 21-015. 21 March 2021. [Fighting COVID-19: Patterns in International Data, Expanded | Department of Economics \(upenn.edu\)](#)
- ***Fighting COVID-19: Performance of Countries in the First Half of 2020***, University of Pennsylvania, Penn Institute for Economic Research(PIER) Working Paper No: 20-040. [Fighting COVID-19: Performance of Countries in the First Half of 2020 | Department of Economics \(upenn.edu\)](#)

# Introduction

- This presentation provides an empirical evaluation of countries' performance in fighting COVID-19, utilizing a performance index (which we call the Disaster Index) based on four health and economic indicators: deaths per population size, deaths per confirmed cases, and quarterly real GDP and monthly unemployment rate relative to pre-pandemic values. International data patterns are studied for these four indicators and the Disaster Index to analyze trends and basic empirical relationships. The ten best performers based on the Disaster Index for the first half of 2020 were (ranked 1<sup>st</sup> to 10<sup>th</sup>): Singapore, Taiwan, Belarus, Korea, New Zealand, Japan, Norway, Israel, Czechia, and Lithuania. The worst twelve performers were (bad to worst): Sweden, US, Canada, Philippines, France, Columbia, Spain, Belgium, United Kingdom, Ecuador, Italy, and Peru.

## . Introduction

- The pandemic exhibited the vulnerabilities in the world and reemphasized the vital significance of international coordination and cooperation in a globalized world.
- The world had 110 million cases and 2.5 million deaths by February 17, 2021. These numbers have been rising steadily. The deaths per hundred thousand is 31.23 (312 in a million) for the world and deaths per hundred confirmed cases is 2.21. No country is immune to this virus. There are data on 192 countries. The situation is fluid everywhere. A country may have a low number for a few weeks, but this may change suddenly. Vaccination is a fresh hope, a potential game-changer, though requiring careful and painstaking implementation.

# Introduction

- This presentation is organized as follows. Section 2 is devoted to trends in indicators and the DI. Relationships and patterns in international data are discussed in Section 3. Some additional thoughts on the pandemic are given in Section 4 – on related issues such as the trade-off between economic loss and health risk, relevance of budget deficit and domestic debt, and modeling concerns for forecasting and policy analysis. A summary of findings and concluding remarks appear in the final section.

## Trends in selected indicators and the Disaster Index

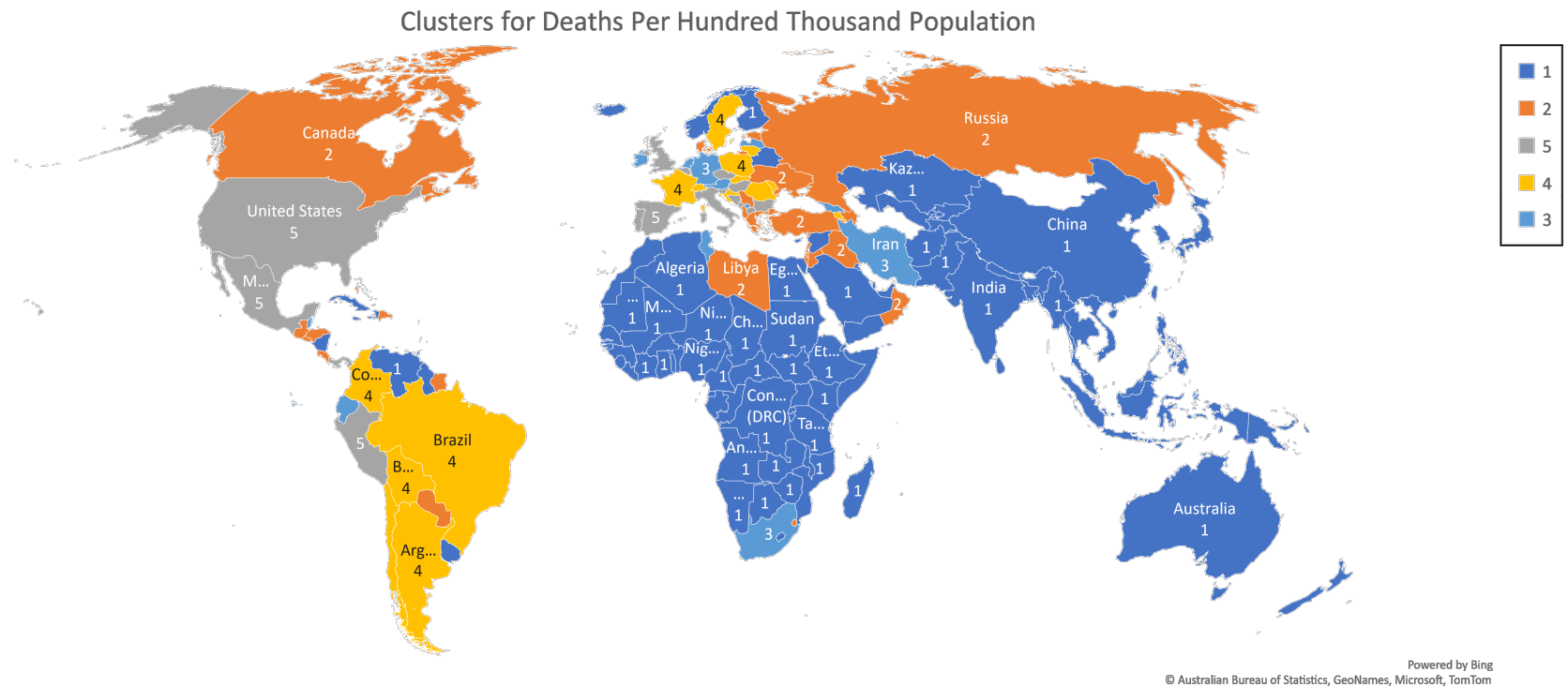
- Two common statistics used for international comparisons are number of deaths in relation to population and the number of deaths in relation to confirmed cases (Table 1). Data are obtained from the Johns Hopkins University COVID Research Center. In addition to the two series, ranks of countries in ascending order and the clusters (based on K-means and using Stata software) are also given in the table). A map for countries shows clusters for deaths per hundred thousand (Figure 1).

