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PIER Working Paper

21-015

Fighting COVID-19: Patterns in International Data, Expanded

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March 21, 2021

https://ssrn.com/abstract=3861714

Fighting COVID-19: Patterns in International Data, Expanded[1]

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March 21, 2021

Abstract

This paper 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 approach is descriptive and primarily based on graphs, scatter diagrams, and correlation analysis. The ten best performers based on the Disaster Index 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 were (bad to worst): Sweden, US, Canada, Philippines, France, Columbia, Spain, Belgium, United Kingdom, Ecuador, Italy, and Peru. Thus, high-income Asian countries performed relatively better than low-income Asian countries, European, and American countries in the first half of 2020. 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 Disaster Index profile shifts in 2021 as vaccination and economic relief accelerate in countries like the United States. The pandemic exhibited the vulnerabilities in the world and reemphasized the vital significance of international coordination and cooperation in a globalized world. Recent trends show that most countries still have a long way to go to control the virus. Vaccination is a reassuring fresh hope, a potential game-changer, though requiring careful, painstaking, and timely implementation.

Keywords: *COVID-19, Disaster Index, Data Patterns, Trends, Correlations, Cluster Analysis*
JEL Classification: C00, E00, F00, I1, O57

[1] This working paper serves as a an expanded version of our paper (with a similar title) to be published in the special memorial issue of the ***Philippine Review of Economics*** in honor of Dr. Benito J. Legarda, Jr. . The empirical analysis reported here was carried out in early March 2021, utilizing data available data up to the first week of March 2021, just as COVID-19 was upsurging once more. Recent developments since then could change the picture dramatically (for better or worse) in some countries – e.g., acceleration followed by slowdown in vaccination in the U.S., vaccines finally getting delivered in Africa and other countries like the Philippines, new COVID variants causing even more serious upsurge and deaths in India, and painfully slow vaccination program in Japan.

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1 Introduction

The pandemic exhibited the vulnerabilities in the world and reemphasized the vital significance of international coordination and cooperation in a globalized world (Asian Development Bank, 2020; European Commission, 2020; European Central Bank, 2020; Federal Reserve Board of Governors, 2020; Global Health Security, 2019; International Monetary Fund, 2020a, 2020b; OECD, 2020a, 2020b; United Nations, 2020; World Bank, 2020a, 2020b, 2021; see Mariano & Ozmucur for additional references).

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 confirmed cases is 2.21%. No country is immune to this virus. There is 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. Everyone must be vigilant all the time. One should remain alert and not let up. There is no other way around it. Vaccination is a fresh hope, a potential game-changer, though requiring careful and painstaking implementation. There are some areas not affected that much, yet. Necessary measures should be taken so that there are no new outbreaks.

In our earlier study (Mariano & Ozmucur, 2020) evaluating countries' performance in fighting a deadly virus, we introduced the Disaster Index (DI), based on four indicators: as health indicators – deaths per hundred thousand population and deaths per confirmed cases; and for economic activity, quarterly real GDP relative to fourth quarter of 2019 and unemployment rate relative to December 2019. In this paper, we take a closer look at the trends and basic empirical relationships that can be extracted from the observed data patterns. The approach is descriptive and primarily based on graphs, scatter diagrams and correlation analysis. There is no argument of causality, except the fact that all data considered are for an earlier year (most of them are for 2019, and some are for 2018) than target variables, which are for 2020.

The paper is organized as follows. Section 2 is devoted to trends in indicators and the Disaster Index. 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.

The ten best performers based on the Disaster Index 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 Disaster Index, were (bad to worst): Sweden, US, Canada, Philippines, France, Columbia, Spain, Belgium, United Kingdom, Ecuador, Italy, and Peru.

Thus, high-income Asian countries performed relatively better than low-income Asian countries, European, and American countries in 2020, first half. 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 Disaster Index profile shifts in 2021 as vaccination and economic relief accelerate in countries like the United States.

2 Trends in Selected Indicators and the Disaster Index

2.1 Deaths per Hundred Thousand and Deaths per Confirmed Cases

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 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 (see Mariano & Ozmucur (2020) for details). Maps for countries shows clusters for deaths per hundred thousand (Figure 1) and deaths per confirmed cases (Figure 2).

Cluster analysis is used to determine the natural groupings of observations. Stata has several algorithms for cluster analysis. In k-means, the number of groups (clusters), k, is determined in the beginning. Here, 5 clusters are chosen, analogous to letter grades in college. Each observation is assigned to the group whose mean is closest. Euclidean distance measure is used among several distance measures available. Using that, new group means are determined. The procedure continues until no observation changes groups. There are many ways to determine initial group means. Here, initial group centers are determined by k unique random observations.

The Philippines had about 550 thousand confirmed cases and about 11 thousand deaths by February 17, 2021 (Table 1). Deaths per hundred thousand population is 10.81 (rank of 76.5 out of 174) which puts the Philippines in the first cluster. On the other hand, deaths per confirmed cases is 2.09% (with rank=110, and cluster=2).

There are six countries with over a hundred thousand deaths by March 8, 2021. These countries are United States , Brazil, India, United Kingdom, Mexico, and Italy. There are 36 countries over ten thousand deaths (Figures 3, 4, 5, 6).

Since daily numbers have large fluctuations mostly because of recording, moving averages may be used. The European Centers for Disease Control and Prevention no longer releases daily numbers, but weekly numbers.

Seven day moving average at time t (D(t-6)+D(t-5)+D(t-4)+D(t-3)+D(t-2)+D(t-1)+D(t))/7 or the average of the weekly change (D(t)-D(t-7))/7 are two equivalent ways of obtaining a better measure. The former is used here. In addition to 7-day, 28-day (4 weeks), 56-day (8 weeks), and 84-day (12 weeks) moving averages are calculated to see general tendencies. A comparison may show whether the deaths number is decreasing or increasing. For example, in Brazil average daily rate is around 1600 week ending March 8th, compared with an average daily rate of about a thousand for the 84-week period ending March 8th. This is a very significant increase. On the other hand, India was able to reduce the number from 1200 to less than 200. Furthermore, India had a single peak in 2020. The United States had the highest daily death rates (over 3000) in 2020. The rate was reduced below 2000 in early March. The Philippines had not realized a steady decrease.

Most countries realized a second wave of deaths. After the initial surge in early 2020, countries took measures mostly in the form of lockdowns of schools, restaurants, and hotels. These measures

helped to reduce the number of deaths, but they did not last very long. Some countries relaxed and some completely abandoned which led to the second wave. Recently smaller numbers for the United States and the United Kingdom may be due to vaccinations. More observations are needed for firm conclusions.

2.2 Percentage Changes in Real GDP from the fourth Quarter of 2019

Real GDP at present is to be compared with real GDP at the end of 2019, before the widespread appearance of the coronavirus. Real GDP in 2020 may be compared with real GDP average of 2019, or fourth quarter of 2019. Here, the comparisons will be made with the fourth quarter of 2019. Data are obtained from the World Bank, Global Economic Monitor (GEM) database. All data are in 2010 US dollars, and seasonally adjusted. Real GDP is calculated as the percentage change from the value in 2019Q4 (the sum of the these may be considered as the real GDP loss as in Mariano & Ozmucur, 2020).

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 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.

2.3 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 in the first quarter and 12.3 in the second quarter from the fourth quarter of 2019.

2.4 Disaster Index and Recent Trends

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 Disaster Index calculations, 56 countries with data on all four indicators available were included (Table 4, see Mariano & Ozmucur (2020) for details). 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).

Principal components analysis for four indicators indicate that the first principal component explains 49% of the variance, and second principal component explain 25.6% 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).

The Disaster Index (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.

It is important to look again on countries that we had calculated Disaster Indexes for the first half of 2020, see Mariano and Ozmucur (2020). By studying recent trends, we can see if the country has improved performance or not since the end of first half of 2020.

Figure 7 shows the 10 best performers based on the Disaster Index 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, who had a very steep trend in the number of deaths during the first months of 2021. Japan and Israel also have positive trends in the number of deaths, but not at the same rate as Czechia.

On the other end of the spectrum, countries with 12 highest Disaster Index figures were: Sweden (45), US(46), Canada (47), Philippines (48), France (49), Columbia (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 can be on the list (Figure 8). The United States continued its upward trend and reaching 525 thousand deaths (right scale) by March 8th. 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 Columbia were the countries with positive trends, although not at the high rates of the United States and the United Kingdom.

2.5 Countries with Recent Trend Decreases

The pandemic has been with us for about a year. It may be informative to compare the most recent number of deaths figure available (March 10th, 2021) with annualized daily averages of death on the same day.

Annualized rates are calculated for 7-day, 28-day, 56-day, and 84-day moving averages of daily deaths figures by multiplying these averages by 365. These roughly correspond to a week, 4 weeks or a month, 8 weeks or 2 months, and 12 weeks or 3 months. If all four averages are below the cumulative deaths figure on March 10th. then the recent trend for the country is in the right direction. The rate of increase in total number of deaths may not increase at the rate the country realized during the past year. Obviously, as an alternative, one can just look at one of these moving averages. Since the situation can change very quickly as the experiences of many countries

showed, we wanted to be on the safe side and kept the multiple criteria options. Since there are 38 countries, these are grouped into two, deaths>1000 and deaths<=1000.

There are sixteen in the group with more than a thousand deaths, but improvements in recent month (Figure 9). Most notable members of this group are India and China. China had about 5 thousand deaths, mostly in 2019. Recent trend is near zero. India had a total death of about 160 thousand. On the other hand, recent trend is around an annual rate of 40 thousand, which still a very high number, but may be lower if recent decreases continue. Afghanistan, Algeria, Armenia, Bangladesh, Belgium, Ecuador, Iran, Iraq, Kazakhstan, Kenya, Kirghizstan, Morocco, Oman, and Saudi Arabia are other countries in the group, with varying degrees of improvements. However, trends of moving averages of deaths for 4 periods are all positive for Ecuador. This is troubling because it does not suggest an improvement. On the contrary, a deterioration of the situation. Further investigation reveals that there may be an issue with Ecuador data. Therefore, the result on Ecuador should be interpreted with caution.

There are 22 countries/entities with less than a thousand deaths by March 10th, 2021 and with quite favorable trends (Figure 10). Australia, Brunei, Central African Republic, New Zealand, Nicaragua, Singapore, Tajikistan, Tanzania, Uzbekistan, and Vietnam are some of these countries.

2.6 Countries with Recent Trend Increases

There are a lot more countries with recent trend increases (143 countries, Figures 11-19). It should be noted that if one the annualized 7-day, 28-day, 56-day, or 84-day moving averages is above the figure for the current cumulative death level (March 10th), then the country is stated as the one with an increase in trend. There are 12 countries with more than 50 thousand deaths (Figure 11). Among these countries Brazil, France, Mexico, Russia, and Spain has all four annualized moving averages above the current death level. Others, including Argentina, Columbia, Germany, Italy, South Africa, United Kingdom, and the US have one or more annualized moving averages below the current death level.

3 Relationships

3.1 Relationships with Selected Indicators

We look for the relationships between selected indicators and 4 variables that are used in the previous section. The list includes over a hundred indicators from the World Bank, Global Health Security, United Nations, and others. The comprehensive list includes variables related to GDP and its components, GDP per capita, surface area, population, health, environment, inequality and poverty, economic and social structure. Here only a few examples with the relationship of death

per hundred thousand and selected indicators are presented. It should be stressed that there is no argument made on causality, but just the correlation.

3.1.1 Size of the Economy (GDP in US Dollars)

Is there a relationship with the size of the economy and 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 20). Kernel densities help to see the distribution of individual variables. Both variables have large variances. Obviously, using logarithms reduced those variances significantly,

The scatter diagram has points for pairs of variables under consideration. The scatter diagram of 159 pairs of observations show general tendencies, but in some cases may not be enough to see the degree and direction of the relationship.

The estimated regression line, nearest neighbor fit and 95% confidence ellipse play supporting roles for the direction and to a certain extent degree of the relationship. The regression line shows the linear association between the two variables. It is possible to see that estimated relationship has a positive slope. Nearest neighbor fit also indicate a positive fit, with some negative relationship at certain intervals of GDP. Outliers can easily be seen by points outside the 95% confidence ellipse.

The simple correlation coefficient, t-statistics and the p-value are given in a box. For example, correlation between logarithms of GDP in US dollars and the death per hundred thousand is 0.194. Although this may seem like a small figure, with 159 observations the correlation is significant at the five percent level. One can conclude at the 95% level of confidence that the correlation is statistically different from zero. In summary, death rate is generally higher in larger economies.

3.1.2 Surface Area

If the size of the economy is measured by its surface area, one finds a negative correlation (Figure 21). The correlation between logarithms of surface area and the death per hundred thousand is negative 0.13. It is not statistically significant at the five percent, but only at the ten percent. If the surface area is larger, death rate is generally lower. The effect is discernable at the 90% confidence level, but not at the 95% level.

3.1.3 Population

If the size of the economy is measured by its population, one finds a negative correlation as in the surface area (Figure 22). The correlation between logarithms of surface area and the death per hundred thousand is negative 0.16. It is statistically significant at the five percent (has a p-value of 0.038). If the population is larger, death rate is generally lower. The relationship is statistically significant at the 95% level.

3.1.4 Share of Older Population

A relatively high positive correlation is obtained between the share of population ages 65 and above and the death per hundred thousand (Figure 23). The correlation is 0.555, which is significant at the one percent level (p-value is very close to zero). This is the reason that people ages 65 and above are considered among the highest risk groups.

3.1.5 Share of Urban Population

Another variable with a high positive correlation with the death per hundred thousand is the share of urban population (Figure 24). The correlation is 0.465, which is also significant at the one percent level (p-value is very close to zero).

3.1.6 Global Health Security Index

The Global Health Security (2019) in which the United States was cited as the best prepared, but with a stark warning that no country is fully prepared for epidemics or pandemics and collectively, international preparedness is weak. The study also reports that the average score for all 195 countries was only 40.2 out of 100 (GHS, 2019, pp. 39). On the other hand, our calculations show that the correlation between the Global Health Security Index and deaths per hundred thousand indicators is positive (0.414) and statistically significant at the one percent level (Figure 25). This leads to the conclusion that if the Index is correctly measured and calculated death rates given here are accurate, then European, and North American countries, which have relatively high GHS Index scores, performed much worse than the rest.

3.1.7 Share of Exports of Goods and Services in GDP

Because of its devastating effects on some sectors, we look for the relationship with those sectors, also (Figure 26). The correlation between the share of exports of goods and services in GDP and death per hundred thousand is positive (0.172) and statistically significant at the ten percent level.

3.1.8 Tourism Revenues

Another variable with a high positive correlation with the death per hundred thousand is international tourism receipts in US dollars (Figure 27). The correlation is 0.270, which is significant at the one percent level (p-value is 0.001).

3.2 Confirmed Cases and Deaths

What is the relationship between deaths and confirmed cases? What is the lead/lag between the two? If there is a relatively stable relationship between the two, then that may help researchers to forecast deaths using confirmed cases. It should be noted that this data is at the aggregate level. A better approach may be to use individual level data, which is released by the Centers for Disease Control and Prevention, to determine the relationship.

3.2.1 Line Graphs and Scatter Diagrams With Lagged Variables

Line graphs for confirmed cases with a lags and deaths may be used to see the lead/lag relationship between the two. Here, an example with 20 lags is given (Figure 28). For some countries, like Bulgaria, France, Italy and Hungary, Poland, and the US this may be a reasoble starting point. For some others, like India, Mexico and Pakistan a shorter lag may be more appropriate. A comparison of the peaks of two variables is enough to see this. Obviously, this is just the starting point. More tests have to be done to determine the appropriate lag. Scatter diagrams may show a similar result (Figure 29).

3.2.2 Scatter Diagrams and Patterns in Different Periods

Scatter diagrams may be useful to see the relationship between confirmed cases with different lags and deaths (Figure 30). The correlation with deaths for the 10, 15, 20 and 25 lags of confirmed cases are all significant at the one percent level. The figures give pairs of deaths and confirmed cases. These relationships follow a pattern. Starting at the origin, and deaths in relation to confirmed cases went up rather fast, and with lockdowns came down almost as fast, and then moved up and then slowly came down, resembling an ellipse. These show that the relationship may require more than one coefficient (higher for early days of the pandemic).

Scatter diagrams also include a linear least squares fit, as well as two lines starting from the origin, and with slopes of 0.01 and 0.02, for comparison purposes. The regression line has a slope closer to 0.01, and has a positive intercept.

4 Some Complementary Thoughts on the Pandemic

Some additional thoughts primarily based on Mariano & Ozmucur(2020) are presented in this section. Some of these points may seem trivial but events that have taken place warrant reiterating these precautionary observations.

4.1 The Fallacy of "Lives Lost and Activity Loss Tradeoff"

Is the economy an alternative to health? The answer is "No". The "health or economy" choice put in front of the people is not the right one. Those are not competitive, but complementary. Public authorities should give guidance and financial support, and not just let the public find a solution for themselves. It is the duty of the authorities to provide both health and economy to the public during a pandemic. Under normal times, that may not be required, and people in general may not demand those, but during a pandemic, authorities should provide those. Here are some of the reasons. A pandemic moves faster if healthcare is not provided to every single one in a society, in this case in the world. If a government asks a company to close its doors because of a pandemic, and not because of a misbehavior of the company, is it fair for that company to bear the full burden of that closure? If the answer is no, which is what common sense tells us, then a government should cover some of the burden to alleviate the pain. The government will cover the cost now, preferably by direct payments to citizens, and then collect taxes when the economy bounces back. This should not even be an issue for advanced economies, but it may be difficult for developing or emerging economies.

Preliminary findings show that health and economy are not competitive (with a negative correlation). On the contrary, they are complementary as indicated by positive correlation coefficients. The correlation between deaths per hundred thousand population and real GDP loss is 0.42. On the other hand, the correlation with deaths per confirmed cases and real GDP loss is 0.25. This is lower, but also statistically significantly different from zero at the five percent level. The correlations between health indicators and the increase in unemployment rate are not statistically significantly different from zero, but estimated coefficients are not negative, that is suggesting no trade-off.

4.2 Pandemic and the Relevancy of Budget Deficit and Domestic Debt

The pandemic forced every government to take extra measures for the welfare of the people. High rate of unemployment forced governments to increase its expenditures and exerted extra pressures on budgets. On the other hand, lower incomes reduced tax revenues for governments, leading to greater deficits. This situation is very common in recessions and downturns, and much amplified during a pandemic. Concepts like "the full employment budget deficit" were introduced for situations like these. Policy makers follow budget deficits closely, but adjustments must be made for the position of the economy in a cycle. It is important to keep in mind the level of full employment budget deficit.

Government debt will increase with higher deficits. Governments will issue bonds to cover increased deficit. In the United States, most of the buyers are the citizens. Government is borrowing money from its own citizens. This may not create a large problem because governments most likely will get those back with higher taxes in the future. What is needed is funds to ease the pain of the people, now. Tomorrow may be too late for the problem.

The deficit and debt will be taken care of later. Now, it is the time to save the patient. Extra weight of the patient is not the most important problem at hand, but the life of the patient is. Take care of the urgent problem, now; and take care of the less urgent problem later. This simple logic should govern the minds and hearts of policy makers. Otherwise, the world be in more trouble. But subsequent downstream problems must be anticipated and prepared for.

4.3 Pandemic and Possible Future Outcomes

What is expected to happen in the "post-globalization" or "New World"?

There are probably two clear extremes and maybe many possibilities in between these two extremes. The first possibility, but maybe not the most likely, is a world with greater cooperation and coordination among countries. The second possibility, and maybe a more likely outcome, is moving towards a complete isolationist approach leading to countries aiming self-sufficiency.

In any case, most important requirement is a very close and complex international cooperation and coordination in every conceivable field for the good of the world population. Whether this will be realized or not mostly depends on the existence of leaders with vision. Without a sound leadership, the world population may have a very long struggle ahead of them.

It is clear for any economist that in a pandemic if there is only one agent who is standing, that agent is expected to help the others. That is the only way out of a depression or recession. During this pandemic of 2020, the world sees a drop in consumer expenditures because of lack of income and rising unemployment, poverty, and uncertainty. Most business are closed because of mandatory lockdowns, lack of demand and greater uncertainty. Since, all countries are affected by the pandemic, there is lack of demand from foreign countries. In terms of Keynesian categories, GDP=C + I + G + X - M, C- private consumption, I – private investment, G- government expenditures (current and investment), X-exports of goods and services, M-imports of goods and services, C, I and (X-M) are all lower since the beginning of the pandemic. To bring GDP back to its previous level, government expenditures (G) should increase. This increase is expected by the people. It is also expected that this should be in the form of an income like universal basic income for the people, not a loan with a low interest.

Unfortunately, not all countries can respond to that expectation because they were already in a vulnerable position even before the pandemic. Even more troubling is, some countries fail to see this need of necessary expansion of government expenditures. Until this is realized, people will continue to suffer. There are also longer-term effects that international organizations are concerned. If schools are closed for a long period of time, the proportion of well-educated people may decrease which will have significant adverse effects on growth prospects of all the countries. This lack of schooling will also perpetuate poverty and inequality.

None of these issues stated here can be solved by the private sector or shrewd entrepreneurs in broken systems or markets with frictions. These problems can only be solved with capable leaders, sound public policies and a very solid foundation of national and international cooperation and coordination. Rulers and public authorities are expected to deliver these to be considered as "true leaders".

Monetary authorities all over the world have been acting swiftly and surely during this crisis. Unfortunately, monetary policy cannot be effective without a firm and determined fiscal policy and incomes policy during a period of uncertainty and insufficient aggregate demand. It is up to governments to start these policies to fight a virus. Unfortunately, security issue is just seen as a military issue. It is necessary to see the security issue as the protection of the people, whether an assault comes from a visible enemy or an invisible virus. The world population seem to have a long way to go.