st country figures.

# Table 1 Confirmed cases and deaths: country ranks and clusters as of February 17, 2021

|     | COUNTRY        | CONFIRMED   | DEATHS    | DEATHS PER 100 THOUSAND | DEATHS PER 100 THOUSAND-CLUSTERS | DEATHS PER 100 THOUSAND-RANKS | CASE FATALITY | CASE FATALITY- CLUSTERS | CASE FATALITY- RANKS |
|-----|----------------|-------------|-----------|-------------------------|----------------------------------|-------------------------------|---------------|-------------------------|----------------------|
| 7   | Argentina      | 2,033,060   | 50,432    | 113.34                  | 4                                | 149                           | 2.48          | 2                       | 127                  |
| 9   | Australia      | 28,911      | 909       | 3.64                    | 1                                | 47                            | 3.14          | 3                       | 146                  |
| 14  | Bangladesh     | 541,434     | 8,298     | 5.14                    | 1                                | 51                            | 1.53          | 1                       | 75                   |
| 23  | Brazil         | 9,921,981   | 240,940   | 115.02                  | 4                                | 150                           | 2.43          | 2                       | 125                  |
| 33  | Chile          | 782,039     | 19,644    | 104.88                  | 4                                | 144                           | 2.51          | 2                       | 128                  |
| 34  | China          | 100,639     | 4,831     | 0.35                    | 1                                | 8                             | 4.80          | 3                       | 168                  |
| 60  | Germany        | 2,352,766   | 65,829    | 79.38                   | 3                                | 131                           | 2.80          | 2                       | 138                  |
| 71  | India          | 10,937,320  | 155,913   | 11.53                   | 1                                | 80                            | 1.43          | 1                       | 66                   |
| 72  | Indonesia      | 1,233,959   | 33,596    | 12.55                   | 1                                | 82                            | 2.72          | 2                       | 137                  |
| 77  | Italy          | 2,739,591   | 94,171    | 155.83                  | 5                                | 169                           | 3.44          | 3                       | 150                  |
| 79  | Japan          | 418,435     | 7,139     | 5.64                    | 1                                | 55                            | 1.71          | 2                       | 85                   |
| 83  | South Korea    | 84,946      | 1,538     | 2.98                    | 1                                | 43                            | 1.81          | 2                       | 92                   |
| 96  | Malaysia       | 269,165     | 983       | 3.12                    | 1                                | 44                            | 0.37          | 1                       | 8                    |
| 113 | Nigeria        | 148,296     | 1,777     | 0.91                    | 1                                | 21                            | 1.20          | 1                       | 50                   |
| 122 | Philippines    | 552,246     | 11,524    | 10.81                   | 1                                | 76.5                          | 2.09          | 2                       | 110                  |
| 127 | Russia         | 4,053,535   | 79,659    | 55.14                   | 2                                | 118                           | 1.97          | 2                       | 100                  |
| 135 | Singapore      | 59,810      | 29        | 0.51                    | 1                                | 9                             | 0.05          | 1                       | 1                    |
| 145 | Sweden         | 617,869     | 12,487    | 122.62                  | 4                                | 153                           | 2.02          | 2                       | 102                  |
| 148 | Taiwan         | 937         | 9         | 0.04                    | 1                                | 3                             | 0.96          | 1                       | 31                   |
| 151 | Thailand       | 24,786      | 82        | 0.12                    | 1                                | 5.5                           | 0.33          | 1                       | 6                    |
| 155 | Turkey         | 2,602,034   | 27,652    | 33.59                   | 2                                | 106                           | 1.06          | 1                       | 37                   |
| 156 | United States  | 27,756,624  | 488,081   | 149.18                  | 5                                | 167                           | 1.76          | 2                       | 88                   |
| 160 | United Kingdom | 4,070,332   | 118,421   | 178.11                  | 5                                | 171                           | 2.91          | 3                       | 140                  |
|     | World          | 109,502,318 | 2,418,776 | 31.23                   | 2                                | 104                           | 2.21          | 2                       | 117                  |

*Figure 1 Clusters for deaths per hundred thousand population as of February 17, 2021*





## Trends in selected indicators and the Disaster Index

- The Philippines had about 550 thousand confirmed cases and about 11 thousand deaths by February 17, 2021 (Table 1). Deaths per hundred thousand population was 10.81 (rank of 76.5 out of 174) which puts the Philippines in the first cluster. On the other hand, deaths from confirmed cases were 2.09 percent (with rank=110 and cluster=2).
- There were six countries with over a hundred thousand deaths by March 8, 2021. These countries were the United States, Brazil, India, United Kingdom, Mexico, and Italy. There were 36 countries with over ten thousand deaths.

## Percentage changes in real GDP from the fourth quarter of 2019

- The Philippines had very high percentage changes from the fourth quarter of 2019, both in 2018 and 2020 (Table 2). Figures for the Philippines for 2018 are very similar to China (they both realized high growth rates). In 2020, starting with the second quarter real GDP in China grew compared with contractions in the Philippines and many other countries. This may be since the virus was in China in 2019 and very serious lockdown measures were taken by China. The large shares of exports in GDP, significant tourism revenues, and remittances may help to explain the large declines in GDP in the Philippines due to COVID-19.

*Table 2 GDP in 2010 US dollars: percentage change from the fourth quarter of 2019*

|        | BRAZIL | CHINA  | GERMAN<br>Y | ITALY  | JAPAN | KOREA | PHILIPPINE<br>S | UNITED<br>KINGDO<br>M | UNITED<br>STATES | WORLD  |
|--------|--------|--------|-------------|--------|-------|-------|-----------------|-----------------------|------------------|--------|
| 2018Q1 | -1.72  | -9.44  | -0.87       | -0.22  | 1.20  | -4.30 | -10.57          | -2.32                 | -3.76            | -3.82  |
| 2018Q2 | -1.83  | -8.08  | -0.40       | -0.10  | 1.24  | -3.71 | -8.30           | -1.94                 | -3.11            | -3.16  |
| 2018Q3 | -1.03  | -7.29  | -0.73       | -0.15  | 0.57  | -3.16 | -7.54           | -1.36                 | -2.61            | -2.78  |
| 2018Q4 | -1.52  | -5.48  | -0.39       | -0.07  | 1.03  | -2.32 | -6.27           | -1.20                 | -2.29            | -2.23  |
| 2019Q1 | -0.26  | -3.59  | 0.22        | 0.12   | 1.61  | -2.65 | -5.01           | -0.65                 | -1.58            | -1.42  |
| 2019Q2 | -0.06  | -2.48  | -0.29       | 0.32   | 1.69  | -1.66 | -3.58           | -0.51                 | -1.21            | -0.86  |
| 2019Q3 | -0.22  | -2.13  | 0.02        | 0.36   | 1.87  | -1.29 | -1.88           | -0.02                 | -0.58            | -0.46  |
| 2019Q4 | 0.00   | 0.00   | 0.00        | 0.00   | 0.00  | 0.00  | 0.00            | 0.00                  | 0.00             | 0.00   |
| 2020Q1 | -1.55  | -10.00 | -1.99       | -5.53  | -0.56 | -1.28 | -5.60           | -2.88                 | -1.26            | -2.85  |
| 2020Q2 | -11.00 | 0.66   | -11.50      | -17.85 | -8.82 | -4.40 | -19.65          | -21.37                | -10.14           | -10.40 |
| 2020Q3 | -4.14  | 2.55   | -3.97       | -4.74  | -4.03 | -2.35 | -13.21          | -8.69                 | -3.42            | -3.31  |
| 2020Q4 |        | 6.55   | -3.88       | -6.62  | -1.11 | -1.29 | -8.38           | -7.80                 | -2.46            | -1.87  |

# Change in the rate of unemployment from December 2019

- The rate of unemployment is another very significant indicator to see the effects of a pandemic. Data are also available from the World Bank, Global Economic Monitor (GEM) database for most countries. These data are available monthly, but for some major countries (for example, India) they are not available. Here, comparisons with unemployment rate in December 2019 are made.
- There were significant increases in the rate of unemployment due to COVID-19 in all the countries, especially in the Philippines and the United States (Table 3). It should be noted that GEM gives monthly figures for the Philippines by using the same quarterly figure for the months of the quarter. This does not change the basic fact that the rate of unemployment increased by 0.4 percentage point in the first quarter of 2020 and 12.3 percentage points in the second quarter from the fourth quarter of 2019.