4.4 Incredible Numbness or A Different Indifference

There are close to three million deaths globally (2,593,222 on March 8th, with about 117 million confirmed cases), according to Johns Hopkins University Coronavirus Resource Center (Coronavirus COVID-19 (2019-nCoV) (arcgis.com). Access date: March 8, 2021). The reason for incredible numbness may be because people do not see patients fighting for their lives, and the dead who were buried without loved ones. This may be part of a more general disturbing trend which may be described in a few sentences: "This is not on TV or on social media. Therefore, it is not actually happening. Social media is the real world. The real world is somehow irrelevant until it hits the person." It does not mean it does not exist if you do not see it. This is true for all the virus, bacteria, etc. that you can only see under a microscope.

The world needs an all out war against the virus by the rulers and by all the peoples. The remarkable efforts of some leaders, governors, public authorities, doctors, healthcare workers, first responders and essential workers may not be enough for this fight.

4.5 The Danger of Transition From Intelligent Social Beings to Thoughtless Individualists

Some people talk about freedom, but they do not seem to know much about freedom. The concept of freedom cannot be taken as lightly as just wearing masks and not wearing them. One's freedom stops when it hurts the freedom of the next person. This is the case in a pandemic. One cannot behave as if there is no deadly virus. The virus may not hurt a person, but that person should behave as if the virus can hurt him/her because it can hurt a relative, neighbor, an office mate, or a stranger in a bus. In time, people seemed to turn from an intelligent social being into a thoughtless individualistic person. Heavy reliance on computers, cell phones and social media may have something to do with this disturbing trend. This cannot be good.

The best examples of rules may be seen in traffic and games. There are universal rules in traffic set for the good of all the people. Those rules reduce the number of accidents and fatalities. One is free to drive anywhere provided traffic rules are obeyed. In general, people follow those rules. Same, if not more, is expected during a pandemic. If scientists suggest wearing masks, social distancing, and hygiene, it is best for all in the world if everyone follows those suggestions. This is more like following a traffic rule than fighting for personal freedom.

There are rules in every game, football, basketball, etc. One must follow those rules; and stop making his/her own rules. There is a simple reason for that. All those rules were made for the benefit of all the players after many years of experience. Players follow those rules even if they do not necessarily like them because it is for the benefit of a larger number of people than one. These

are like rules during a pandemic. It helps everyone to follow those rules because people live in a society.

4.6 Modeling Issues – Structural Analysis, Policy Formulation, Forecasting

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 than 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 of next 3 or 5 years. Giving forecasts for individual periods may not be suggested until we have answers for all the questions posed here.

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.

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 than 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.

Is it possible to have additional surveys? Under periods of uncertainty, business and consumer surveys may be useful source of information. They are generally released earlier; and they may be more informative about the possible behavior of consumers and producers. Is it possible to talk to policy makers and decision makers in private sector and labor? Is it possible 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.

Another important question that researchers should ask is: Is appearance of COVID-19 really a random event? or an ignored or missed event, given earlier outbreaks? SARS, MERS, H1N1, Ebola, Swine flu, etc. 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 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.

5 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, 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 approach is descriptive and primarily based on graphs, scatter diagrams, and correlation analysis. The ten best performers based on the Disaster Index 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 Disaster Index, were (bad to worst): Sweden, US, Canada, Philippines, France, Columbia, Spain, Belgium, United Kingdom, Ecuador, Italy, and Peru.

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 Disaster Index profile shifts in 2021 as vaccination and economic relief accelerate in countries like the United States.

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 our courageous doctors, healthcare workers, first responders and other essential workers. Vaccination is a fresh hope, a potential game-changer, though requiring careful and painstaking implementation.

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.

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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
1	Afghanistan	55,518	2,428	6.53	1	60	4.37	3	166
2	Albania	94,651	1,582	55.19	2	119	1.67	2	81
3	Algeria	111,069	2,945	6.97	1	63	2.65	2	135
4	Andorra	10,555	107	138.95	5	159	1.01	1	34
5	Angola	20,389	494	1.60	1	28	2.42	2	124
6	Antigua and Barbuda	443	9	9.35	1	69	2.03	2	105
7	Argentina	2,033,060	50,432	113.34	4	149	2.48	2	127
8	Armenia	169,391	3,150	106.72	4	145	1.86	2	93
9	Australia	28,911	909	3.64	1	47	3.14	3	146
10	Austria	436,139	8,260	93.36	3	139	1.89	2	96
11	Azerbaijan	232,337	3,185	32.03	2	105	1.37	1	62
12	Bahamas	8,383	179	46.42	2	115	2.14	2	112
13	Bahrain	114,361	410	26.12	2	99	0.36	1	7
14	Bangladesh	541,434	8,298	5.14	1	51	1.53	1	75
15	Barbados	2,331	25	8.72	1	66	1.07	1	39
16	Belarus	270,921	1,867	19.68	1	93	0.69	1	20
17	Belgium	741,205	21,750	190.42	5	173	2.93	3	141
18	Belize	12,188	313	81.71	3	132	2.57	2	132
19	Benin	5,039	62	0.54	1	11	1.23	1	51
20	Bolivia	237,706	11,274	99.30	4	140	4.74	3	167
21	Bosnia and Herzegovina	126,413	4,935	148.47	5	166	3.90	3	159
22	Botswana	25,802	226	10.03	1	73	0.88	1	26
23	Brazil	9,921,981	240,940	115.02	4	150	2.43	2	125
24	Brunei	184	3	0.70	1	13.5	1.63	2	79
25	Bulgaria	232,096	9,703	138.14	5	158	4.18	3	164
26	Burkina Faso	11,630	138	0.70	1	13.5	1.19	1	48
27	Myanmar	141,659	3,192	5.94	1	58	2.25	2	118
28	Cabo Verde	14,785	140	25.75	2	98	0.95	1	29
29	Cameroon	32,098	479	1.90	1	35	1.49	1	71

30	Canada	836,594	21,395	57.73	2	122	2.56	2	131
31	Central African Republic	4,996	63	1.35	1	27	1.26	1	54
32	Chad	3,689	131	0.85	1	20	3.55	3	152
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
35	Colombia	2,202,598	57,949	116.72	4	152	2.63	2	134
36	Comoros	3,393	133	15.98	1	88	3.92	3	160
37	Republic of the Congo	24,423	695	13.25	1	86	2.85	2	139
38	Democratic Republic of the Congo	8,419	123	0.15	1	7	1.46	1	68
39	Costa Rica	200,454	2,737	54.75	2	117	1.37	1	61
40	Côte d'Ivoire	31,365	179	0.71	1	15	0.57	1	15
41	Croatia	237,999	5,357	131.00	4	155	2.25	2	117
42	Cuba	39,941	274	2.42	1	40	0.69	1	18
43	Cyprus	32,707	225	18.92	1	91	0.69	1	19
44	Czechia	1,099,654	18,430	173.45	5	170	1.68	2	82
45	Denmark	205,871	2,309	39.83	2	110	1.12	1	44
46	Djibouti	5,981	63	6.57	1	61	1.05	1	36
47	Dominican Republic	231,095	2,975	27.99	2	101	1.29	1	57
48	Ecuador	268,073	15,392	90.09	3	137	5.74	4	169
49	Egypt	175,059	10,101	10.26	1	74	5.77	4	170
50	El Salvador	58,023	1,758	27.38	2	100	3.03	3	142
51	Equatorial Guinea	5,694	87	6.65	1	62	1.53	1	74
52	Estonia	53,444	508	38.46	2	109	0.95	1	30
53	Eswatini	16,606	634	55.80	2	120	3.82	3	157
54	Ethiopia	148,490	2,223	2.04	1	37	1.50	1	72
55	Finland	51,047	720	13.05	1	85	1.41	1	65
56	France	3,548,452	82,961	123.85	4	154	2.34	2	120
57	Gabon	12,865	75	3.54	1	46	0.58	1	16
58	Gambia	4,469	138	6.05	1	59	3.09	3	145
59	Georgia	266,462	3,377	90.51	3	138	1.27	1	55
60	Germany	2,352,766	65,829	79.38	3	131	2.80	2	138

61	Ghana	77,046	555	1.86	1	31	0.72	1	21
62	Greece	173,905	6,181	57.62	2	121	3.55	3	154
63	Guatemala	168,103	6,158	35.70	2	108	3.66	3	156
64	Guinea	15,020	85	0.68	1	12	0.57	1	14
65	Guinea-Bissau	2,950	46	2.45	1	41	1.56	2	76
66	Guyana	8,262	188	24.13	1	96	2.28	2	119
67	Haiti	12,192	247	2.22	1	39	2.03	2	103
68	Honduras	161,727	3,913	40.81	2	111	2.42	2	123
69	Hungary	389,622	13,837	141.65	5	163	3.55	3	153
70	Iceland	6,039	29	8.20	1	65	0.48	1	10
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
73	Iran	1,534,034	59,117	72.27	3	129	3.85	3	158
74	Iraq	649,982	13,192	34.32	2	107	2.03	2	104
75	Ireland	211,113	3,980	82.00	3	133	1.89	2	94
76	Israel	734,575	5,441	61.25	2	126	0.74	1	22
77	Italy	2,739,591	94,171	155.83	5	169	3.44	3	150
78	Jamaica	19,773	378	12.88	1	84	1.91	2	97
79	Japan	418,435	7,139	5.64	1	55	1.71	2	85
80	Jordan	352,219	4,491	45.11	2	114	1.28	1	56
81	Kazakhstan	252,821	3,144	17.20	1	90	1.24	1	52
82	Kenya	103,188	1,797	3.50	1	45	1.74	2	87
83	South Korea	84,946	1,538	2.98	1	43	1.81	2	92
84	Kosovo	64,868	1,548	83.89	3	135	2.39	2	121
85	Kuwait	179,488	1,014	24.51	1	97	0.56	1	13
86	Kyrgyzstan	85,564	1,444	22.86	1	94	1.69	2	83
87	Latvia	77,697	1,486	77.13	3	130	1.91	2	98
88	Lebanon	343,601	4,092	59.75	2	124	1.19	1	49
89	Lesotho	10,350	254	12.05	1	81	2.45	2	126
90	Liberia	1,985	85	1.76	1	29	4.28	3	165
91	Libya	128,036	2,051	30.71	2	103	1.60	2	77
92	Lithuania	191,264	3,095	110.95	4	147	1.62	2	78

93	Luxembourg	53,062	612	100.70	4	142	1.15	1	46
94	Madagascar	19,598	292	1.11	1	26	1.49	1	70
95	Malawi	29,421	968	5.34	1	52	3.29	3	148
96	Malaysia	269,165	983	3.12	1	44	0.37	1	8
97	Maldives	18,082	58	11.25	1	79	0.32	1	5
98	Mali	8,241	342	1.79	1	30	4.15	3	163
99	Malta	20,047	297	61.42	2	127	1.48	1	69
100	Mauritania	17,016	431	9.79	1	70.5	2.53	2	129
101	Mauritius	603	10	0.79	1	19	1.66	2	80
102	Mexico	2,004,575	175,986	139.46	5	160	8.78	4	173
103	Moldova	171,514	3,678	103.73	4	143	2.14	2	113
104	Montenegro	69,770	910	146.22	5	165	1.30	1	58
105	Morocco	479,071	8,504	23.60	1	95	1.78	2	89
106	Mozambique	51,800	551	1.87	1	32	1.06	1	38
107	Namibia	36,366	392	16.01	1	89	1.08	1	40
108	Nepal	272,945	2,055	7.32	1	64	0.75	1	23
109	Netherlands	1,049,120	15,050	87.34	3	136	1.43	1	67
110	New Zealand	2,340	26	0.53	1	10	1.11	1	42
111	Nicaragua	6,398	172	2.66	1	42	2.69	2	136
112	Niger	4,706	169	0.75	1	17	3.59	3	155
113	Nigeria	148,296	1,777	0.91	1	21	1.20	1	50
114	North Macedonia	97,456	3,003	144.17	5	164	3.08	3	144
115	Norway	67,140	593	11.16	1	78	0.88	1	27
116	Oman	137,929	1,544	31.97	2	104	1.12	1	43
117	Pakistan	565,989	12,436	5.86	1	57	2.20	2	116
118	Panama	333,251	5,655	135.39	5	156	1.70	2	84
119	Papua New Guinea	955	10	0.12	1	5.5	1.05	1	35
120	Paraguay	146,216	2,971	42.71	2	113	2.03	2	106
121	Peru	1,238,501	43,880	137.17	5	157	3.54	3	151
122	Philippines	552,246	11,524	10.81	1	76.5	2.09	2	110
123	Poland	1,596,673	41,028	108.03	4	146	2.57	2	133
124	Portugal	788,561	15,522	150.97	5	168	1.97	2	101

125	Qatar	158,138	256	9.20	1	68	0.16	1	3
126	Romania	765,970	19,526	100.27	4	141	2.55	2	130
127	Russia	4,053,535	79,659	55.14	2	118	1.97	2	100
128	Rwanda	17,594	240	1.95	1	36	1.36	1	60
129	San Marino	3,352	72	213.11	5	174	2.15	2	114
130	Sao Tome and Principe	1,520	19	9.00	1	67	1.25	1	53
131	Saudi Arabia	373,368	6,441	19.11	1	92	1.73	2	86
132	Senegal	31,476	760	4.79	1	50	2.41	2	122
133	Serbia	424,020	4,261	61.03	2	125	1.00	1	33
134	Sierra Leone	3,825	79	1.03	1	23.5	2.07	2	107
135	Singapore	59,810	29	0.51	1	9	0.05	1	1
136	Slovakia	279,696	6,063	111.31	4	148	2.17	2	115
137	Slovenia	180,520	3,733	180.57	5	172	2.07	2	108
138	Somalia	5,373	163	1.09	1	25	3.03	3	143
139	South Africa	1,494,119	48,313	83.62	3	134	3.23	3	147
140	South Sudan	5,710	79	0.72	1	16	1.38	1	64
141	Spain	3,096,343	65,979	141.21	5	162	2.13	2	111
142	Sri Lanka	77,184	409	1.89	1	33.5	0.53	1	12
143	Sudan	30,052	1,863	4.46	1	48	6.20	4	171
144	Suriname	8,820	167	28.99	2	102	1.89	2	95
145	Sweden	617,869	12,487	122.62	4	153	2.02	2	102
146	Switzerland	544,282	9,817	115.27	4	151	1.80	2	91
147	Syria	14,951	984	5.82	1	56	6.58	4	172
148	Taiwan	937	9	0.04	1	3	0.96	1	31
149	Tajikistan	13,308	90	0.99	1	22	0.68	1	17
150	Tanzania	509	21	0.04	1	3	4.13	3	162
151	Thailand	24,786	82	0.12	1	5.5	0.33	1	6
152	Togo	5,953	81	1.03	1	23.5	1.36	1	59
153	Trinidad and Tobago	7,656	138	9.93	1	72	1.80	2	90
154	Tunisia	224,329	7,617	65.86	3	128	3.40	3	149
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

157	Uganda	40,063	331	0.77	1	18	0.83	1	25
158	Ukraine	1,322,406	25,862	57.96	2	123	1.96	2	99
159	United Arab Emirates	355,131	1,041	10.81	1	76.5	0.29	1	4
160	United Kingdom	4,070,332	118,421	178.11	5	171	2.91	3	140
161	Uruguay	49,725	546	15.83	1	87	1.10	1	41
162	Uzbekistan	79,461	622	1.89	1	33.5	0.78	1	24
163	Venezuela	133,927	1,292	4.48	1	49	0.96	1	32
164	Vietnam	2,311	35	0.04	1	3	1.51	1	73
165	West Bank and Gaza	169,487	1,942	42.50	2	112	1.15	1	45
166	Yemen	2,148	618	2.17	1	38	28.77	5	174
167	Zambia	70,823	974	5.61	1	54	1.38	1	63
168	Zimbabwe	35,315	1,414	9.79	1	70.5	4.00	3	161
169	Burundi	1,855	3	0.03	1	1	0.16	1	2
170	Liechtenstein	2,540	53	139.80	5	161	2.09	2	109
171	Monaco	1,787	21	54.29	2	116	1.18	1	47
172	Saint Lucia	2,549	23	12.65	1	83	0.90	1	28
173	Saint Vincent and the Grenadines	1,457	6	5.44	1	53	0.41	1	9
174	Seychelles	2,058	10	10.33	1	75	0.49	1	11
	World	109,502,318	2,418,776	31.23	2	104	2.21	2	117

Source: Data on confirmed, deaths, deaths per 100 thousand population and case fatality are obtained from Johns Hopkins University Coronavirus Resource Center. Mortality Analyses - Johns Hopkins Coronavirus Resource Center (jhu.edu). Updated on Wednesday, February 17, 2021 at 06:50 EST. Access date: February 18, 2021.

Clusters and Ranks: Authors calculations. Microsoft Excel is used for ranks and Stata is used for Cluster analysis. Note: Raw figures for the World are not included in calculations. Rank and cluster for the World is determined by closest country figures.

Table 2 GDP in 2010 US Dollars: Percentage Change from the Fourth Quarter of 2019

	BRAZIL	CHINA	GERMANY	ITALY	JAPAN	KOREA	PHILIPPINES	UNITED KINGDOM	UNITED 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

Source: Authors calculations using the World Bank, World Economic Monitor (GEM) database. Global Economic Monitor (GEM) | Data Catalog (worldbank.org) Access date: February 24, 2021.

Table 3 The Rate of Unemployment: Difference from December 2019

	BRAZIL	CHINA	GERMANY	ITALY	JAPAN	KOREA	PHILIPPINES	UNITED KINGDOM	UNITED STATES	WORLD
2019M01	0.69	0.05	0.10	0.69	0.20	0.60	0.30	0.00	0.40	0.19
2019M02	0.65	0.07	-0.28	1.05	0.17	0.10	0.30	-0.10	0.20	0.15
2019M03	0.50	0.05	0.17	0.43	0.23	0.10	0.30	-0.10	0.20	0.13
2019M04	0.41	0.02	-0.19	0.65	0.22	0.30	0.10	-0.10	0.10	0.07
2019M05	0.37	0.01	-0.20	0.55	0.12	0.10	0.10	0.00	0.10	0.05
2019M06	0.27	-0.01	-0.28	-0.10	0.08	0.20	0.10	-0.10	0.00	0.00
2019M07	0.15	-0.02	-0.14	0.27	0.07	0.20	0.40	0.00	0.00	0.02
2019M08	0.22	-0.03	-0.12	0.01	0.04	-0.50	0.40	-0.10	0.10	0.03
2019M09	0.32	-0.03	-0.16	0.11	0.14	-0.20	0.40	-0.10	-0.10	0.03
2019M10	0.34	-0.02	-0.17	-0.24	0.14	-0.20	0.00	-0.10	0.00	0.03
2019M11	0.12	-0.02	-0.06	-0.27	0.06	0.00	0.00	-0.10	0.00	0.02
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

Source: Authors calculations using the World Bank, World Economic Monitor (GEM) database. Global Economic Monitor (GEM) | Data Catalog (worldbank.org) Access date: February 24, 2021.

Table 4 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
3	Austria	-0.1473	33	3
4	Belarus	-1.1960	3	1
5	Belgium	1.9508	52	5
6	Brazil	0.6442	43	4
7	Bulgaria	-0.2052	32	3
8	Canada	1.0011	47	4
9	Chile	0.4964	42	4
10	China	-0.3906	26	2
11	Colombia	1.4267	50	5
12	Croatia	-0.3212	28	3
13	Cyprus	-0.6458	12	2
14	Czechia	-0.7135	9	2
15	Denmark	-0.5712	23	2
16	Ecuador	2.2086	54	5
17	Egypt	-0.4361	25	2
18	Estonia	-0.6325	13	2
19	Finland	-0.6110	19	2
20	France	1.0737	49	4
21	Germany	-0.2634	30	3
22	Greece	-0.3642	27	3
23	Hungary	-0.2110	31	3
24	Iceland	-0.6268	15	2
25	Ireland	0.1767	40	3
26	Israel	-0.7440	8	2
27	Italy	2.2103	55	5
28	Japan	-0.9479	6	1
29	Korea, South	-1.1645	4	1
30	Latvia	-0.6223	17	2
31	Lithuania	-0.7045	10	2
32	Luxembourg	-0.5735	22	2
33	Malta	-0.3149	29	3
34	Morocco	0.0503	38	3
35	New Zealand	-0.9712	5	1

36	North Macedonia	0.3980	41	4
37	Norway	-0.8418	7	2
38	Peru	2.9267	56	5
39	Philippines	1.0590	48	4
40	Poland	-0.6311	14	2
41	Portugal	-0.0809	36	3
42	Romania	-0.1327	34	3
43	Russia	-0.6611	11	2
44	Singapore	-1.5380	1	1
45	Slovakia	-0.5994	21	2
46	Slovenia	-0.0447	37	3
47	South Africa	-0.6214	18	2
48	Spain	1.5865	51	5
49	Sweden	0.7849	45	4
50	Switzerland	-0.0978	35	3
51	Taiwan	-1.3779	2	1
52	Tunisia	0.0876	39	3
53	Turkey	-0.5608	24	2
54	United Kingdom	2.0765	53	5
55	Uruguay	-0.6072	20	2
56	United States	0.9551	46	4

Source: Mariano & Ozmucur (2020). Table 9.

Figure 1 Clusters for Deaths Per Hundred Thousand Population as of February 17, 2021

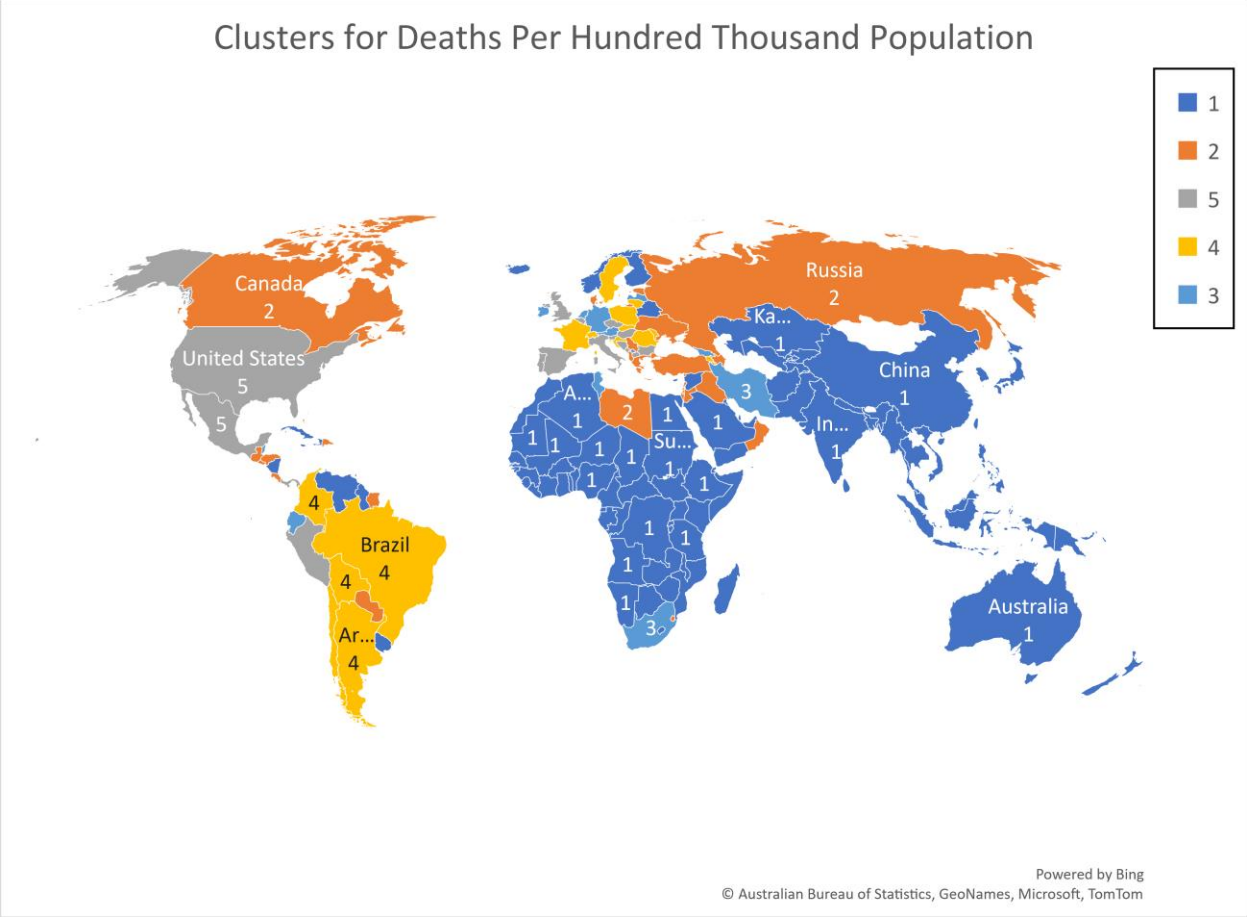


Figure 2 Clusters for Case Fatality as of February 17, 2021

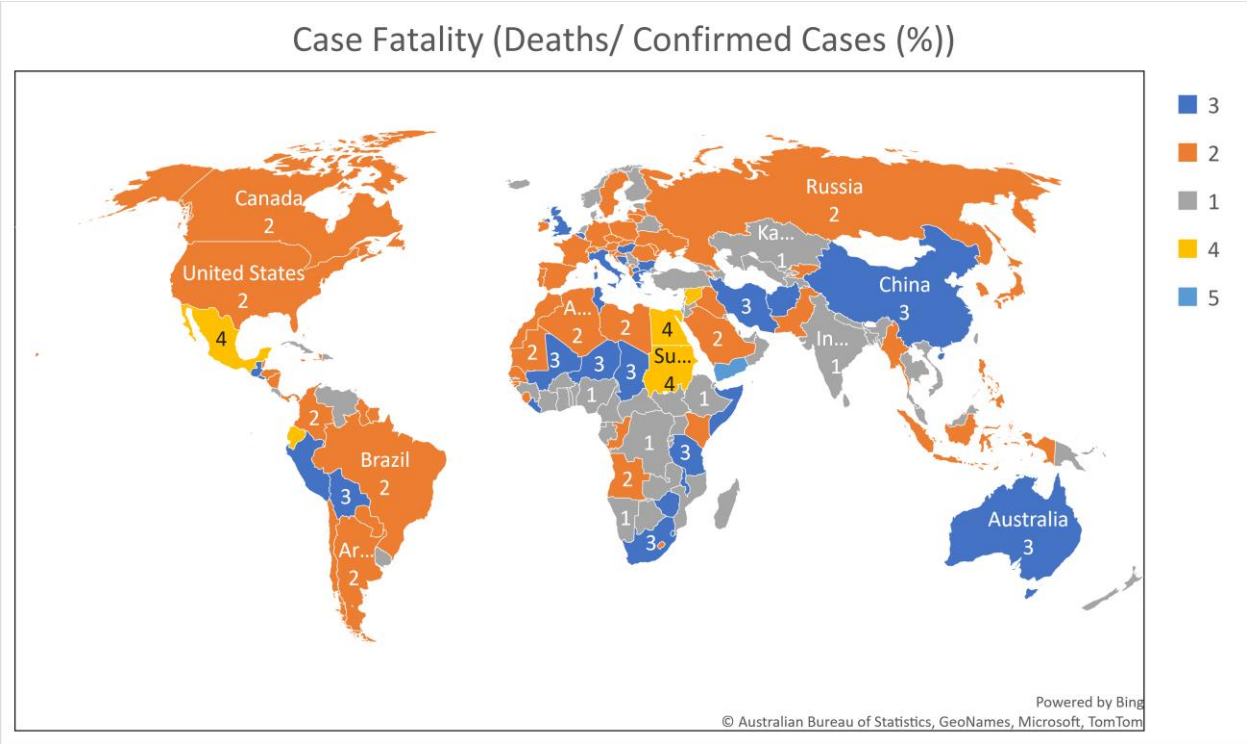
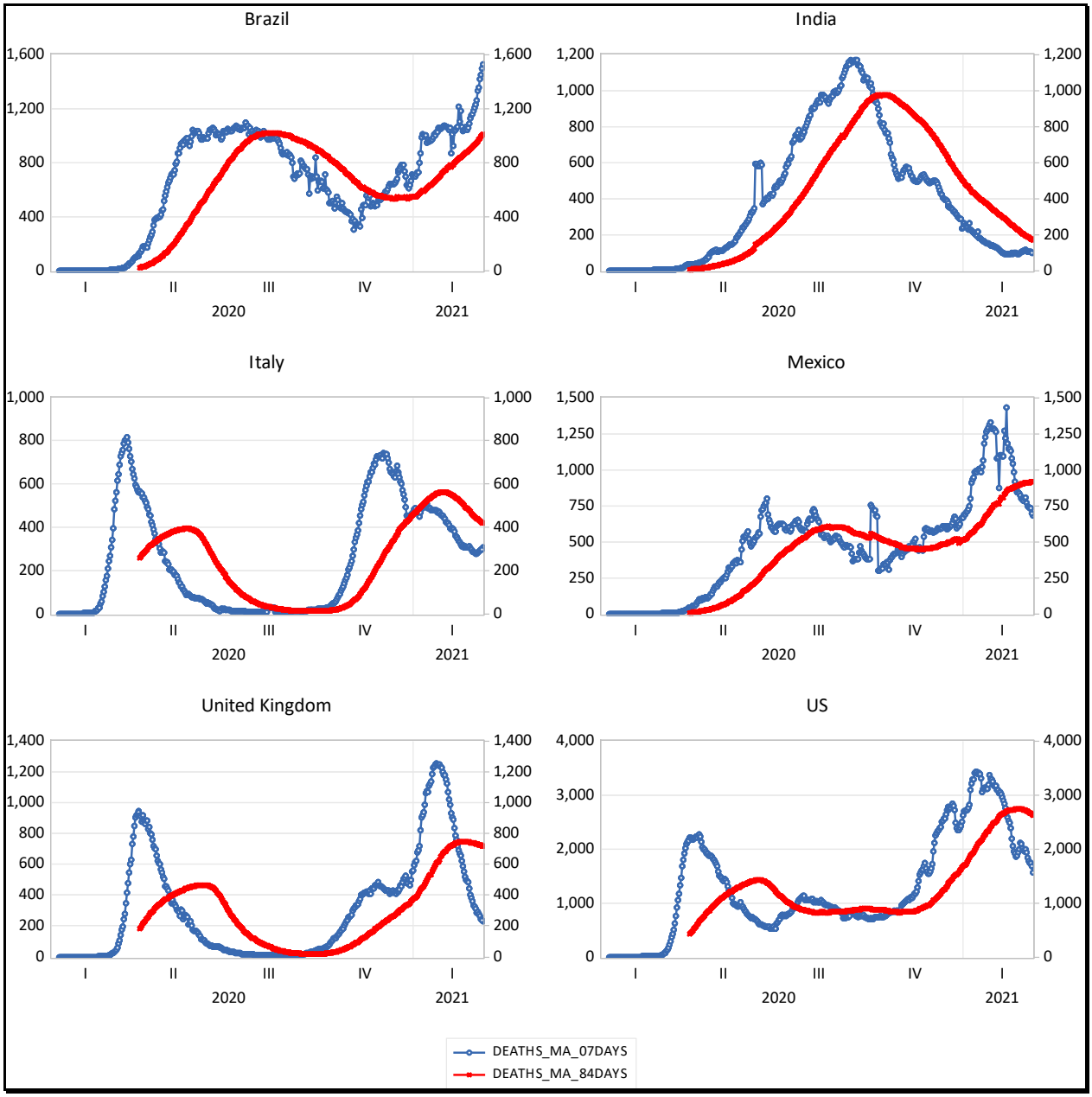
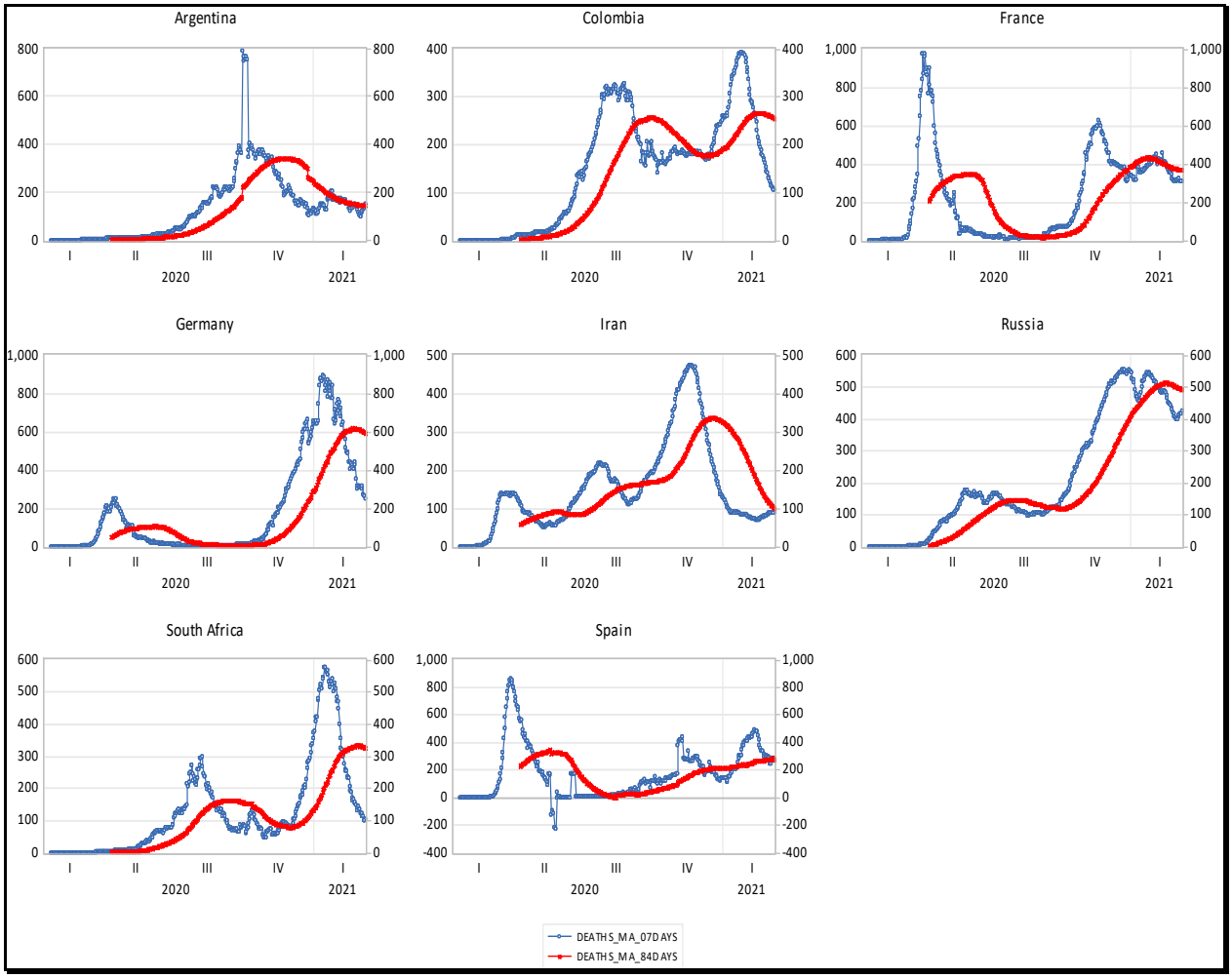


Figure 3 Moving Average of Daily Deaths, 1/22/2020 – 3/8/2021: Countries with More than 100 Thousand Deaths by March 8, 2021



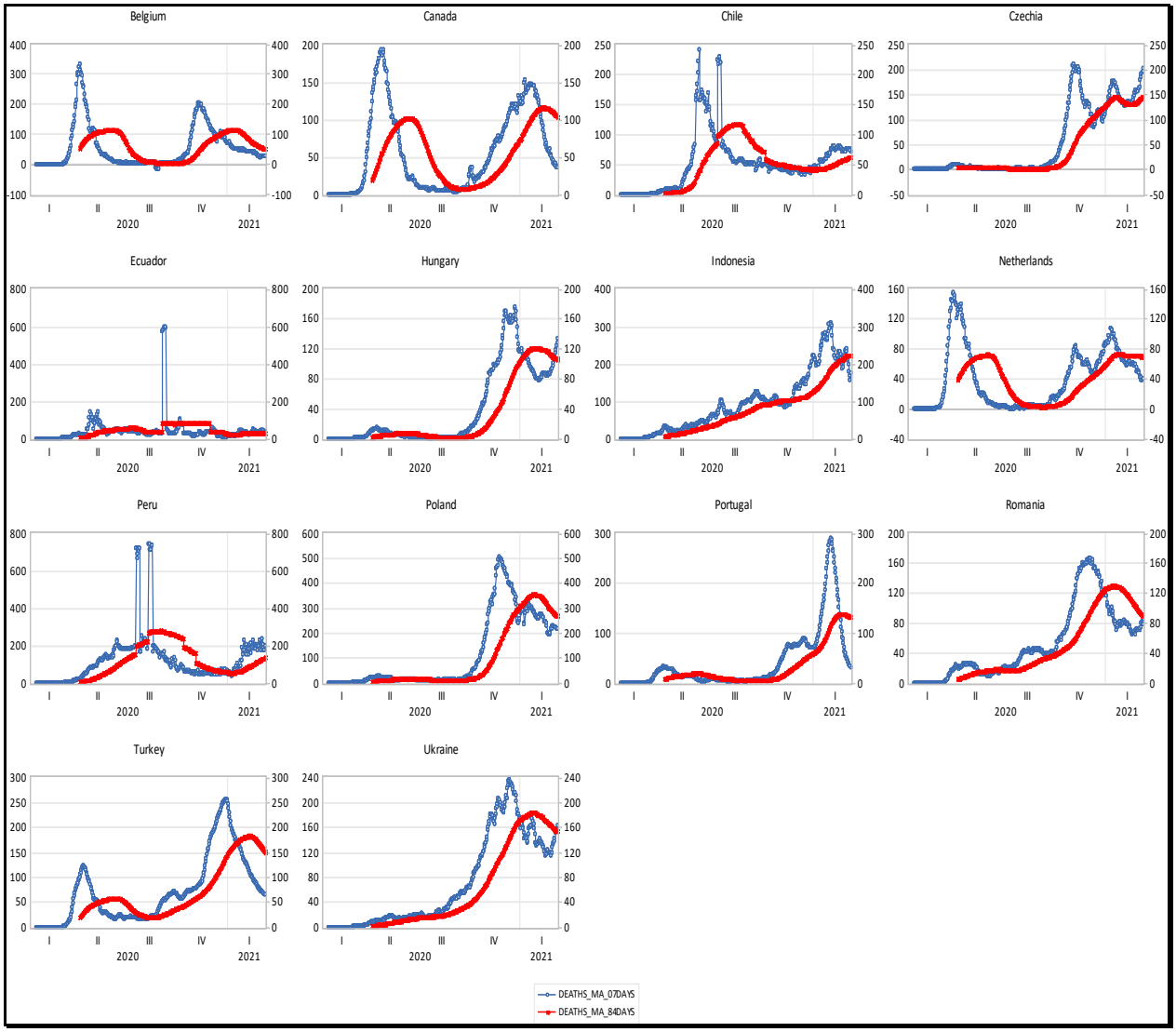
Source: Authors calculations using data from the Johns Hopkins University Coronavirus Resource Center.

Figure 4 Moving Average of Daily Deaths, 1/22/2020 – 3/8/2021: Countries with 50 Thousand to 100 Thousand Deaths by March 8, 2021



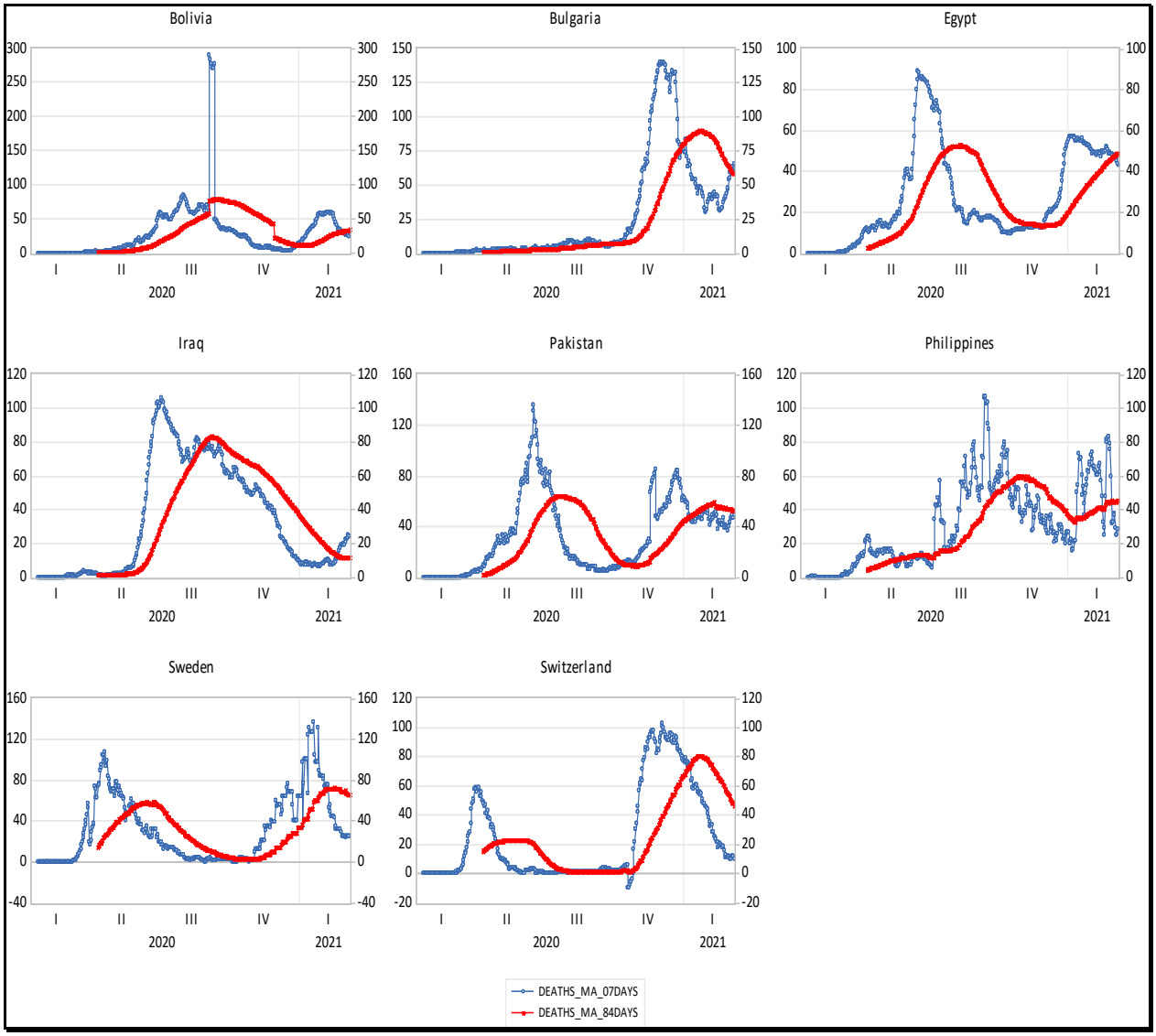
Source: Authors calculations using data from the Johns Hopkins University Coronavirus Resource Center.

Figure 5 Moving Average of Daily Deaths, 1/22/2020 – 3/8/2021: Countries with 15 Thousand to 50 Thousand Deaths by March 8, 2021



Source: Authors calculations using data from the Johns Hopkins University Coronavirus Resource Center.

Figure 6 Moving Average of Daily Deaths, 1/22/2020 – 3/8/2021: Countries with 10 Thousand to 15 Thousand Deaths by March 8, 2021



Source: Authors calculations using data from the Johns Hopkins University Coronavirus Resource Center.