# Table 3 The rate of unemployment: difference from December 2019

|         | BRAZIL | CHINA | GERMANY | ITALY | JAPAN | KOREA | PHILIPPINES | UNITED KINGDOM | UNITED STATES | WORLD |
|---------|--------|-------|---------|-------|-------|-------|-------------|----------------|---------------|-------|
| 2019M12 | 0.00   | 0.00  | 0.00    | 0.00  | 0.00  | 0.00  | 0.00        | 0.00           | 0.00          | 0.00  |
| 2020M01 | -0.13  | 0.04  | 0.00    | -0.17 | 0.11  | 0.20  | 0.40        | 0.10           | -0.10         | 0.05  |
| 2020M02 | -0.14  | 0.06  | -0.09   | -0.08 | 0.18  | -0.30 | 0.40        | 0.10           | -0.10         | 0.06  |
| 2020M03 | 0.03   | 0.04  | 0.48    | -2.54 | 0.33  | 0.10  | 0.40        | 0.10           | 0.80          | 0.21  |
| 2020M04 | 0.52   | 0.26  | 0.85    | -3.33 | 0.41  | 0.10  | 12.30       | 0.20           | 11.20         | 2.06  |
| 2020M05 | 0.96   | 0.25  | 1.23    | -1.41 | 0.61  | 0.60  | 12.30       | 0.20           | 9.70          | 2.14  |
| 2020M06 | 1.56   | 0.22  | 1.19    | -0.09 | 0.58  | 0.50  | 12.30       | 0.40           | 7.50          | 1.95  |
| 2020M07 | 2.14   | 0.56  | 1.17    | 1.30  | 0.66  | 0.40  | 4.80        | 0.60           | 6.60          | 1.94  |
| 2020M08 | 2.82   | 0.55  | 1.15    | 1.44  | 0.73  | -0.40 | 4.80        | 0.90           | 4.80          | 1.77  |
| 2020M09 | 3.13   | 0.55  | 1.27    | 0.49  | 0.73  | 0.30  | 4.80        | 1.00           | 4.20          | 1.65  |
| 2020M10 | 3.10   | 0.59  | 1.28    | 0.10  | 0.82  | 0.50  | 4.50        | 1.10           | 3.30          | 1.53  |
| 2020M11 | 3.14   | 0.60  | 1.30    | -1.58 | 0.69  | 0.50  | 4.50        |                | 3.10          | 1.42  |
| 2020M12 |        | 0.62  | 1.37    | -0.68 | 0.75  | 0.80  | 4.50        |                | 3.10          | 1.39  |

# Disaster Index

- Individual indicators are very useful, but each one may not capture the entire effect of a phenomenon. Since all four indicators will be used in DI calculations, 56 countries with data on all four indicators available were included. Since the numbers have different units, standardizing makes them more comparable. The mean and standard deviation of indicators for 56 countries were then used to calculate standardized variables and the Index with equal weights (EWI).

# Disaster Index

- Principal components analysis for four indicators indicates that the first principal component explains 49 percent of the variance, and the second principal component explains 25.6 percent of the variance. First two components explain close to three quarters of total variance. Loadings indicate that the first principal component has a correlation of 0.64 with the deaths per hundred thousand population. The second principal component has the highest correlation with the increase in unemployment rate (0.83). The first principal component is to be used as the Index (PC1).

# Table 4 Principal Components Analysis- Loadings

| Eigenvectors (loadings):     |          |           |           |           |  |
|------------------------------|----------|-----------|-----------|-----------|--|
| Variable                     | PC 1     | PC 2      | PC 3      | PC 4      |  |
| S_CASE_FATALITY              | 0.544693 | -0.460624 | 0.352348  | 0.605794  |  |
| S_DEATHS_100KPOP             | 0.637678 | -0.141565 | 0.115690  | -0.748292 |  |
| S_REALGDPLOSS                | 0.482901 | 0.271890  | -0.798032 | 0.236700  |  |
| S_INCREASEINUNEMPLOYMENTRATE | 0.251956 | 0.832983  | 0.474986  | 0.130560  |  |



# Disaster Index

- The DI is a weighted average of the Index with Equal Weights (EWI) and the first principal component (PC1) of the group of four indicators. The weights are the reciprocal of standard deviations of EWI and PC1.
- $DI = (EWI/0.6845216733 + PC1/1.4129912355)/2$
- It is important to look again at countries that we had calculated DIs for during the first half of 2020. By studying recent trends, we can see if the country has improved performance or not since the end of first half of 2020.