Figure 7 Deaths in Ten Countries with Lowest Disaster Index, 1/1/2021-3/6/2021

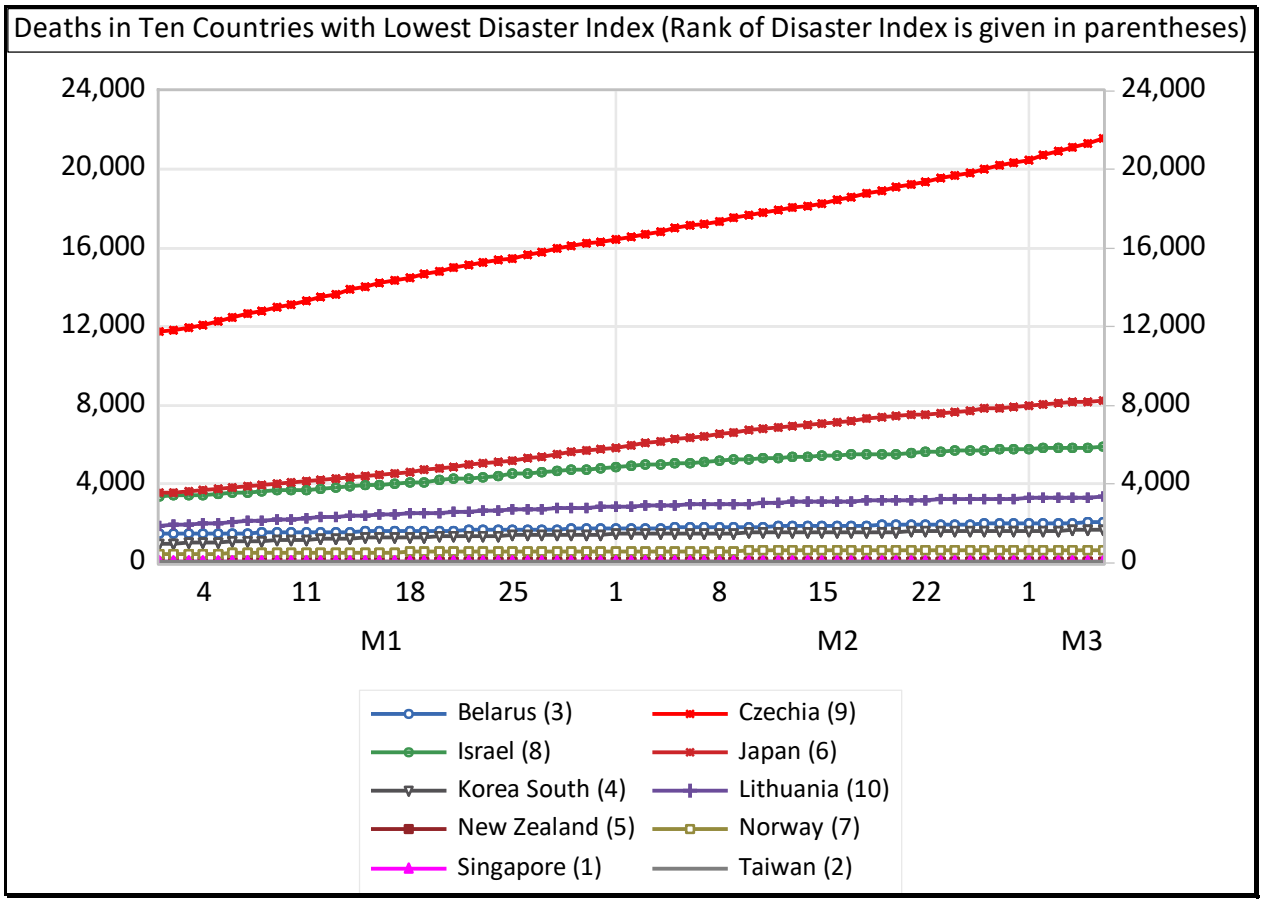


Figure 8 Deaths in Twelve Countries with Highest Disaster Index (US-right scale, other countries-left scale),1/1/2021-3/6/2021