*Table 5 Disaster Index for the first half of 2020*

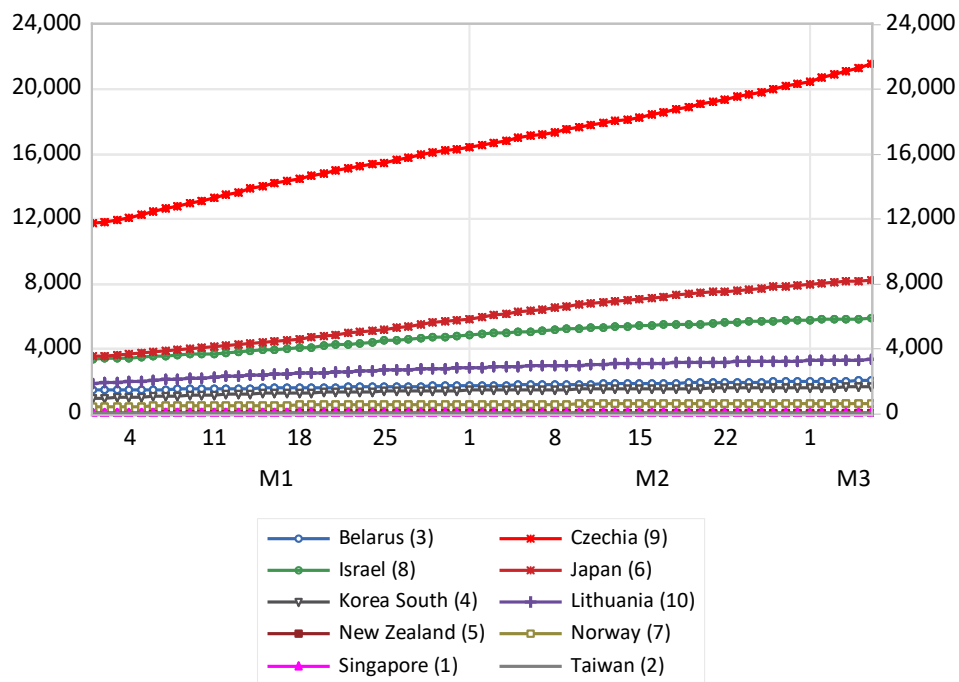
| Order | Country        | Disaster Index (DI) | Disaster Index (DI) (Rank) | Disaster Index (Cluster) |
|-------|----------------|---------------------|----------------------------|--------------------------|
| 1     | Argentina      | 0.6847              | 44                         | 4                        |
| 2     | Australia      | -0.6244             | 16                         | 2                        |
| 6     | Brazil         | 0.6442              | 43                         | 4                        |
| 9     | Chile          | 0.4964              | 42                         | 4                        |
| 10    | China          | -0.3906             | 26                         | 2                        |
| 21    | Germany        | -0.2634             | 30                         | 3                        |
| 28    | Japan          | -0.9479             | 6                          | 1                        |
| 29    | Korea, South   | -1.1645             | 4                          | 1                        |
| 38    | Peru           | 2.9267              | 56                         | 5                        |
| 39    | Philippines    | 1.0590              | 48                         | 4                        |
| 43    | Russia         | -0.6611             | 11                         | 2                        |
| 44    | Singapore      | -1.5380             | 1                          | 1                        |
| 51    | Taiwan         | -1.3779             | 2                          | 1                        |
| 53    | Turkey         | -0.5608             | 24                         | 2                        |
| 54    | United Kingdom | 2.0765              | 53                         | 5                        |
| 56    | United States  | 0.9551              | 46                         | 4                        |

# Disaster Index

- Figure 2 shows the 10 best performers based on the DI for the first half of 2020: Singapore (1), Taiwan (2), Belarus (3), Korea (4), New Zealand (5), Japan (6), Norway (7), Israel (8), Czechia (9), and Lithuania (10). Some countries were able to keep the level of performance. Some, on the other hand, could not. Most notably Czechia had a very steep trend in the number of deaths during the first months of 2021. Japan and Israel also had positive trends in the number of deaths, but not at the same rate as Czechia (Figure 2).

*Figure 2 Deaths in ten countries with lowest disaster index, 1/1/2021-3/6/2021*

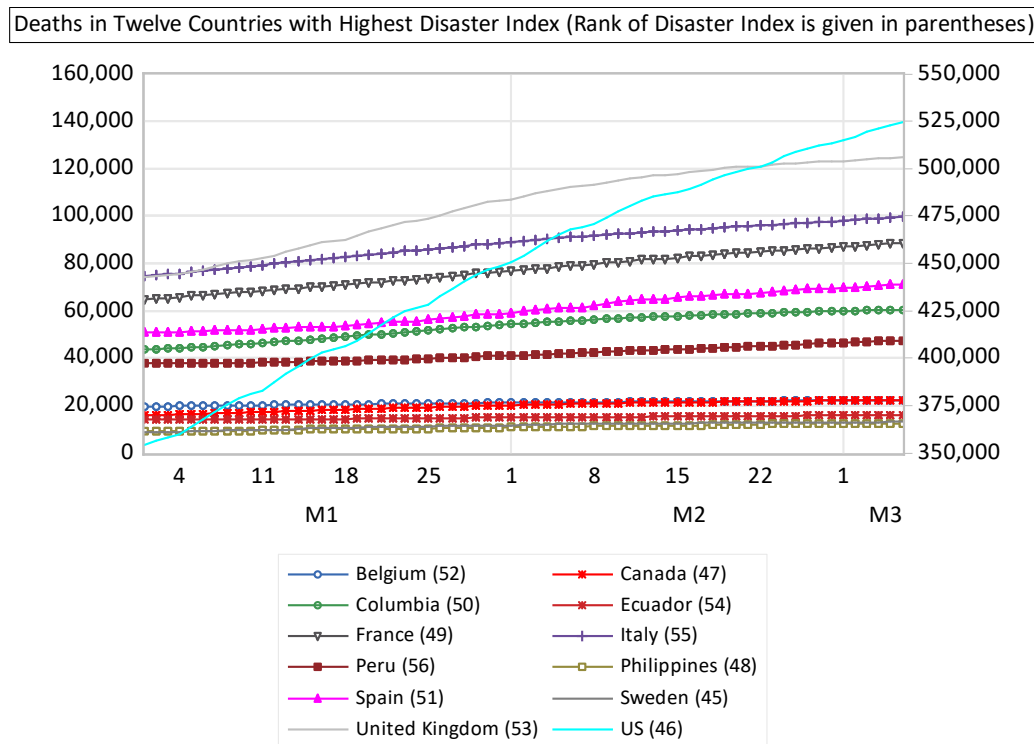
Deaths in Ten Countries with Lowest Disaster Index (Rank of Disaster Index is given in parentheses)