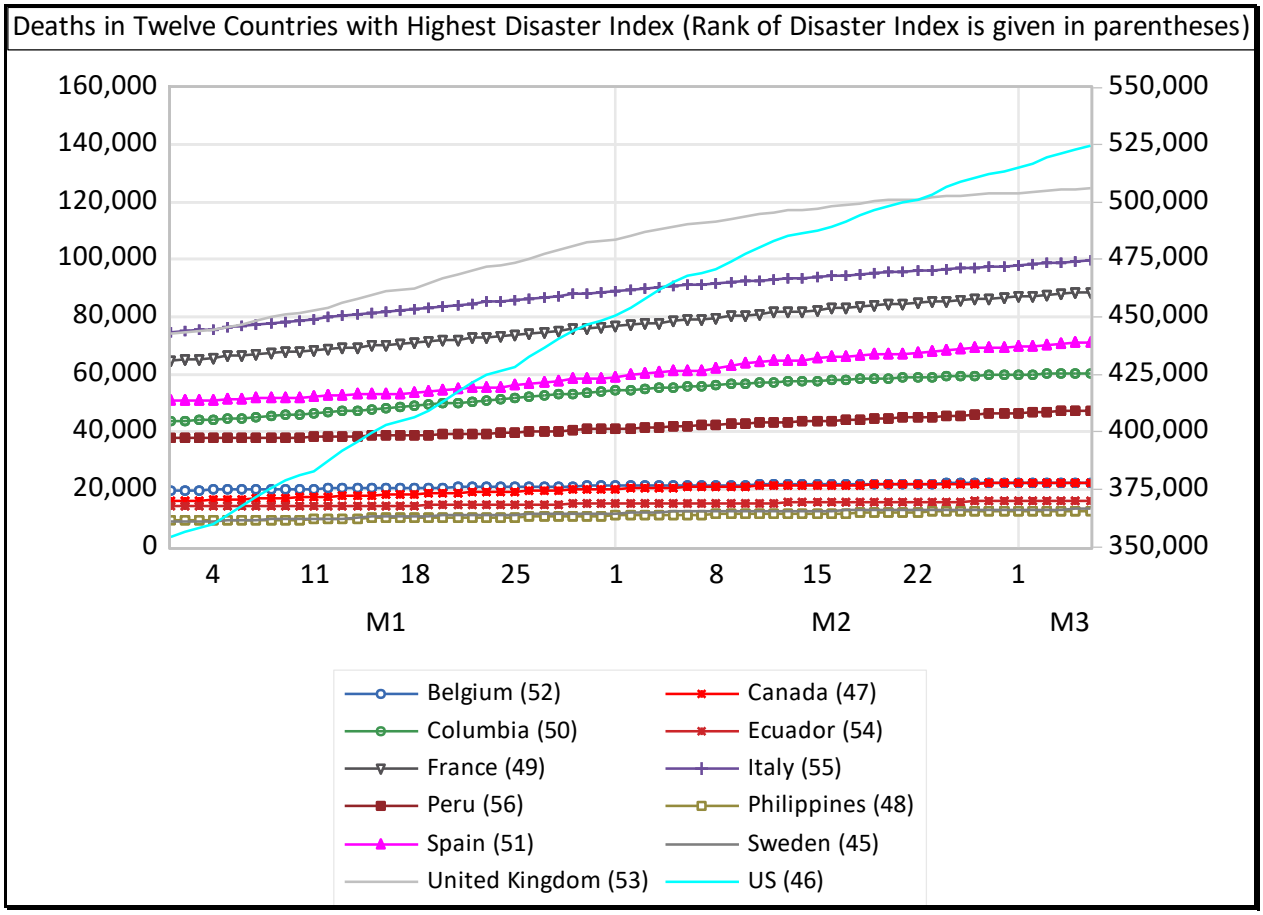


Figure 9 Countries with More Than 1000 Deaths and Recent Decreases in Trend

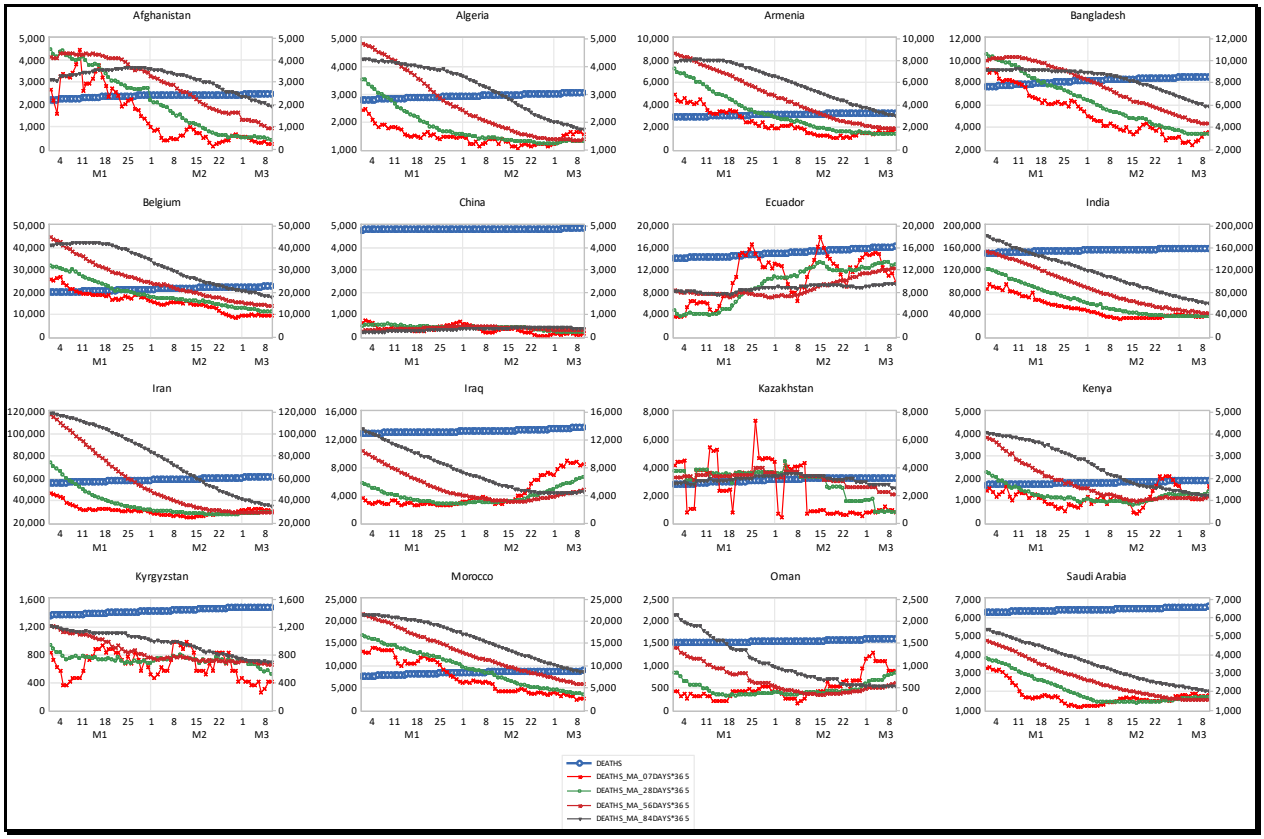


Figure 10 Countries with Less Than 1000 Deaths and Recent Decreases in Trend

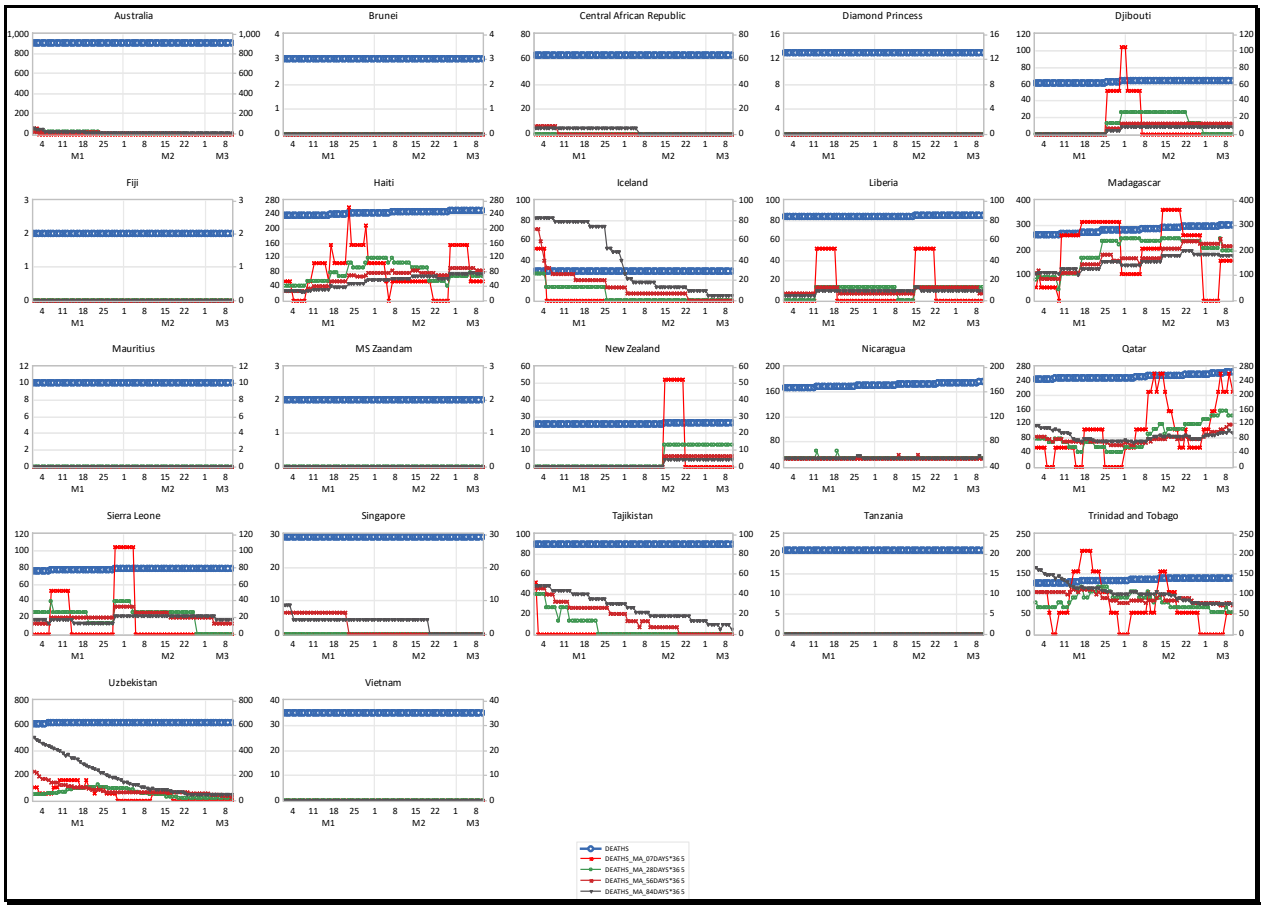


Figure 11 Countries with More Than 50,000 Deaths and Recent Increases in Trend

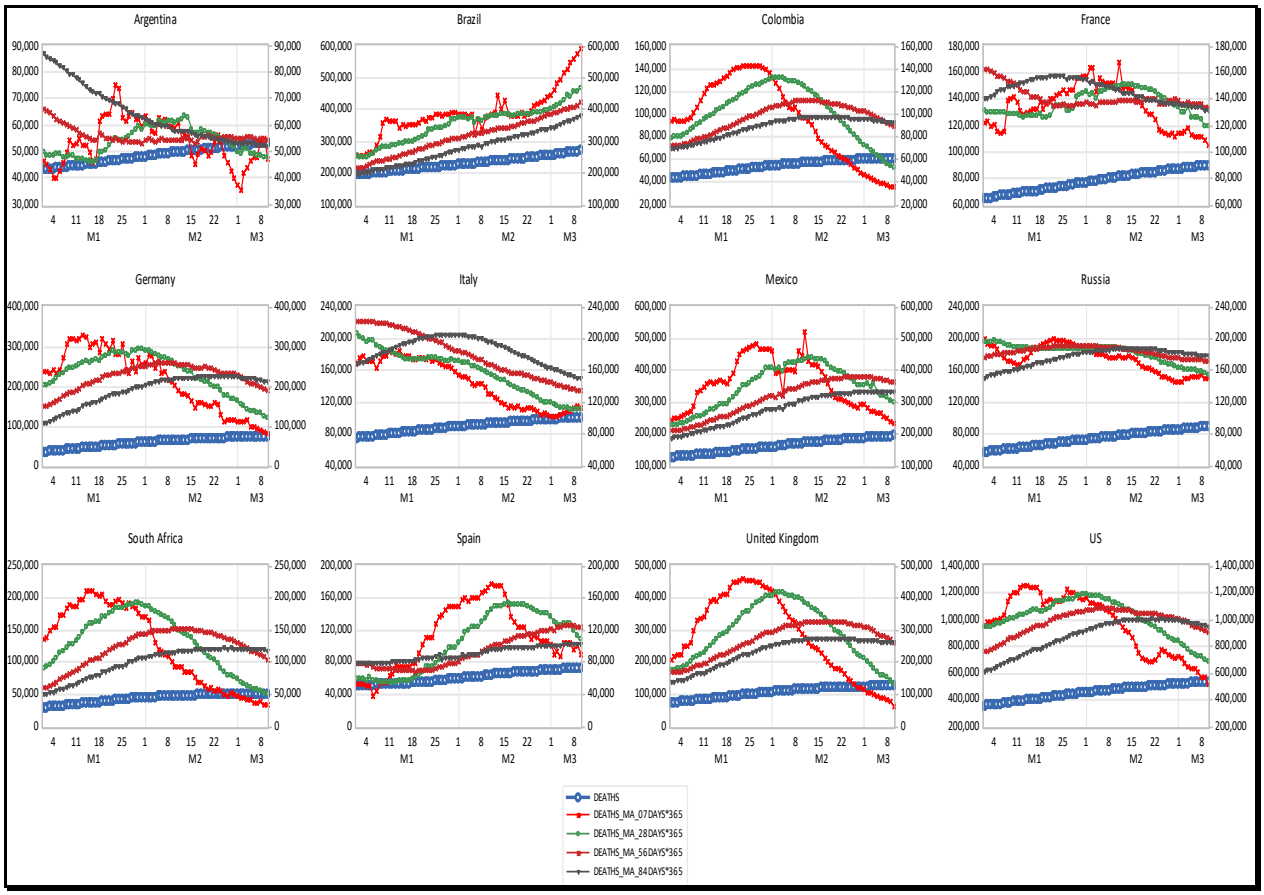


Figure 12 Countries with 12,000 to 50,000 Deaths and Recent Increases in Trend

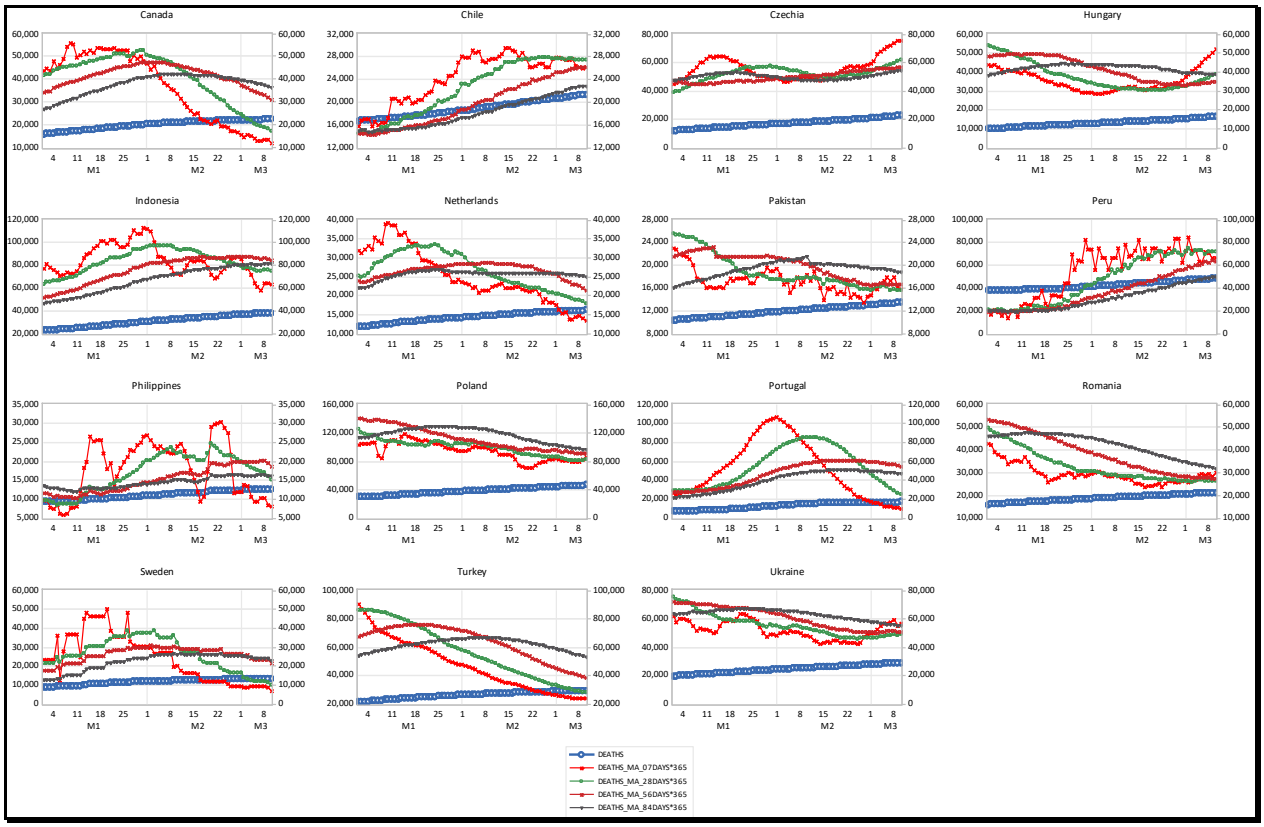


Figure 13 Countries with 5,000 to 12,000 Deaths and Recent Increases in Trend

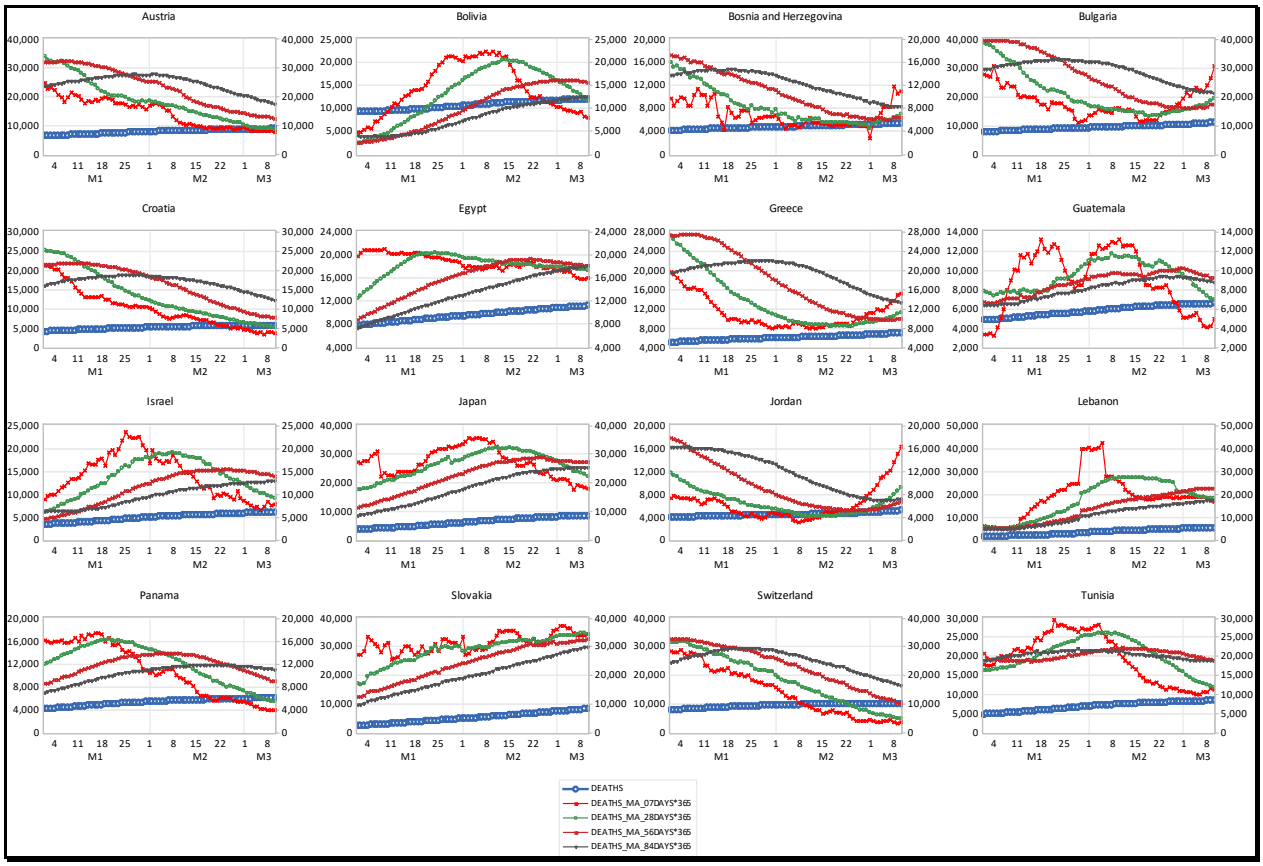


Figure 14 Countries with 2,000 to 5,000 Deaths and Recent Increases in Trend

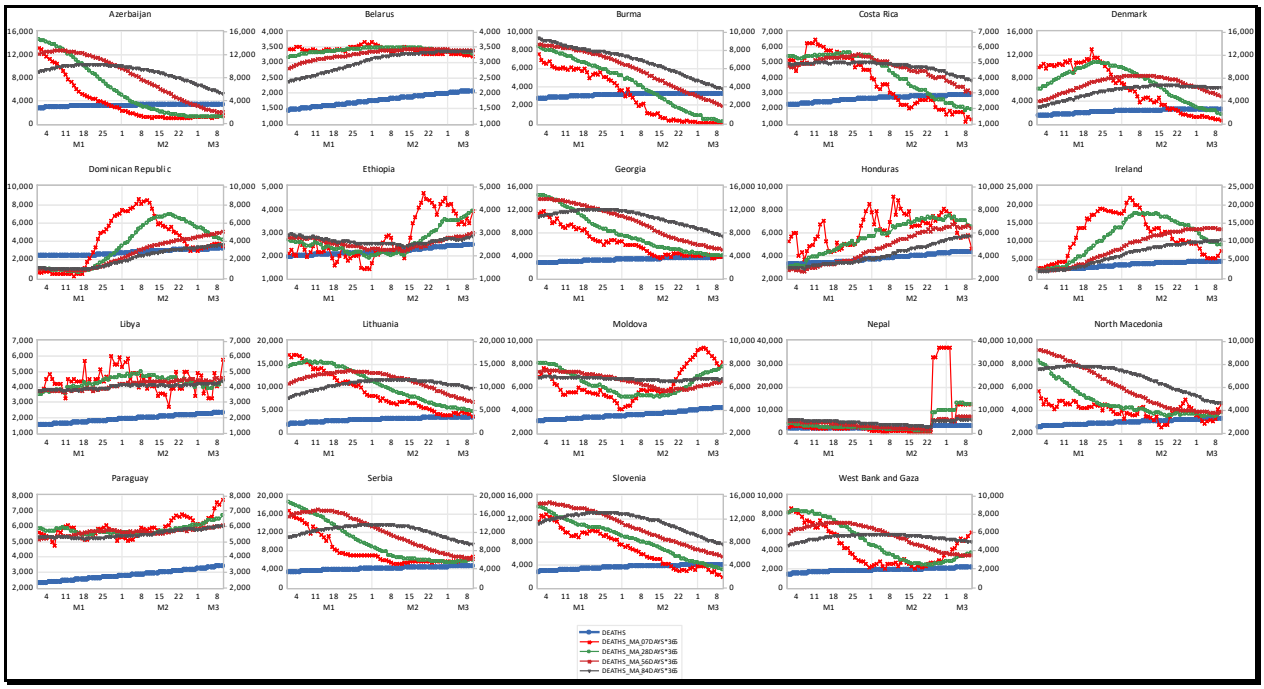


Figure 15 Countries with 1,000 to 2,000 Deaths and Recent Increases in Trend

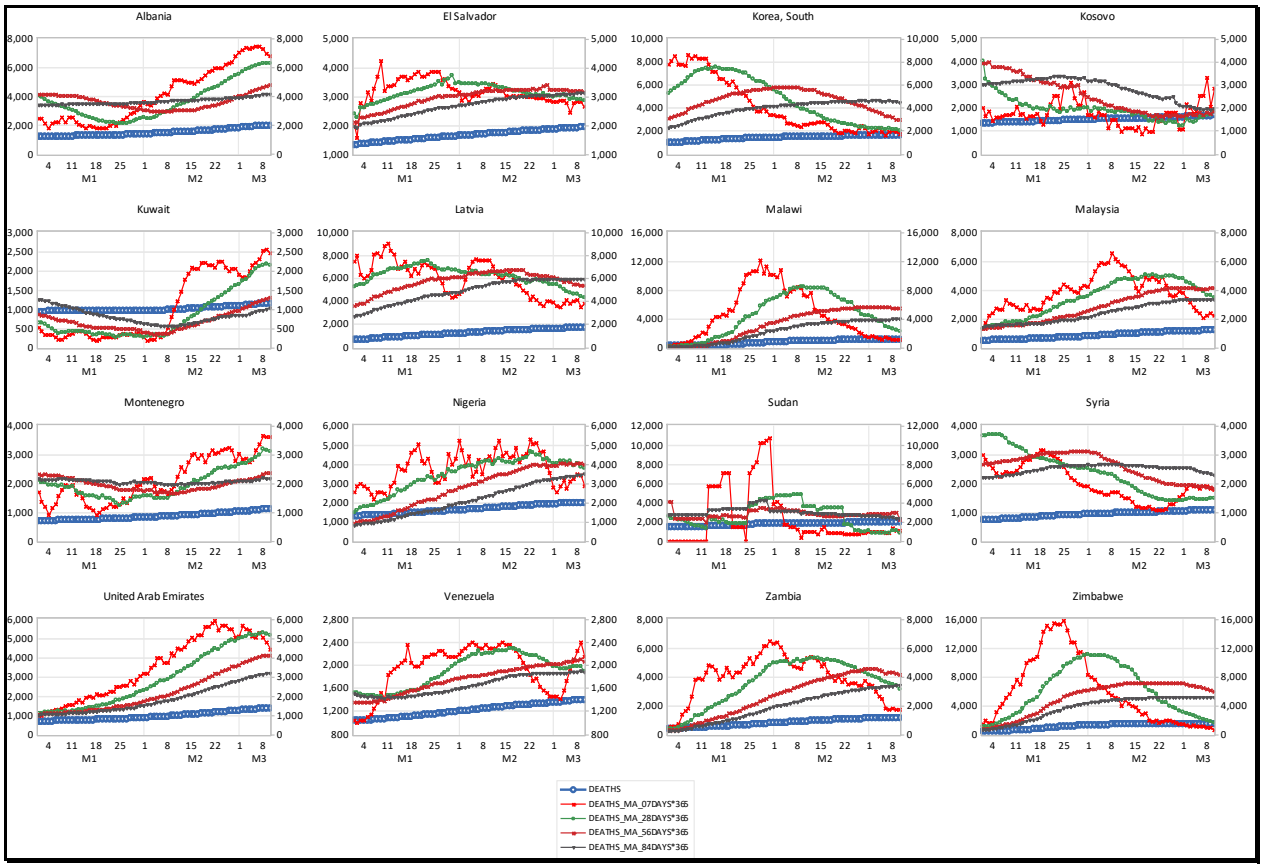


Figure 16 Countries with 500 to 1,000 Deaths and Recent Increases in Trend

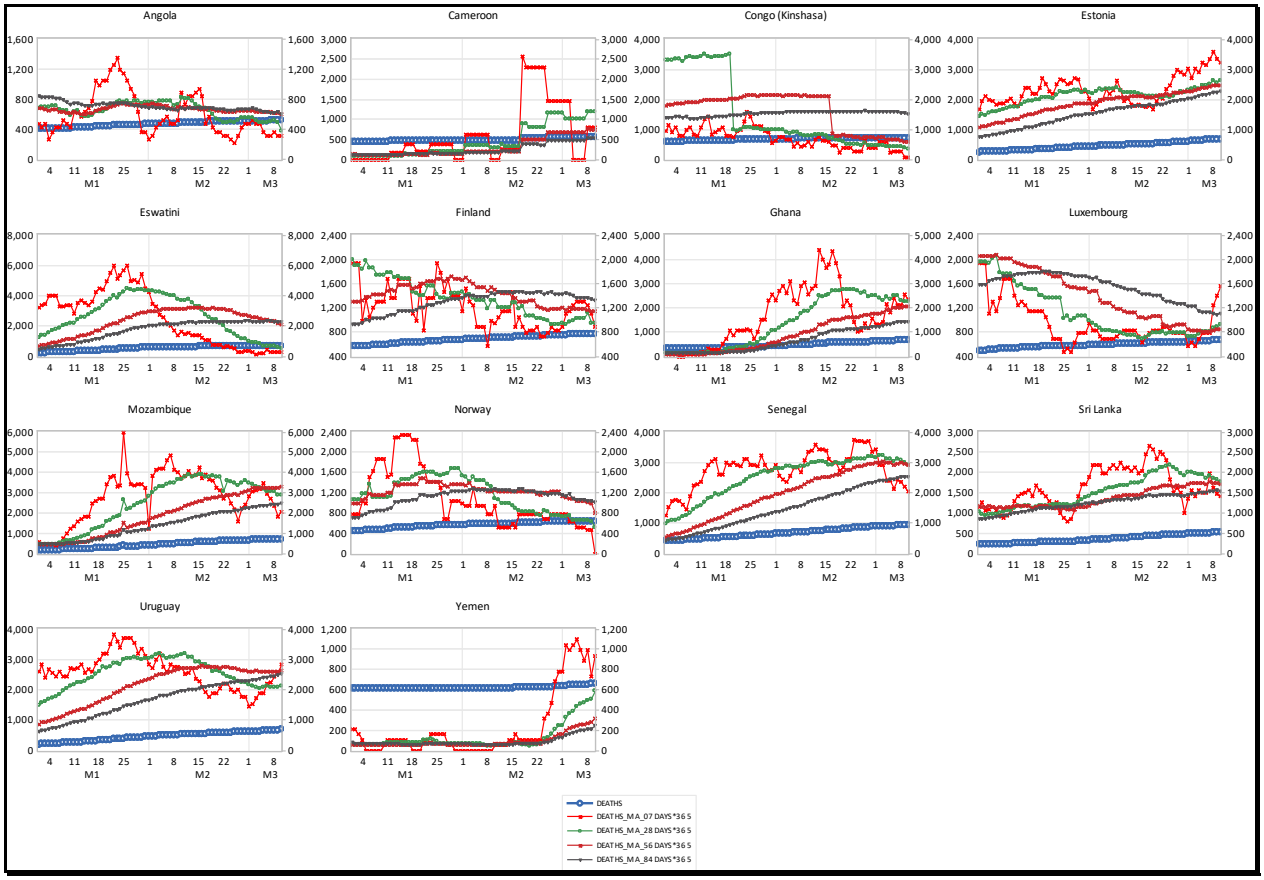


Figure 17 Countries with 200 to 500 Deaths and Recent Increases in Trend

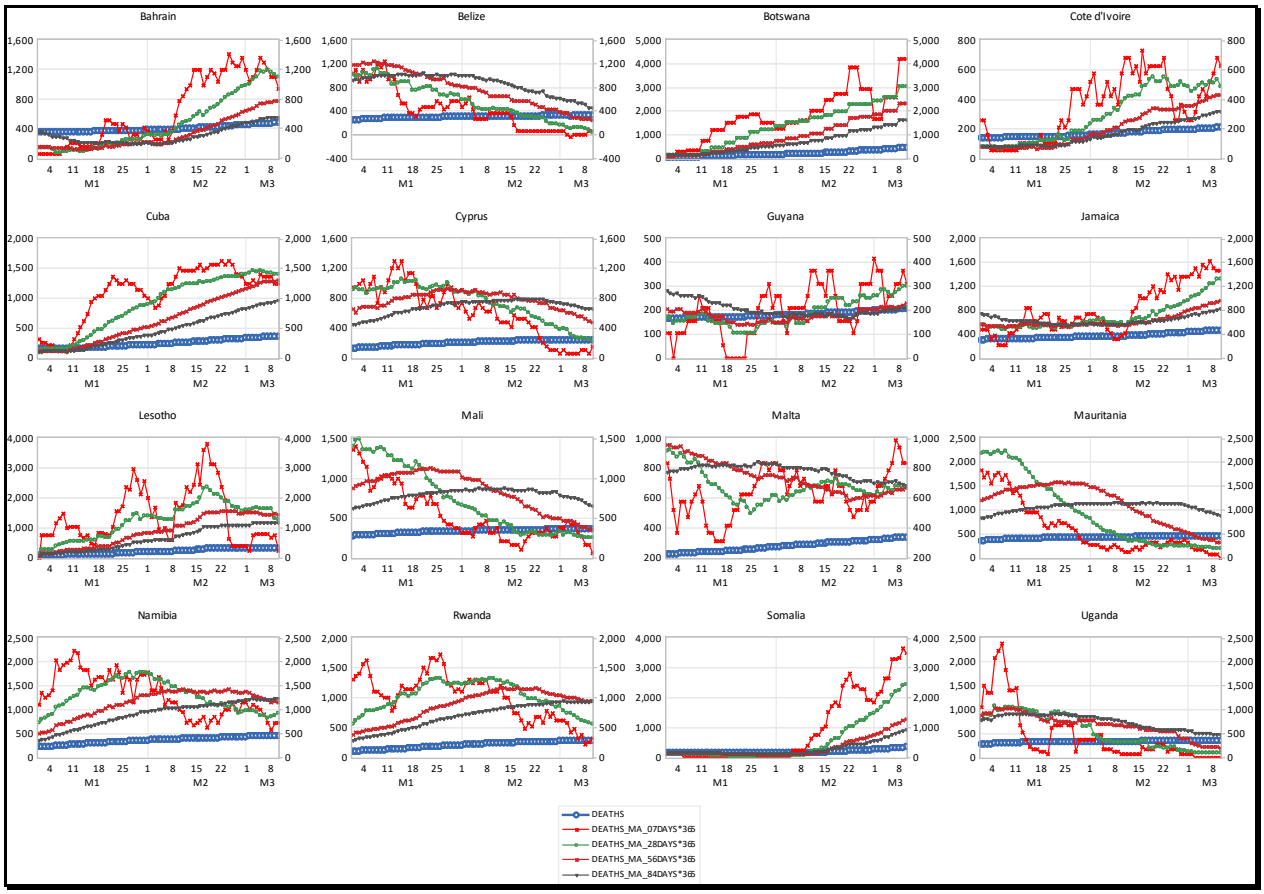

Bahrain
Belize
Botswana
Cote d'Ivoire
Cuba
Cyprus
Guyana
Jamaica
Lesotho
Mali
Malta
Mauritania
Namibia
Rwanda
Somalia
Uganda
M1
M2
M3
DEATHS
DEATHS_MA_07DAYS*365
DEATHS_MA_28DAYS*365
DEATHS_MA_56DAYS*365
DEATHS_MA_84DAYS*365

Figure 18 Countries with 25 to 200 Deaths and Recent Increases in Trend

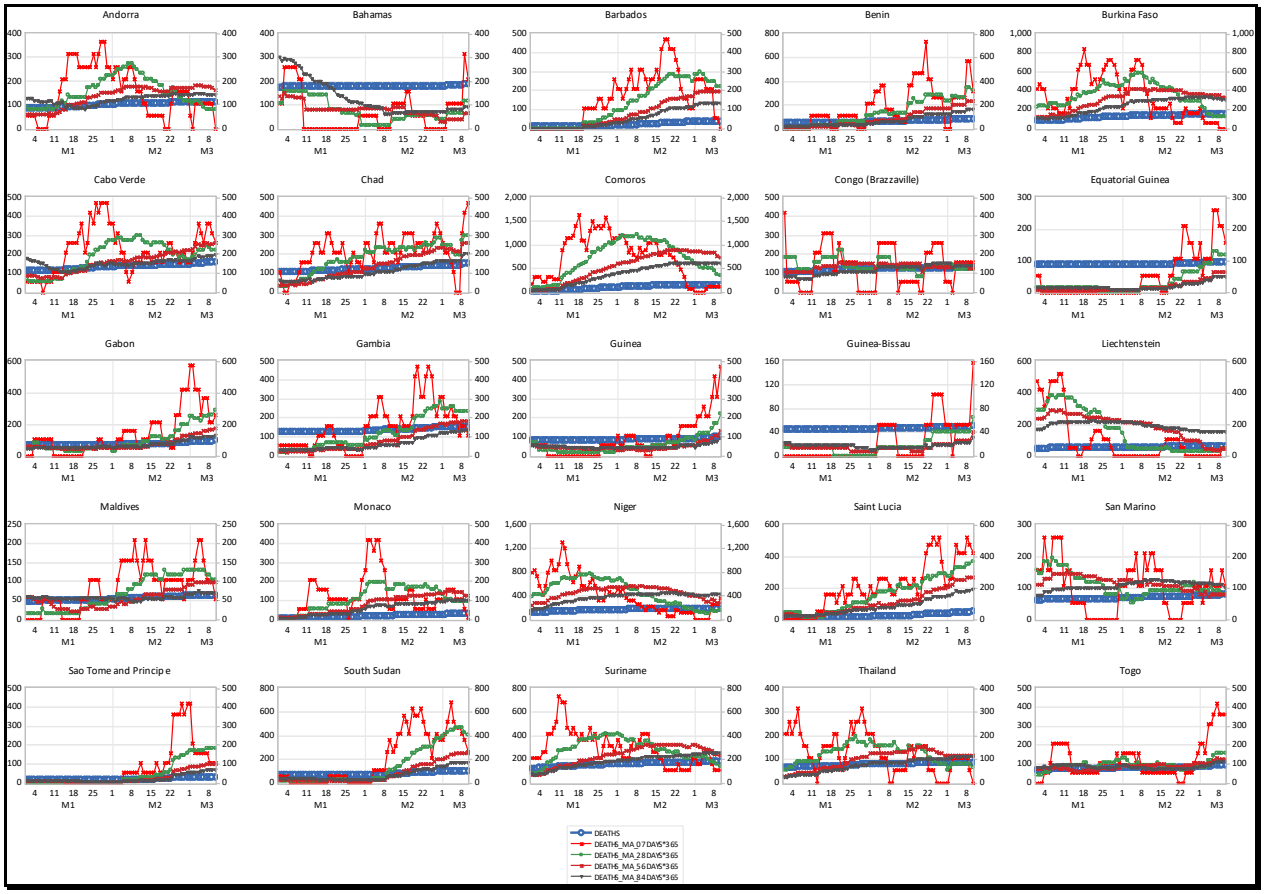


Figure 19 Countries with Less Than 25 Deaths and Recent Increases in Trend

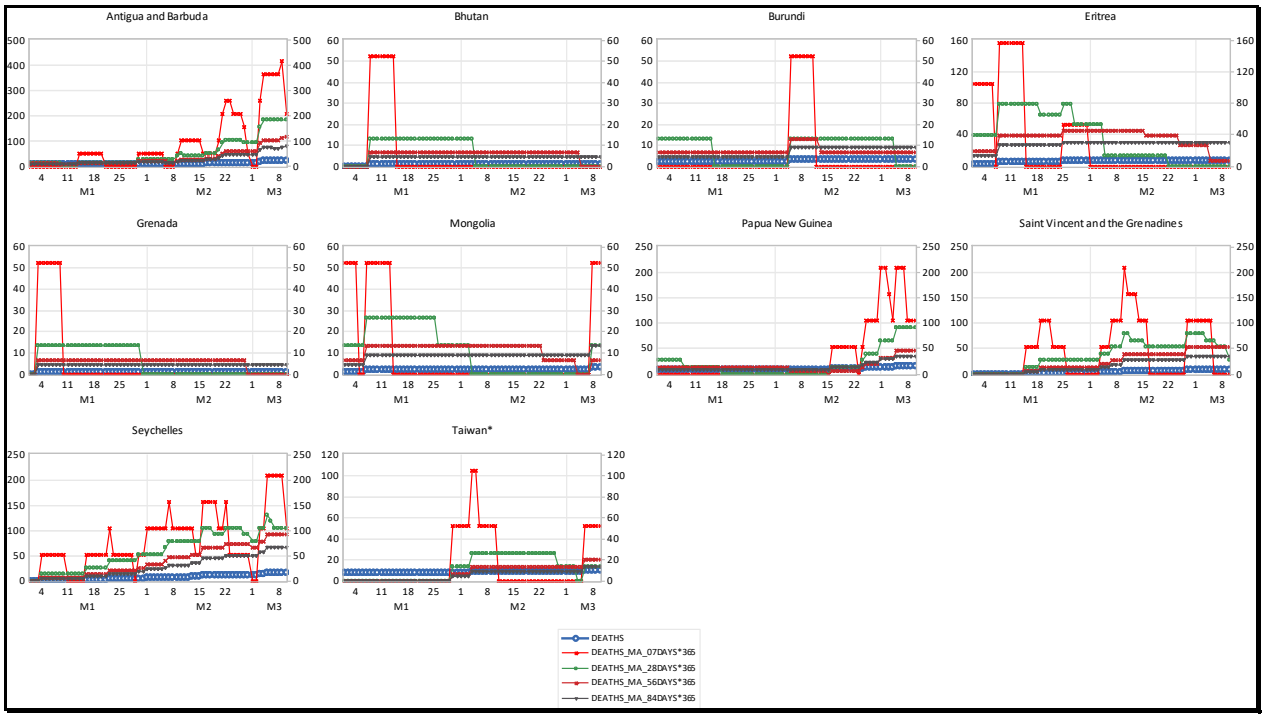

Antigua and Barbuda
Bhutan
Burundi
Eritrea
Grenada
Mongolia
Papua New Guinea
Saint Vincent and the Grenadines
Seychelles
Taiwan*
M1
M2
M3
DEATHS
DEATHS_MA_07DAYS*365
DEATHS_MA_28DAYS*365
DEATHS_MA_56DAYS*365
DEATHS_MA_84DAYS*365