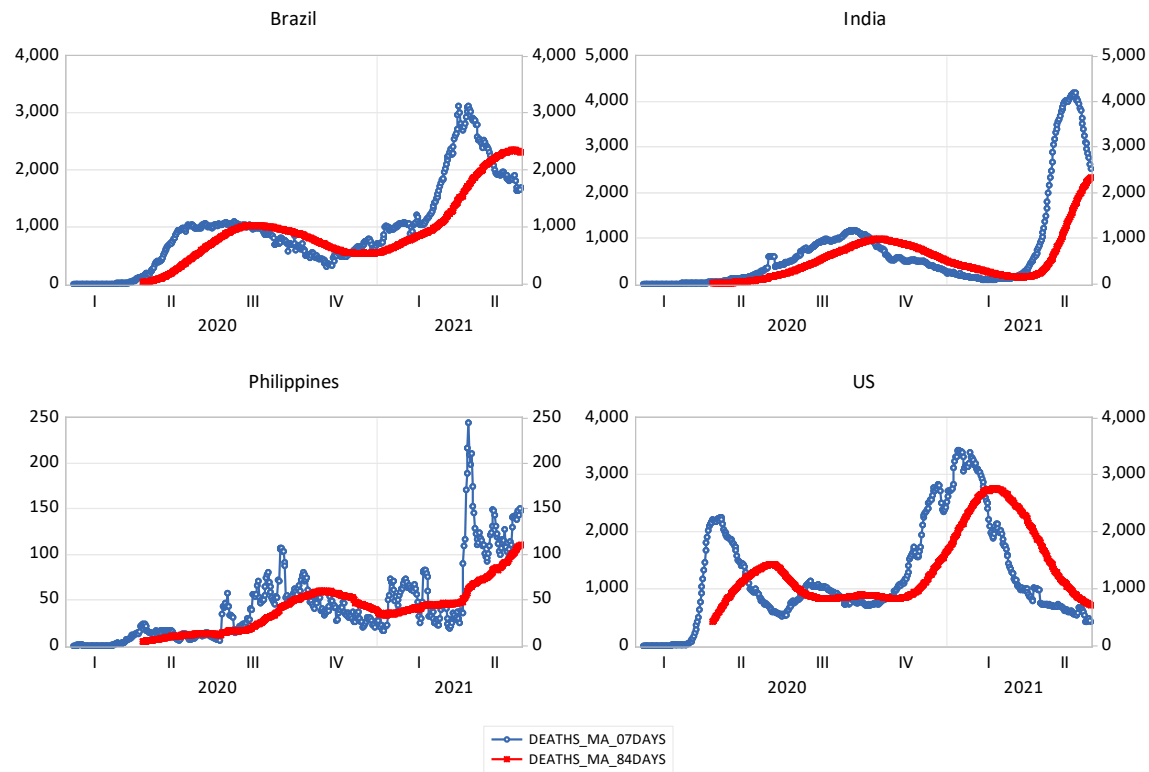
# Disaster Index

- On the other end of the spectrum, countries with the 12 highest DI figures were: Sweden (45), US (46), Canada (47), Philippines (48), France (49), Colombia (50), Spain (51), Belgium (52), United Kingdom (53), Ecuador (54), Italy (55), Peru (56). Instead of 10, 12 were chosen so that Sweden and the US could be on the list (Figure 3). The United States continued its upward trend and reached 525 thousand deaths (right scale) by March 8<sup>th</sup>. The United Kingdom also continued its upward trend and reached 125 thousand deaths (left scale with other countries except the US). Italy, Spain, France, and Colombia were the countries with positive trends, although not at the high rates of the United States and the United Kingdom.

Figure 3 Deaths in twelve countries with highest Disaster Index (US-right scale, other countries-left scale), 1/1/2021-3/6/2021