Figure 20 Size of the Economy and Deaths per Hundred Thousand

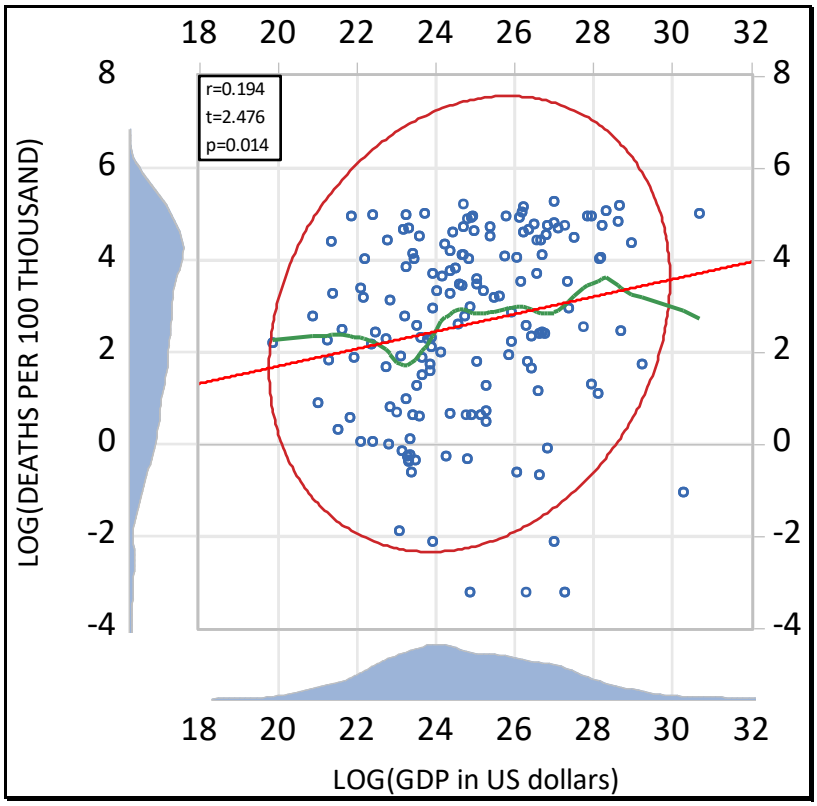


Figure 21 Surface Area and Deaths per Hundred Thousand

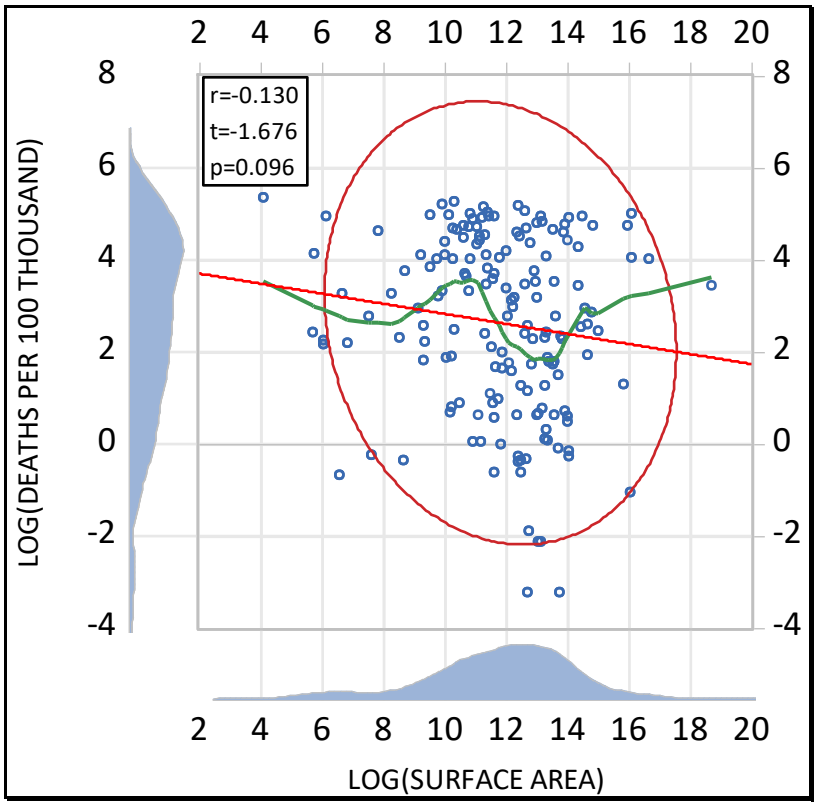


Figure 22 Population and Deaths per Hundred Thousand

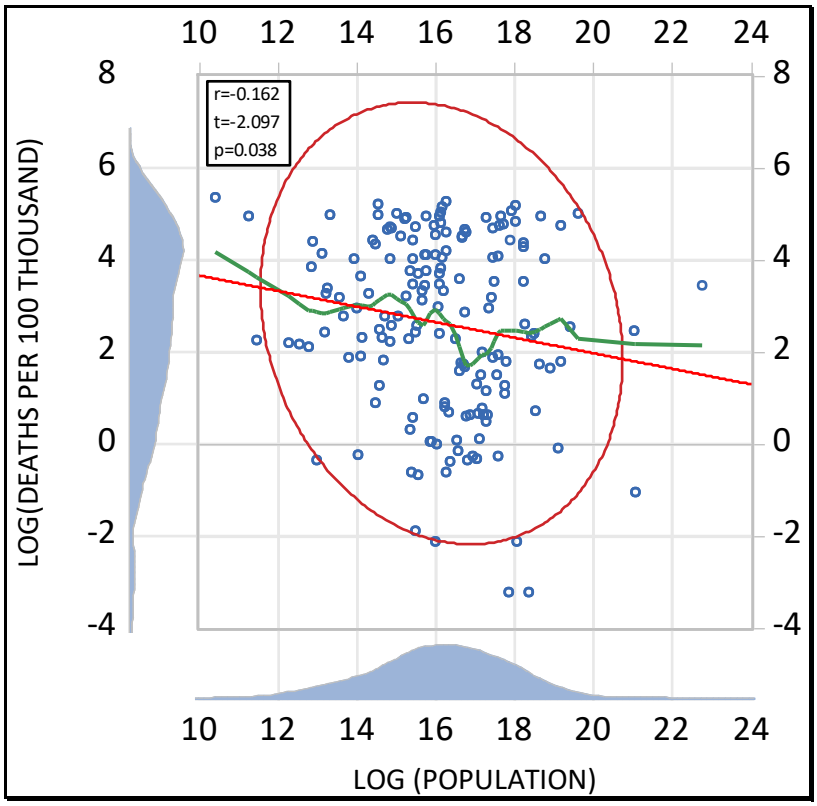


Figure 23 Share of Population Ages 65 and Above and Deaths per Hundred Thousand

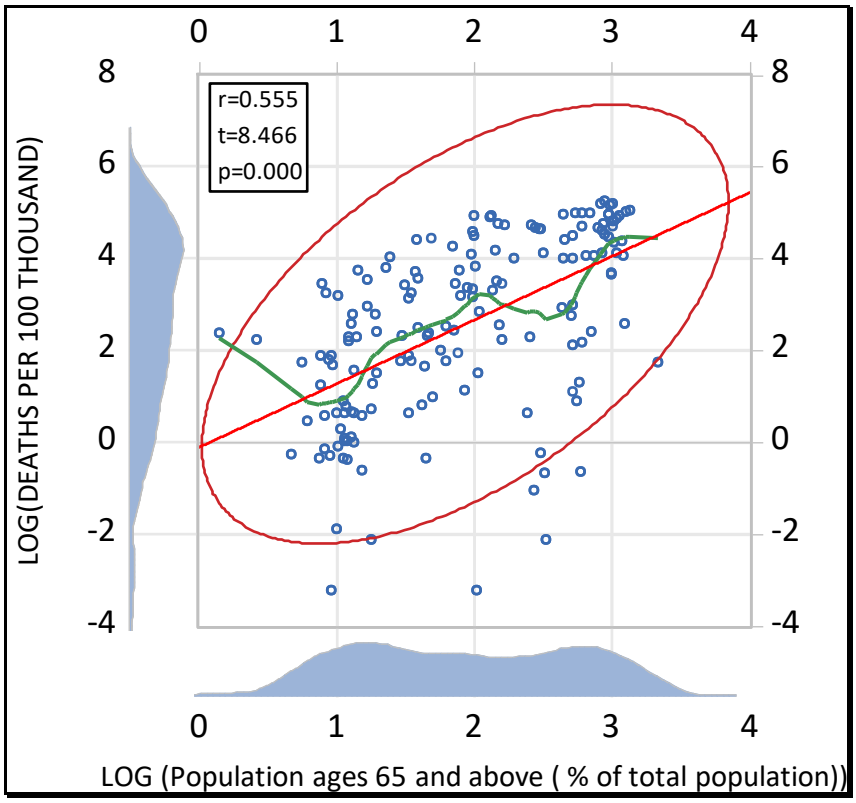


Figure 24 Share of Urban Population and Deaths per Hundred Thousand

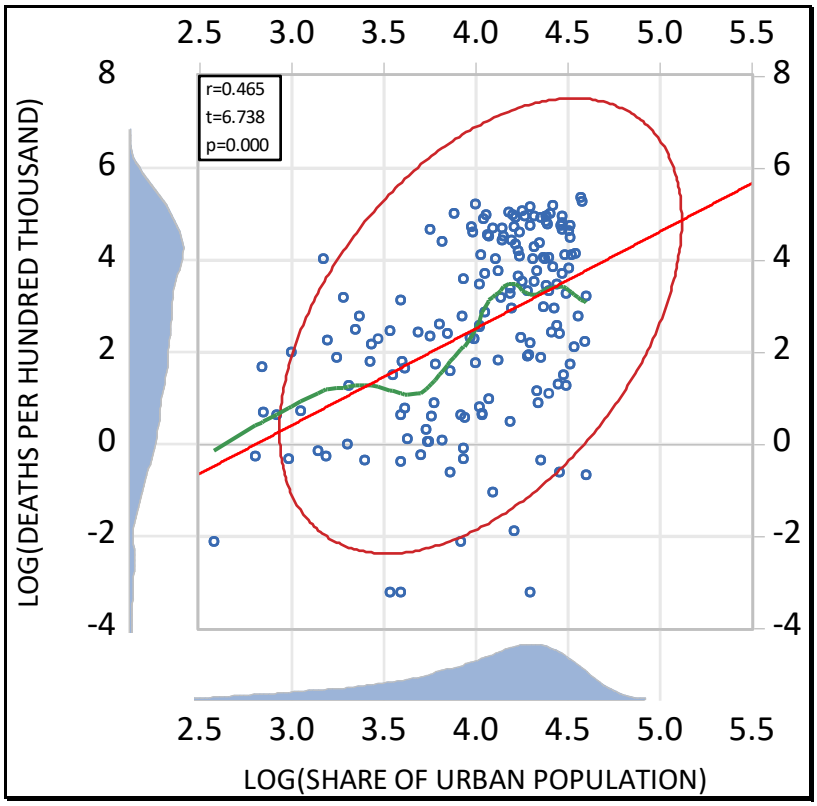


Figure 25 Global Health Security Index and Deaths per Hundred Thousand

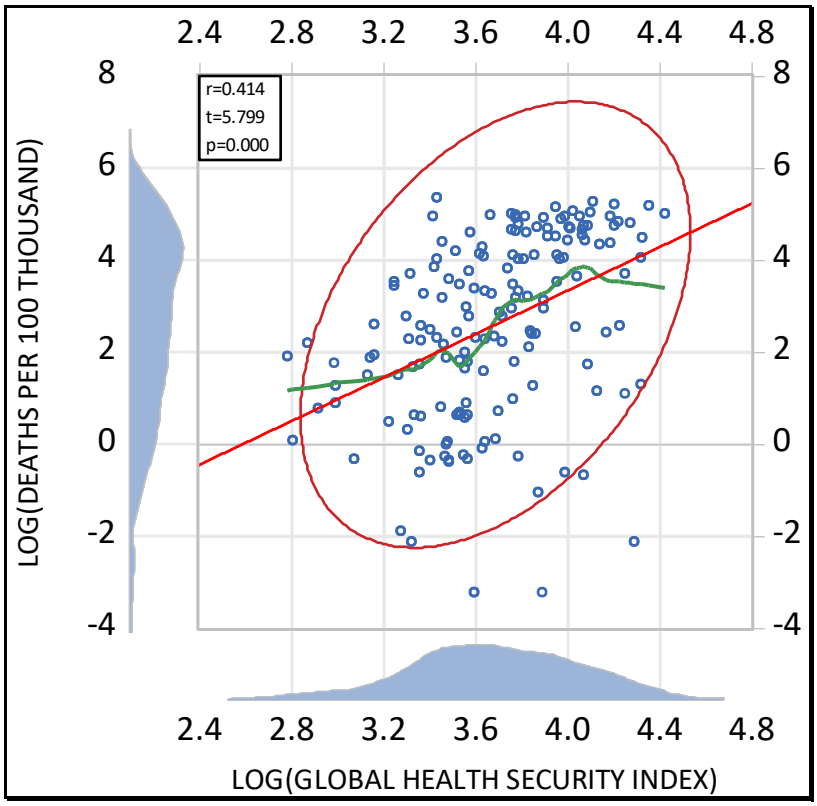


Figure 26 Share of Exports of Goods and Services in GDP and Deaths per Hundred Thousand

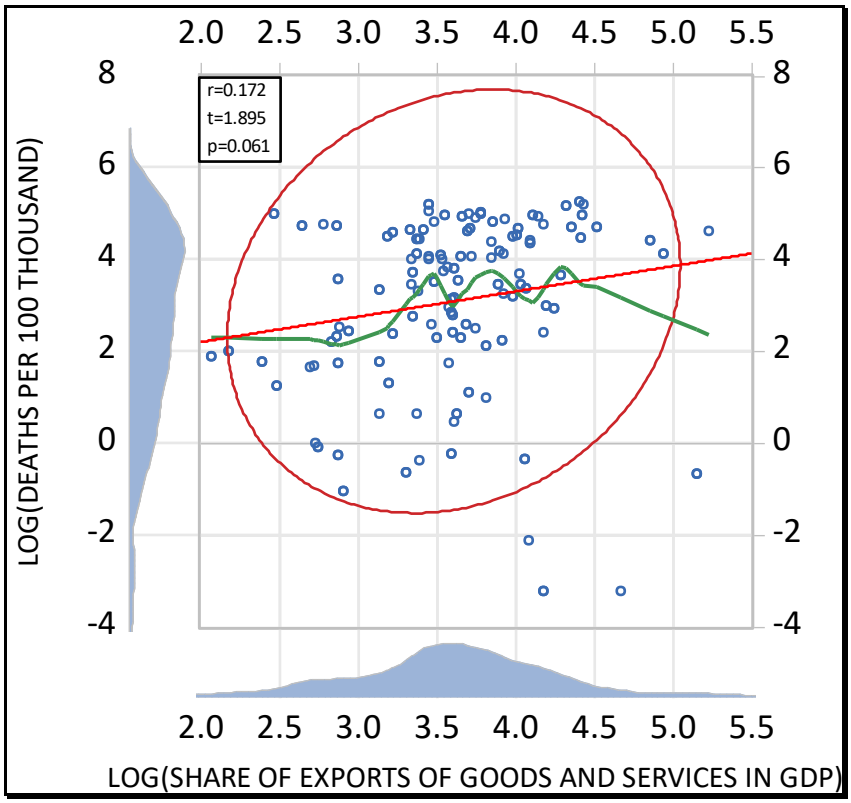


Figure 27 International Tourism Receipts and Deaths per Hundred Thousand

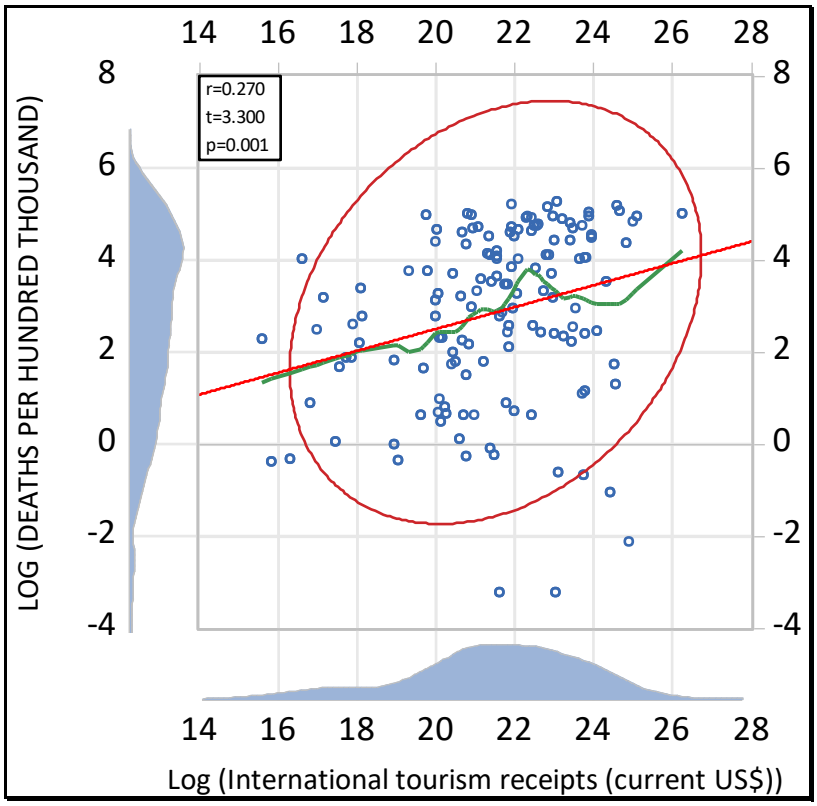


Figure 28 Confirmed Cases (left scale) and Death (right scale) for Countries with More Than Ten Thousand Deaths, 1/22/2020 – 3/10/202