# Figure 4 Moving Average of Deaths in Selected Countries, 1/22/2020 - 6/9/2021



# Figure 5 Moving Average of Deaths in the Philippines, 1/1/2021 - 6/9/2021

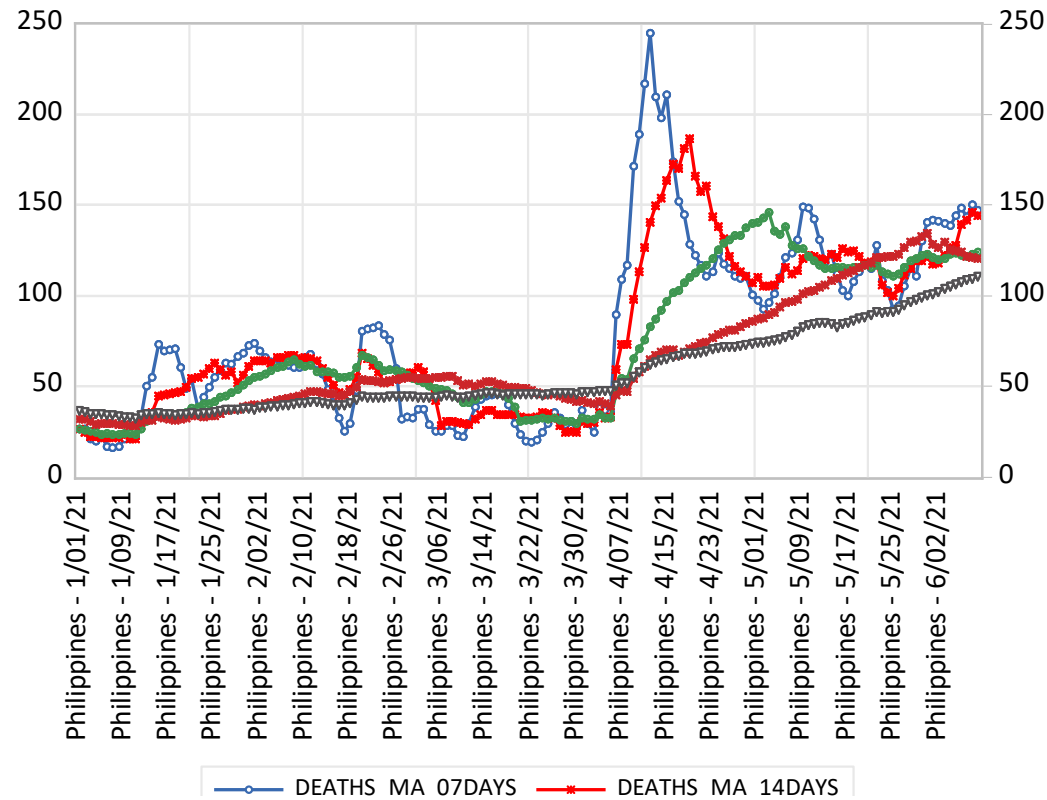
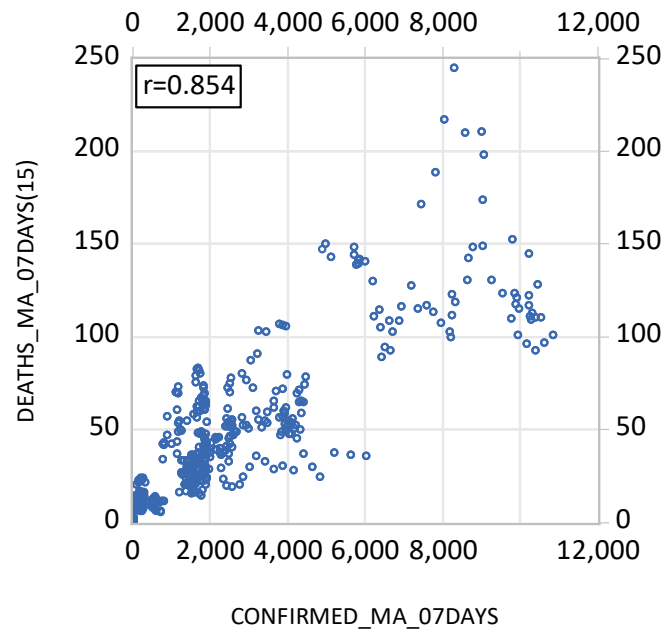




Figure 6 Number of Confirmed Cases and Deaths in the Philippines, 1/22/2020-6/9/2021

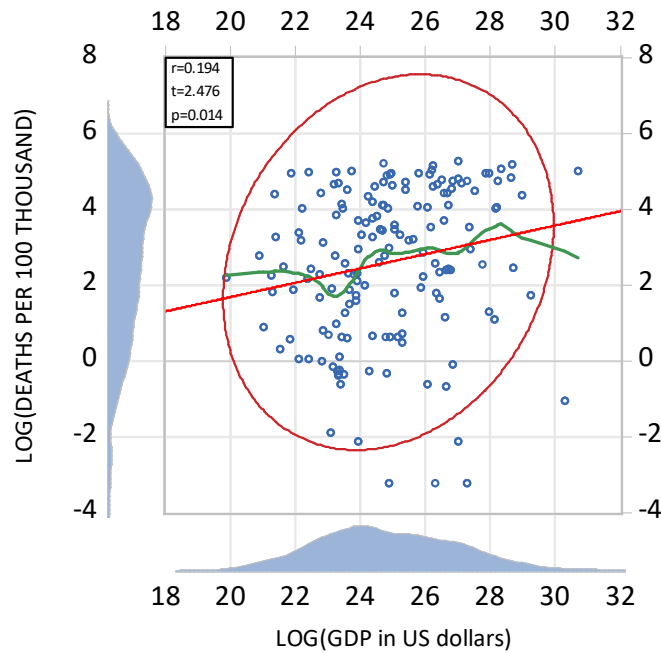


# Relationships

## Size of the economy (GDP in US Dollars)

- Is there a relationship between the size of the economy and the health and economic activity indicators? This can be studied with the help of figures, which may have four components:
- The kernel density for GDP in US dollars is given on the horizontal axis; and the kernel density for the deaths per 100 thousand is given on the vertical axis (Figure 7). Kernel densities help to see the distribution of individual variables. Both variables have large variances. Obviously, using logarithms reduced those variances significantly.