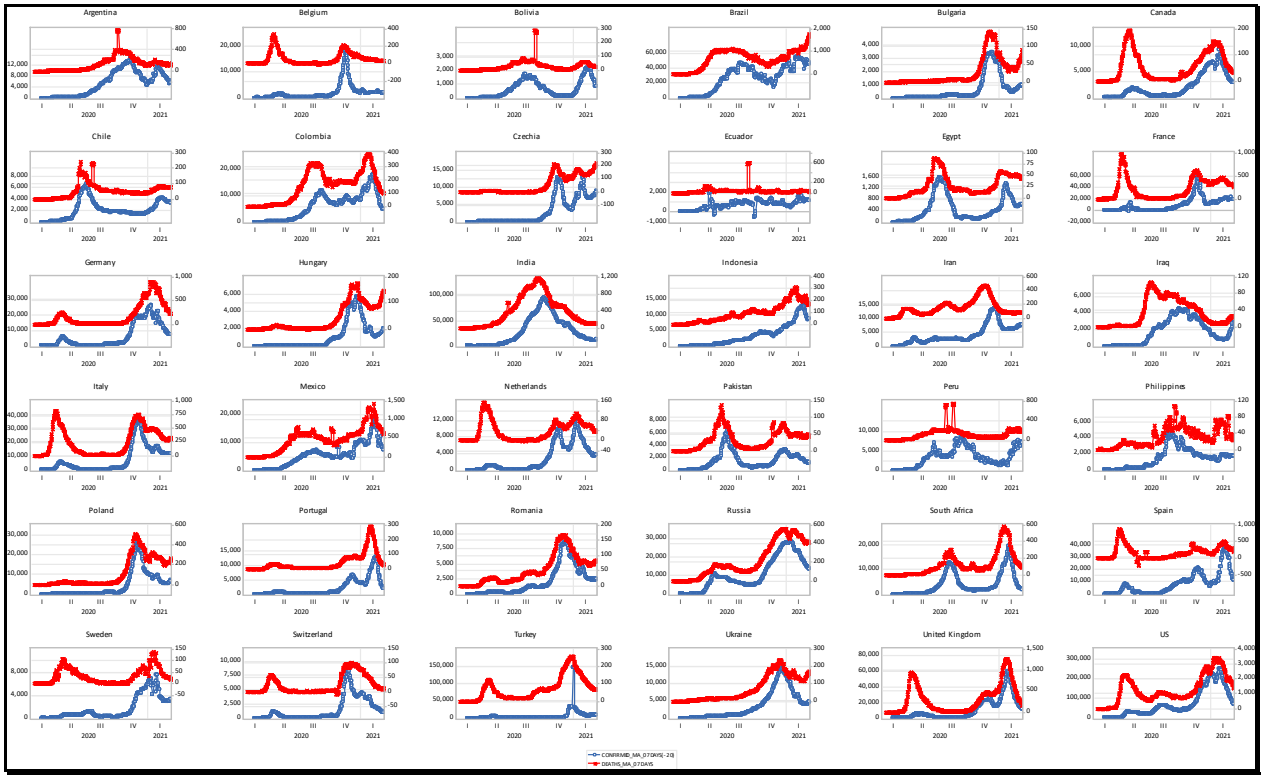


Figure 29 Scatter Diagrams for Confirmed Cases and Death for Countries with More Than Ten Thousand Deaths, 1/22/2020 – 3/10/202

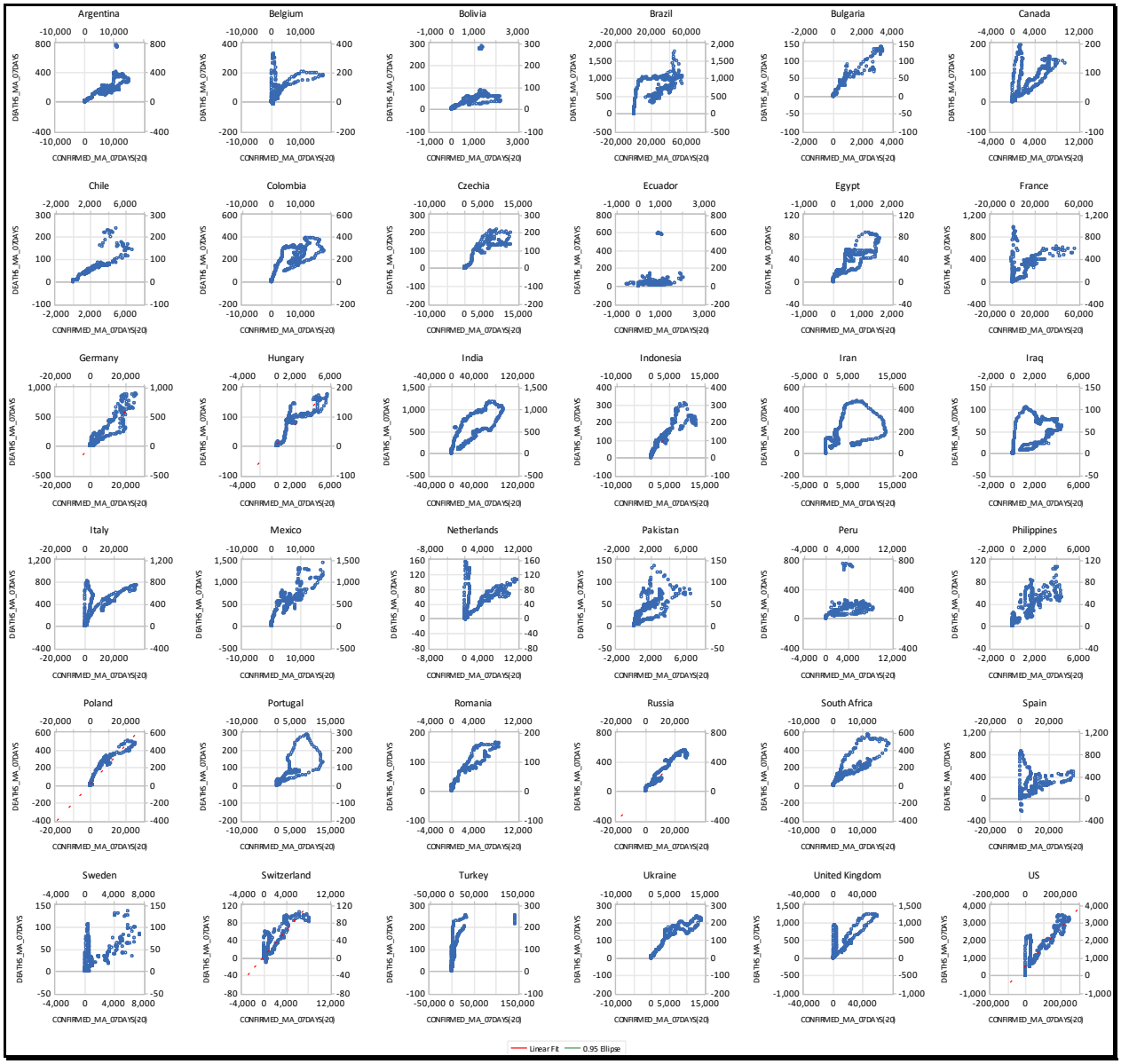
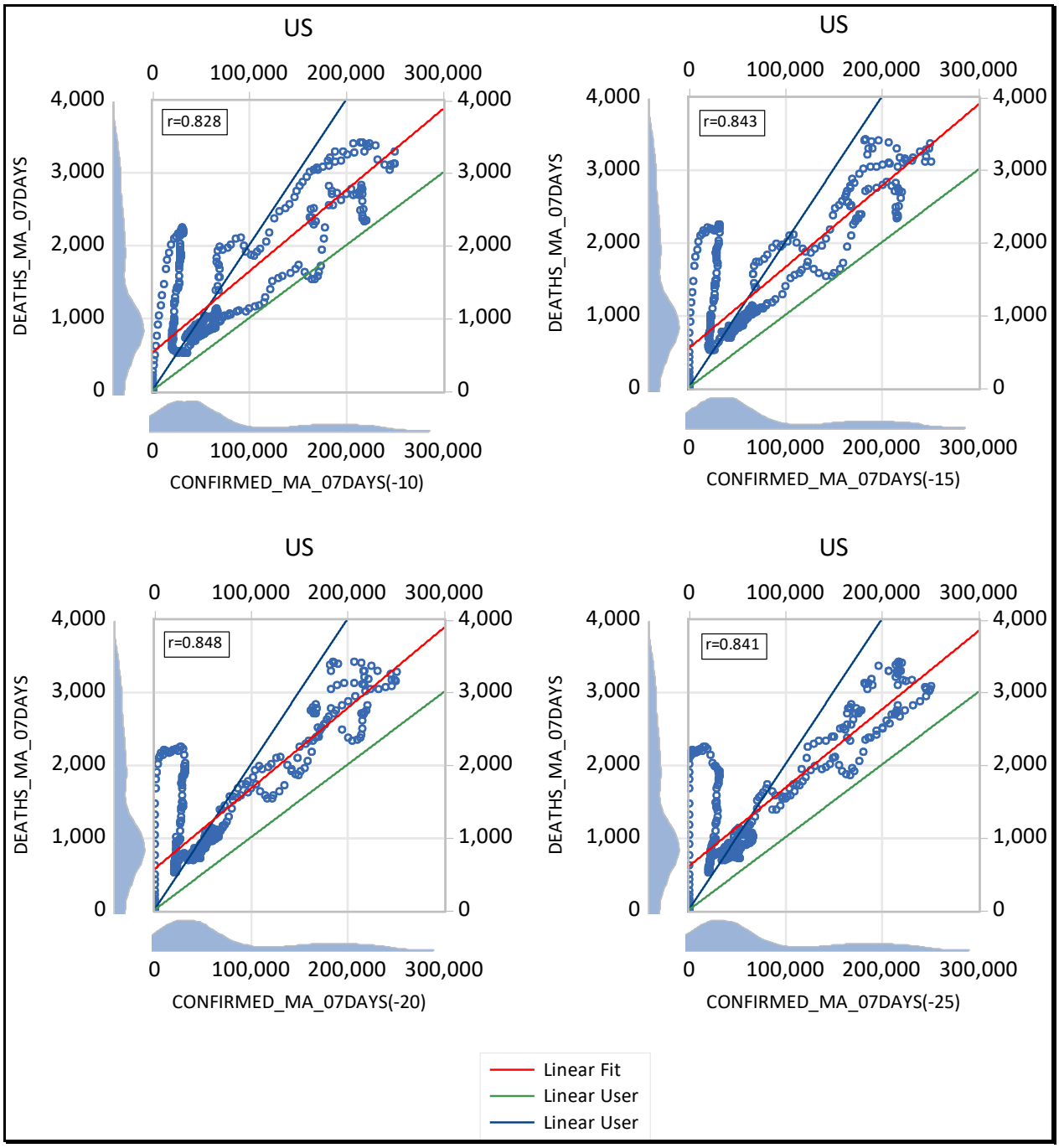


Figure 30 Confirmed Cases and Deaths Relationships in the US, 2/29/2020-3/10/2021



7 Appendix A: Summary Statistics for Daily Data on Deaths and Their Distributions[2]

Table 5 Descriptive Statistics for 7-Day Moving Average of Deaths, 1/22/2020 to 3/10/2021, Deaths>0

COUNTRY	Mean	Median	Max	Min.	Std. Dev.	Skew.	Kurt.	Obs.
Afghanistan	6.92	4.57	25.14	0.14	6.24	1.02	3.04	354
Albania	5.30	3.86	20.43	0.00	5.24	1.14	3.38	365
Algeria	8.28	8.00	21.57	0.14	4.31	0.93	4.01	364
Andorra	0.32	0.14	2.00	0.00	0.43	1.66	5.40	354
Angola	1.48	1.43	4.57	0.00	1.14	0.36	2.24	347
Antigua and Barbuda	0.06	0.00	1.14	0.00	0.17	3.93	19.79	338
Argentina	143.99	133.21	788.86	0.14	141.68	1.76	7.93	368
Armenia	9.21	6.29	29.71	0.14	8.38	1.18	3.21	350
Australia	2.42	0.29	22.00	-0.14	4.65	2.28	7.25	375
Austria	23.94	6.57	129.29	0.00	32.18	1.51	4.31	364
Azerbaijan	8.93	3.29	42.14	0.00	11.95	1.74	4.73	363
Bahamas	0.53	0.14	3.71	0.00	0.77	1.83	6.32	344
Bahrain	1.31	1.14	3.86	0.00	1.07	0.55	2.09	360
Bangladesh	23.64	24.36	44.86	0.14	13.05	-0.16	1.87	358
Barbados	0.11	0.00	1.29	0.00	0.25	2.56	9.34	340
Belarus	5.91	5.14	10.00	0.14	2.30	0.21	2.17	345
Belgium	61.01	33.14	333.43	-14.43	73.34	1.59	5.13	365
Belize	0.93	0.29	5.00	-0.14	1.25	1.46	4.15	339
Benin	0.23	0.00	2.00	0.00	0.35	1.88	6.48	339
Bhutan	0.02	0.00	0.14	0.00	0.05	2.45	6.98	62
Bolivia	34.07	25.29	289.57	0.14	41.84	4.00	23.72	347
Bosnia and Herzegovina	14.85	8.43	59.00	0.14	16.22	1.35	3.58	355
Botswana	1.11	0.14	11.57	0.00	2.31	2.53	9.03	345
Brazil	739.71	780.00	1,626.43	0.14	339.65	-0.49	2.67	359
Brunei	0.01	0.00	0.14	0.00	0.03	3.69	14.64	348
Bulgaria	29.33	7.14	140.43	0.00	39.29	1.53	4.28	365
Burkina Faso	0.40	0.14	2.29	0.00	0.51	1.48	4.45	358
Burma	9.28	0.43	36.00	0.00	11.51	0.73	1.93	345
Burundi	0.01	0.00	0.14	0.00	0.03	3.59	13.88	332
Cabo Verde	0.44	0.29	1.71	0.00	0.40	1.13	3.65	352
Cameroon	1.59	0.57	13.00	0.00	2.24	2.16	8.00	351
Canada	60.60	42.00	193.14	0.14	54.89	0.65	2.16	367
Central African Republic	0.22	0.00	3.71	0.00	0.59	3.90	18.83	292

[2] See Appendix B for data issues.

Chad	0.45	0.29	3.57	0.00	0.65	2.77	11.26	317
Chile	59.48	49.79	240.86	0.14	46.03	1.75	6.53	354
China	11.76	0.71	185.14	0.00	33.39	3.59	16.06	407
Colombia	170.88	179.21	391.86	0.29	110.05	0.01	2.09	354
Comoros	0.47	0.00	4.43	0.00	1.03	2.24	6.72	309
Congo (Brazzaville)	0.38	0.29	5.14	-3.71	0.79	0.77	15.01	343
Congo (Kinshasa)	2.00	1.14	30.57	0.00	4.06	6.21	42.43	355
Costa Rica	7.95	8.57	18.86	0.00	6.40	0.01	1.51	357
Cote d'Ivoire	0.58	0.43	2.14	0.00	0.51	0.86	2.85	347
Croatia	15.67	3.14	78.86	0.00	21.79	1.44	3.86	357
Cuba	0.97	0.36	4.43	-0.14	1.26	1.41	3.65	358
Cyprus	0.66	0.14	3.57	-0.14	0.94	1.41	3.74	354
Czechia	61.40	8.36	209.71	-0.14	71.39	0.63	1.76	354
Denmark	6.57	2.71	35.57	0.00	8.28	1.62	4.73	362
Diamond Princess	0.03	0.00	0.57	0.00	0.10	3.32	13.86	385
Djibouti	0.19	0.00	2.14	0.00	0.40	2.68	9.92	335
Dominican Republic	8.83	7.57	24.43	0.14	6.18	0.70	2.48	359
Ecuador	44.29	31.14	597.00	0.29	79.47	6.18	42.23	362
Egypt	29.89	19.36	88.86	0.14	22.74	0.86	2.71	368
El Salvador	5.53	5.71	12.29	0.00	3.27	-0.12	1.89	345
Equatorial Guinea	0.29	0.00	4.57	0.00	0.86	3.74	16.61	323
Eritrea	0.09	0.00	0.43	0.00	0.14	1.40	3.66	79
Estonia	1.86	0.43	9.86	-0.86	2.55	1.23	3.26	351
Eswatini	2.00	0.57	16.43	0.00	3.54	2.42	7.99	329
Ethiopia	7.15	7.00	21.86	0.00	5.19	0.52	2.82	340
Fiji	0.01	0.00	0.14	0.00	0.03	3.60	14.00	223
Finland	2.17	1.14	13.86	-0.14	2.51	1.87	8.04	355
France	227.84	153.21	975.29	0.00	229.50	0.93	3.30	390
Gabon	0.25	0.14	1.71	0.00	0.33	2.02	7.49	356
Gambia	0.43	0.14	6.29	0.00	0.94	3.94	19.69	353
Georgia	10.50	0.43	46.14	0.00	14.10	1.14	2.92	341
Germany	196.56	49.29	894.43	0.29	254.25	1.28	3.40	367
Ghana	1.81	0.86	12.00	0.00	2.26	2.00	7.18	355
Greece	18.51	4.00	100.71	0.00	27.19	1.73	4.96	365
Grenada	0.01	0.00	0.14	0.00	0.04	2.59	7.69	67
Guatemala	17.99	17.14	44.57	0.00	11.86	0.01	1.97	360
Guinea	0.29	0.29	1.29	0.00	0.23	0.82	3.65	330
Guinea-Bissau	0.15	0.14	0.71	0.00	0.19	1.37	4.00	319
Guyana	0.55	0.43	2.43	0.00	0.53	1.05	3.55	364
Haiti	0.74	0.29	4.00	0.00	0.89	1.52	4.66	338
Honduras	12.18	10.93	43.00	0.14	7.97	0.81	3.60	350
Hungary	44.00	10.29	176.43	0.00	53.33	0.90	2.40	361
Iceland	0.08	0.00	1.57	-0.57	0.21	3.52	18.16	359

India	432.48	379.57	1,168.00	0.14	355.79	0.56	2.05	365
Indonesia	102.38	92.43	309.00	0.14	76.60	0.81	2.80	365
Iran	157.22	125.71	473.43	0.29	113.44	1.31	4.10	386
Iraq	36.49	23.57	106.00	0.29	32.65	0.44	1.73	372
Ireland	12.14	4.57	70.29	-0.14	16.33	1.64	4.73	365
Israel	16.53	11.93	64.86	0.14	14.88	1.11	3.53	356
Italy	260.05	201.21	814.29	0.14	249.27	0.53	1.89	384
Jamaica	1.26	1.00	5.14	0.00	1.34	0.90	2.75	357
Japan	21.08	8.50	97.71	0.14	26.97	1.49	3.88	392
Jordan	14.19	1.00	78.29	0.00	20.25	1.49	4.22	349
Kazakhstan	9.09	5.86	74.86	0.00	11.08	2.41	9.73	350
Kenya	5.37	3.57	22.57	0.00	4.64	1.37	4.53	350
Korea, South	4.26	2.00	23.43	0.00	5.47	2.08	6.54	385
Kosovo	4.66	4.14	21.14	0.00	4.25	0.91	3.29	353
Kuwait	3.30	3.00	8.29	0.00	2.03	0.48	2.38	341
Kyrgyzstan	4.31	1.71	149.14	-63.00	21.56	3.93	29.49	342
Latvia	4.95	0.43	24.57	0.00	7.05	1.21	3.01	342
Lebanon	13.80	5.36	116.43	0.00	22.33	2.38	8.75	366
Lesotho	1.26	0.43	10.43	0.00	2.06	2.32	7.97	245
Liberia	0.25	0.00	3.71	0.00	0.51	3.88	20.98	341
Libya	6.62	8.43	16.57	0.00	5.03	-0.11	1.50	343
Liechtenstein	0.16	0.00	1.43	0.00	0.32	2.38	7.91	341
Lithuania	9.45	0.86	47.14	0.00	13.72	1.34	3.46	352
Luxembourg	1.82	1.00	8.71	0.00	2.04	1.14	3.29	362
Madagascar	1.00	0.57	5.00	0.00	1.15	1.82	5.51	298
Malawi	3.16	0.29	33.14	0.00	6.60	2.77	10.06	338
Malaysia	3.26	2.00	18.00	0.00	4.07	1.54	4.70	359
Maldives	0.20	0.14	0.57	0.00	0.17	0.61	2.50	316
Mali	1.03	0.57	5.71	0.00	1.12	1.55	5.15	347
Malta	0.98	0.43	3.43	0.00	1.03	0.65	2.04	337
Mauritania	1.28	0.36	8.29	0.00	1.88	1.77	5.37	346
Mauritius	0.03	0.00	0.71	0.00	0.10	4.49	24.97	355
Mexico	534.06	543.29	1,427.71	0.14	303.12	0.38	3.30	357
Moldova	11.49	10.07	25.71	0.00	6.44	0.33	2.28	358
Monaco	0.07	0.00	1.14	-0.43	0.20	2.52	13.98	347
Mongolia	0.03	0.00	0.14	0.00	0.06	1.24	2.54	72
Montenegro	3.03	2.29	10.00	0.00	2.80	0.58	2.06	353
Morocco	23.72	16.43	79.86	0.14	23.23	0.76	2.44	366
Mozambique	2.38	0.86	16.29	0.00	3.44	1.76	4.85	290
MS Zaandam	0.01	0.00	0.29	0.00	0.04	6.79	47.16	344
Namibia	1.80	1.50	6.14	0.00	1.50	0.85	2.87	244
Nepal	9.96	6.43	102.29	0.14	15.55	4.40	25.32	299
Netherlands	43.15	39.57	154.29	-1.29	40.11	0.75	2.76	370