Figure 7 Size of the economy and deaths per hundred thousand



# Some complementary thoughts on the pandemic

- The fallacy of “lives lost and activity loss tradeoff”
- Pandemic and the relevance of budget deficit and domestic debt
- Pandemic and possible future outcomes
- Incredible numbness or a different indifference
- The danger of transition from intelligent social beings to thoughtless individualists
- Modeling issues – structural analysis, policy formulation, forecasting

# Modeling Issues

- Modeling issues require answers to some questions. Is this virus a temporary phenomenon or a permanent one? If it is a permanent phenomenon, there is need for a detailed sectoral breakdown of economic activity. Using real GDP as the only target variable may not be enough. Some sectors may not come back at all. Structural relationships such as the consumption function or investment function may be different from what they were before the pandemic. If it is a temporary phenomenon, what will be the duration of the pandemic? What will be the new relationships? Is it possible to use the old relationships after the end of the pandemic? Different answers to these questions will lead to different models. In the meantime, a historical average of the growth rate may be the best forecast for the average of the period over the next 3 or 5 years. Giving forecasts for individual periods may not be suggested until we have answers for all the questions posed here.

# Modeling Issues

- For the problem at hand, these suggest a sectoral model and not just a model for real GDP. A model that enables policy simulations may guide us for the appropriate policy to boost the activity if there are reasonably stable relationships.

# Modeling Issues

- Is there a need for a new modeling approach? The short answer is “yes”, for the simple reason that the world in 2021 is very different from the one in 1980, and models are supposed to be just simple representations of the real world. How should the model be different? The model should probably address globalization and rising uncertainty. Building such a model may be a challenge that we would like to tackle with no guarantee of success. The problem is like the one in data mining. Most internet data are based on non-random samples. The models may be based on non-random samples.

# Modeling Issues

- Is it useful to have additional surveys? Under periods of uncertainty, business and consumer surveys may be useful sources of information. They are generally released earlier; and they may be more informative about the possible behavior of consumers and producers. Is it worthwhile to talk to policy makers and decision makers in private sector and labor? Is it necessary to add some questions to (online) business and consumer surveys? These subjective views or expectations may be very helpful during a period when accurate hard data may be difficult to get.



# Modeling Issues

- Another important question that researchers should ask is: Is the appearance of COVID-19 really a random event, or an ignored or missed event, given earlier outbreaks: SARS, MERS, H1N1, Ebola, Swine flu? How many observations do we need to have some positive number in the empirical probabilities of such events? A regional climate model with appearance of a virus or bacteria may have predicted an outbreak or pandemic, maybe not the exact timing. Although, we think we know a lot about the world, we probably ignored the degree of interrelatedness. Did we miss an event because of lack of understanding of today's world? These questions have been asked. Hopefully, researchers will work on these and alleviate some of the pain in the future. The coordination of international community appears to be the key in all aspects of the issues we deal with.

# Concluding remarks

- This paper has provided an empirical evaluation of countries' performance in fighting COVID-19, utilizing a performance index (which we call the Disaster Index) based on four health and economic indicators: deaths per population size, share of deaths to confirmed cases, and quarterly real GDP and monthly unemployment rate relative to pre-pandemic values. International data patterns are studied for these four indicators and the DI to analyze trends and basic empirical relationships. The approach is descriptive and primarily based on graphs, scatter diagrams, and correlation analysis. The ten best performers based on the DI for the first half of 2020 were (best #1 to #10): Singapore, Taiwan, Belarus, Korea, New Zealand, Japan, Norway, Israel, Czechia, and Lithuania. The worst twelve performers, with highest DI, were (from bad to worst): Sweden, US, Canada, Philippines, France, Columbia, Spain, Belgium, United Kingdom, Ecuador, Italy, and Peru.

## Concluding remarks

- These results support the proposition that high-income Asian countries performed relatively better than low-income Asian countries, European, and American countries. Reasons for this geographical divide are very important and must be studied more carefully and closely, as successful methods in better performing countries will provide some lessons for other countries. It also would be interesting to see how this DI profile shifts in 2021 as vaccination and economic relief accelerate in countries like the United States.

## Concluding remarks

- Unfortunately, in absolute terms, countries were not very successful in coping with the virus, with close to three million deaths in the world in about a year despite enormous medical and technological achievements over the years and altruistic and heroic efforts of doctors, healthcare workers, first responders and other essential workers. Vaccination is a fresh hope, a potential game-changer, though requiring careful and painstaking implementation.

## Concluding remarks

- The virus is a reminder that national security really means the protection of citizens, whether it is from a visible military force or from an invisible enemy such as a virus, a disease, or a cyber-attack. In this century, peoples from all nations observed that more emphasis was given to the visible enemy; and with national and international cooperation and coordination some positive steps were taken with some success. A similar approach must be taken for all adversaries, not just visible, but also invisible ones such as viruses, bacteria, and cyber-attacks.

Thank you