New Zealand	0.07	0.00	1.29	0.00	0.22	3.78	17.17	347
Nicaragua	0.50	0.14	2.57	0.00	0.55	1.56	5.25	349
Niger	0.50	0.14	3.57	0.00	0.66	1.51	5.25	351
Nigeria	5.59	5.29	14.43	0.14	4.21	0.33	1.83	353
North Macedonia	9.04	6.00	33.00	0.14	8.13	1.35	3.85	354
Norway	1.75	0.93	8.29	0.00	1.99	1.41	4.20	362
Oman	4.61	4.00	16.00	0.14	3.61	0.42	2.01	345
Pakistan	36.99	33.43	135.71	0.29	28.78	0.76	3.01	358
Panama	16.23	13.00	47.43	0.00	11.69	0.99	3.29	365
Papua New Guinea	0.07	0.00	0.57	0.00	0.12	2.19	8.79	227
Paraguay	9.35	12.71	23.00	0.00	7.75	-0.11	1.33	355
Peru	133.93	109.43	743.86	0.43	134.89	3.11	14.14	356
Philippines	30.98	25.86	106.71	0.00	24.35	0.67	2.74	403
Poland	124.38	19.71	505.29	0.14	149.66	0.92	2.46	364
Portugal	46.07	16.00	290.86	0.14	64.16	2.16	7.36	359
Qatar	0.75	0.43	3.57	0.00	0.84	1.65	4.82	348
Romania	59.08	42.07	166.86	0.43	46.27	0.90	2.70	354
Russia	245.35	160.86	554.57	0.14	180.89	0.47	1.68	357
Rwanda	0.94	0.43	4.71	0.00	1.21	1.48	3.95	285
Saint Lucia	0.37	0.29	1.43	0.00	0.40	1.08	3.31	121
Saint Vincent and the Grenadines	0.15	0.14	0.57	0.00	0.15	0.62	2.46	55
San Marino	0.20	0.00	2.14	0.00	0.35	2.69	11.95	373
Sao Tome and Principe	0.10	0.00	1.14	0.00	0.21	2.92	12.54	314
Saudi Arabia	18.55	16.07	52.71	0.14	13.56	0.54	2.09	352
Senegal	2.66	1.43	10.29	0.00	2.77	1.23	3.34	344
Serbia	12.82	5.57	58.86	0.00	15.94	1.60	4.42	356
Seychelles	0.22	0.14	0.57	0.00	0.15	0.72	3.04	66
Sierra Leone	0.25	0.14	2.00	0.00	0.41	2.32	8.05	322
Singapore	0.08	0.00	0.86	0.00	0.16	2.33	8.57	355
Slovakia	22.54	0.86	102.43	0.00	33.91	1.23	2.85	348
Slovenia	10.75	1.57	53.14	0.00	15.06	1.27	3.28	362
Somalia	0.89	0.29	10.00	-0.14	1.75	3.14	13.07	337
South Africa	145.34	92.71	577.57	0.14	142.53	1.50	4.57	349
South Sudan	0.34	0.14	2.43	0.00	0.47	1.78	5.72	300
Spain	191.13	148.43	865.71	-232.14	195.75	1.17	4.55	373
Sri Lanka	1.44	0.14	7.29	0.00	1.97	1.09	2.89	348
Sudan	5.24	2.86	39.86	0.00	7.27	2.67	11.79	363
Suriname	0.51	0.29	2.86	0.00	0.60	1.84	6.44	342
Sweden	35.57	28.50	137.57	-0.29	33.07	0.86	2.99	366
Switzerland	27.09	8.86	103.14	-10.00	33.02	0.94	2.40	371
Syria	3.07	2.86	14.29	0.00	3.03	1.29	4.71	347
Taiwan*	0.02	0.00	0.43	0.00	0.07	3.68	18.22	389
Tajikistan	0.29	0.14	3.00	0.00	0.52	3.63	16.04	313

Tanzania	0.06	0.00	1.00	0.00	0.20	3.37	13.14	345
Thailand	0.23	0.00	2.57	0.00	0.47	3.07	12.65	375
Togo	0.26	0.14	1.14	0.00	0.25	1.18	3.93	349
Trinidad and Tobago	0.40	0.14	2.71	0.00	0.57	1.94	6.57	351
Tunisia	22.96	2.43	90.29	0.00	27.30	0.73	2.00	357
Turkey	80.87	66.00	255.14	0.14	65.83	1.07	3.27	359
Uganda	1.45	1.29	6.57	0.00	1.23	1.49	5.50	230
Ukraine	78.48	47.00	235.86	0.14	72.25	0.57	1.84	363
United Arab Emirates	3.71	2.50	16.14	0.00	3.80	1.83	5.44	356
United Kingdom	337.14	258.36	1,253.00	0.14	343.85	1.00	3.08	370
Uruguay	1.87	0.29	10.43	0.00	2.85	1.49	3.69	348
US	1,396.67	1,041.00	3,417.86	0.14	894.22	0.61	2.39	376
Uzbekistan	1.78	0.43	6.57	0.00	2.11	0.87	2.22	349
Venezuela	3.96	4.00	9.00	-0.86	2.63	-0.06	1.94	349
Vietnam	0.16	0.00	2.00	0.00	0.39	2.58	8.90	223
West Bank and Gaza	6.12	4.29	25.43	0.00	6.79	1.29	3.69	350
Yemen	2.07	0.57	16.43	0.00	3.01	2.37	9.32	315
Zambia	3.28	1.00	17.71	0.00	4.69	1.48	3.82	343
Zimbabwe	4.21	1.00	43.14	0.00	8.43	3.04	11.99	353
All	42.54	1.57	3,417.86	-232.14	172.67	9.12	119.88	60,986

Source: Johns Hopkins University COVID-19 Resource Center. Coronavirus COVID-19 (2019-nCoV) (arcgis.com). Access Date: March 11, 2021.

Figure 31 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 1000

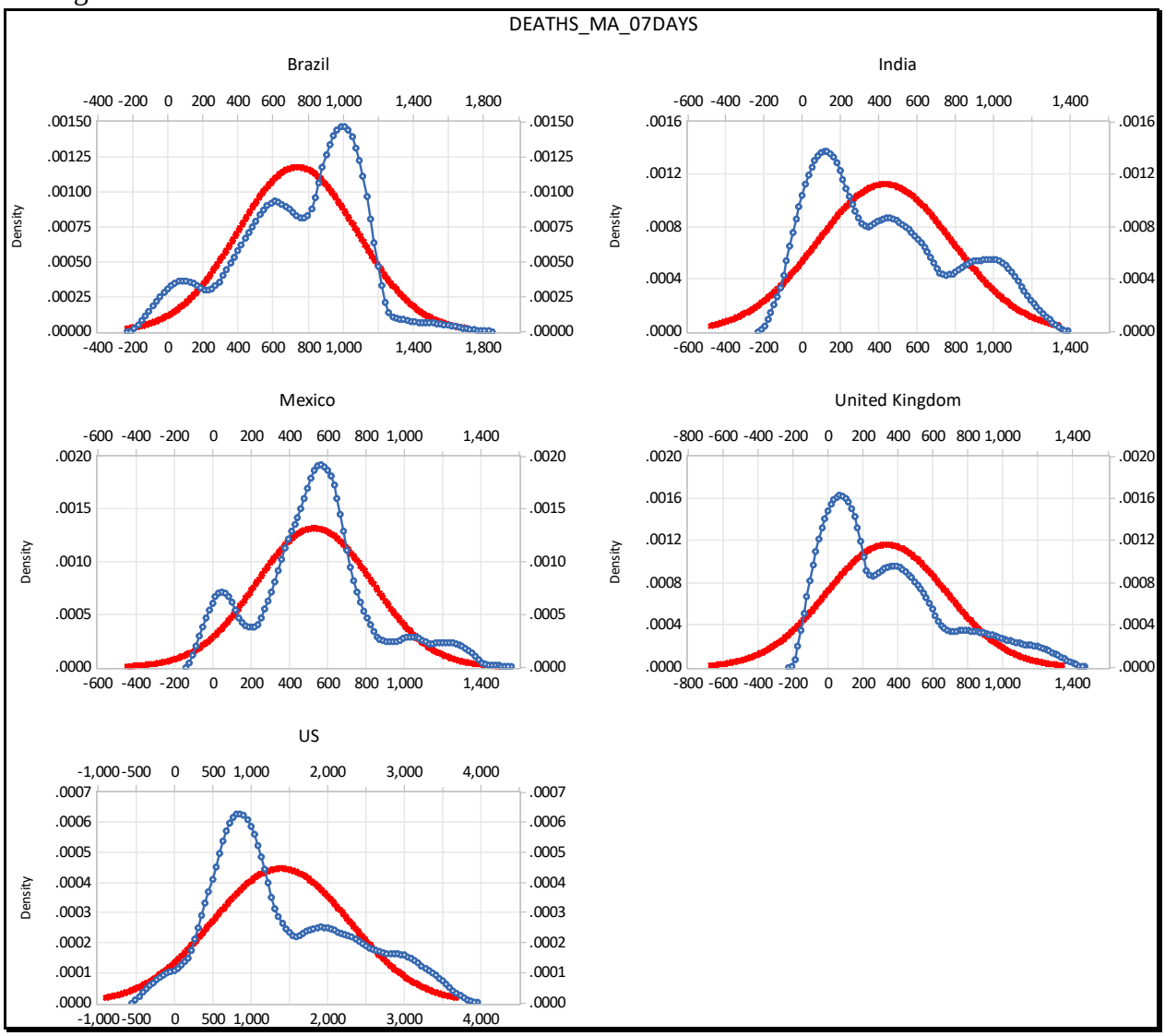


Figure 32 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 500 and Less Than or Equal to 1000

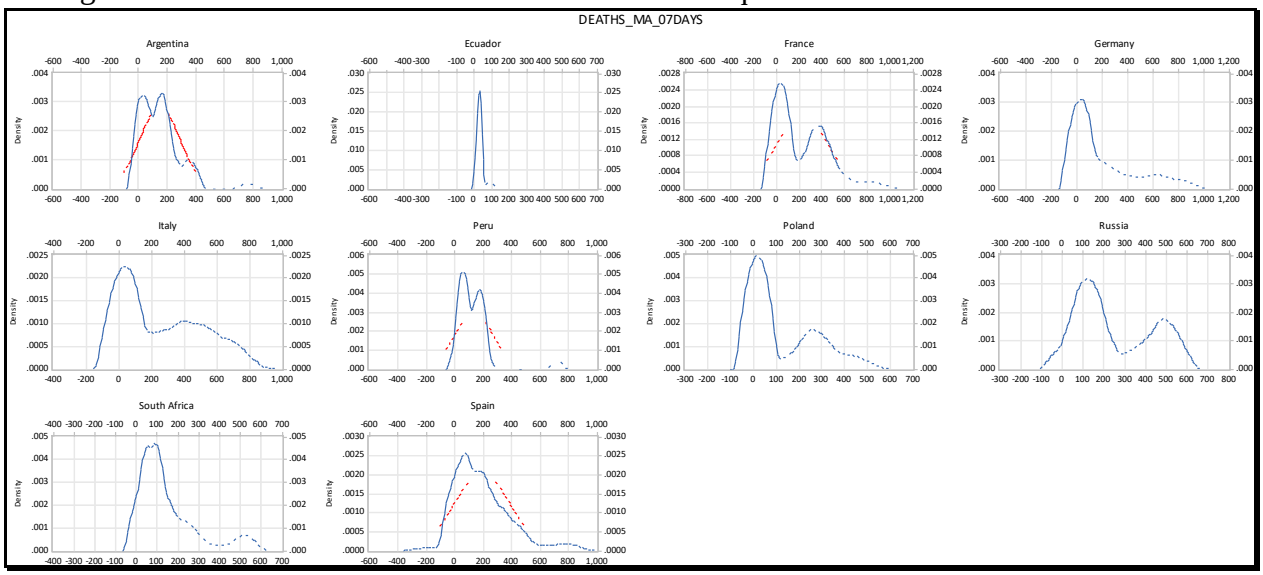


Figure 33 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 200 and Less Than or Equal to 500

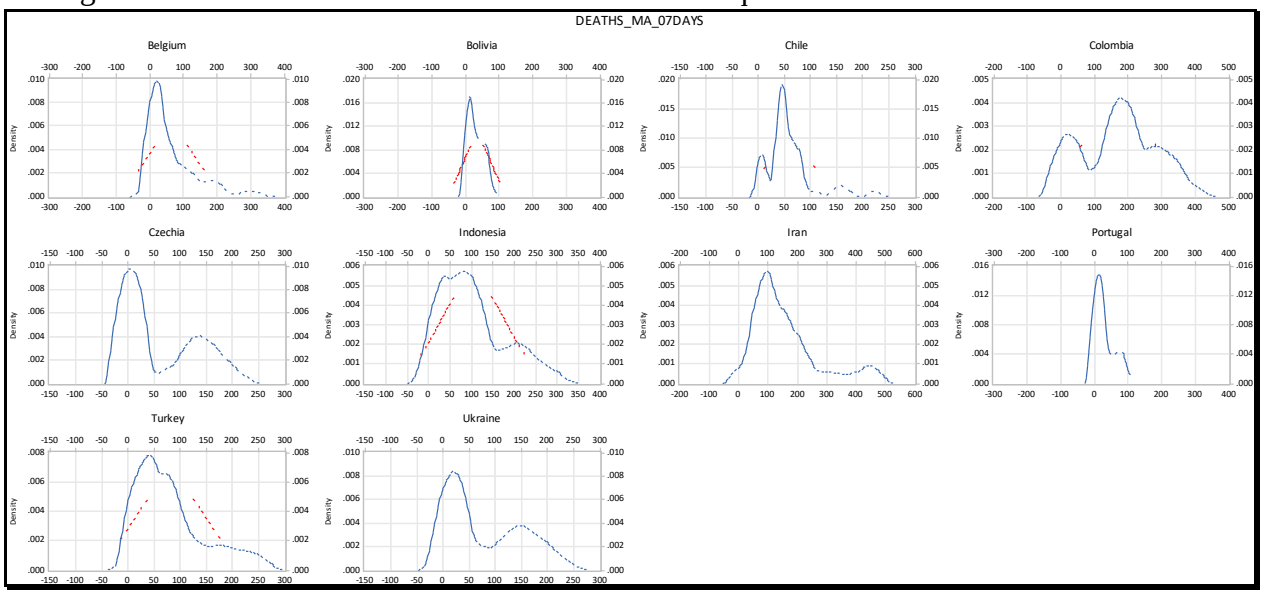


Figure 34 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 100 and Less Than or Equal to 200

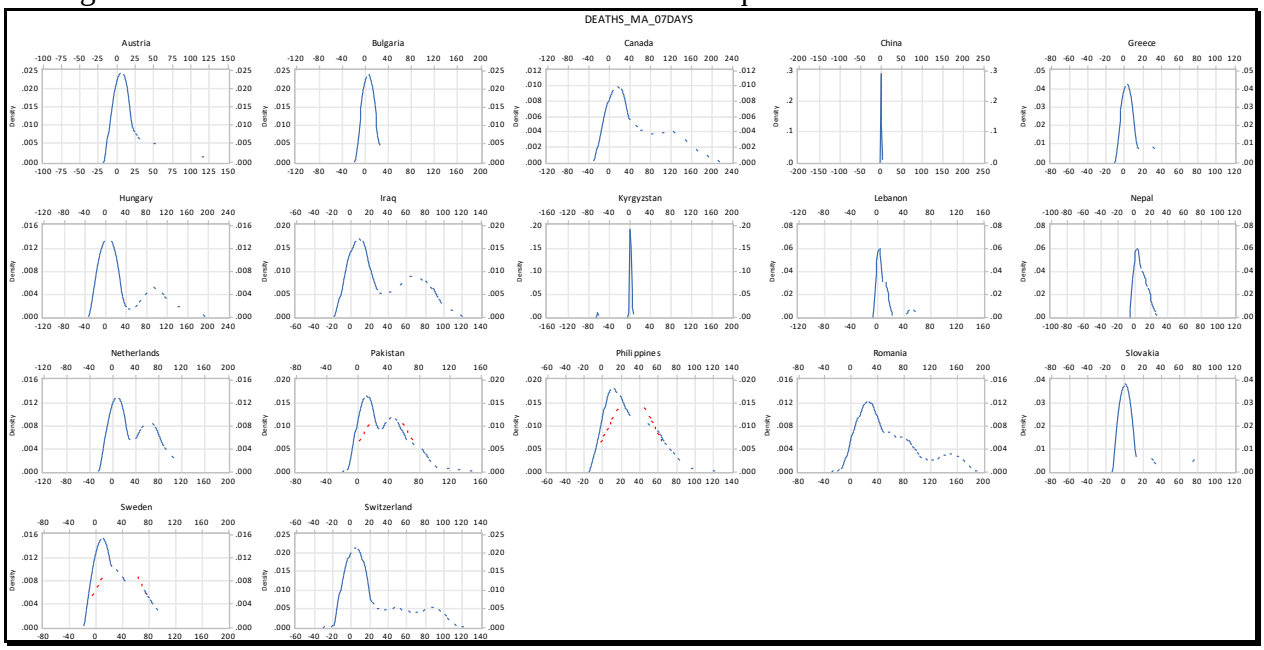


Figure 35 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 50 and Less Than or Equal to 100

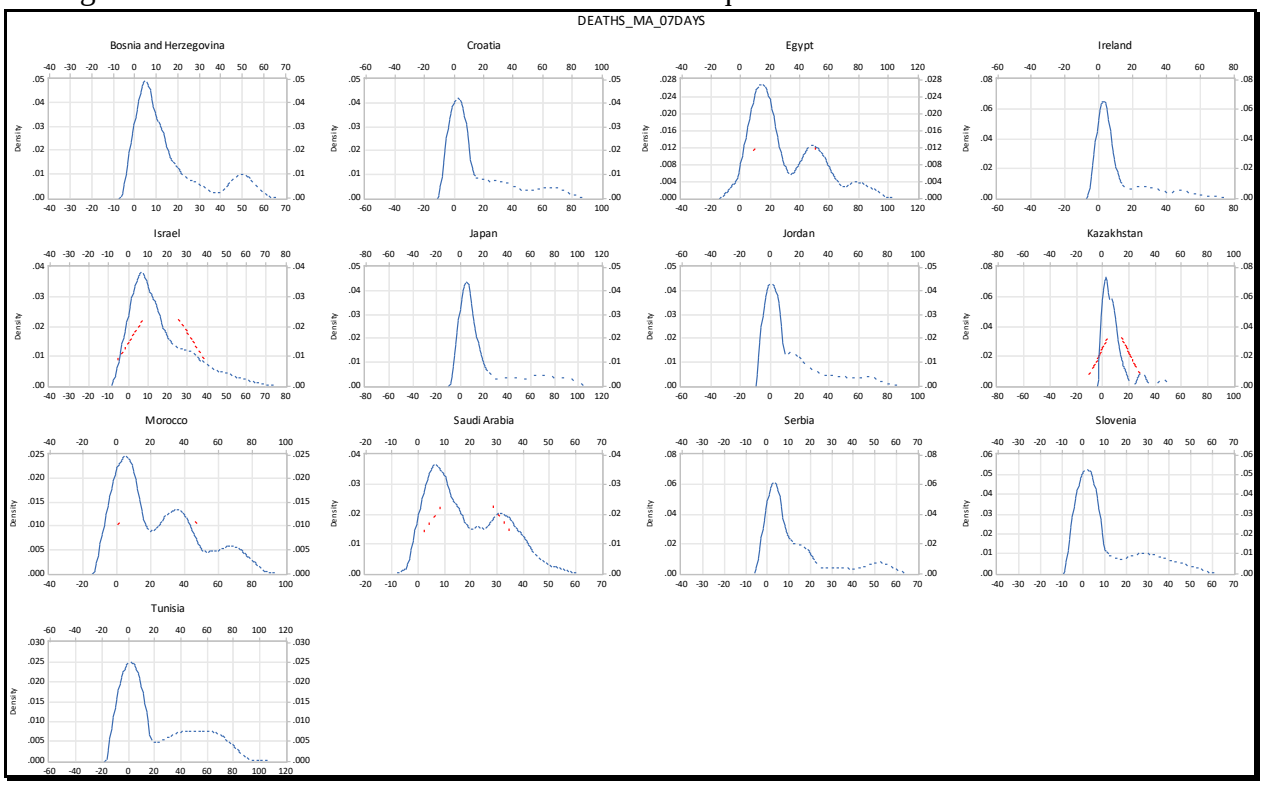


Figure 36 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 30 and Less Than or Equal to 50

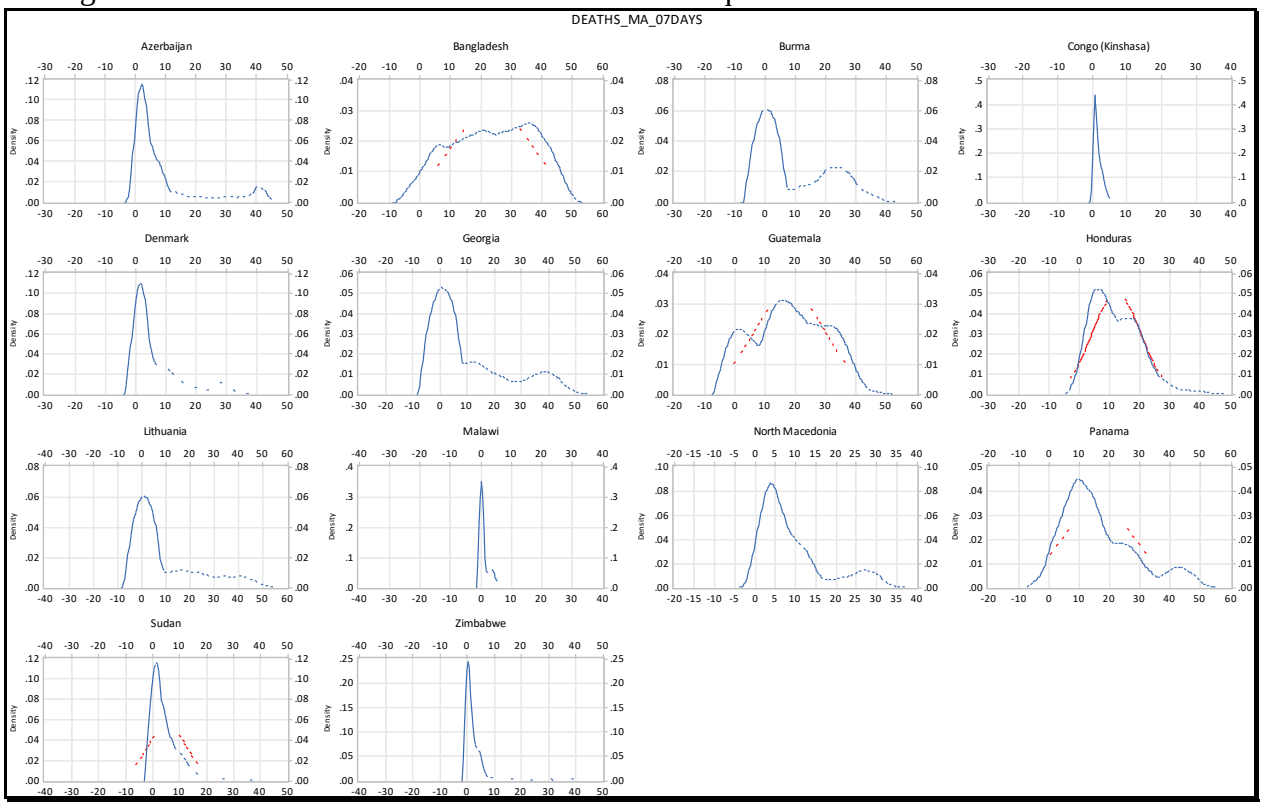


Figure 37 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 20 and Less Than or Equal to 30

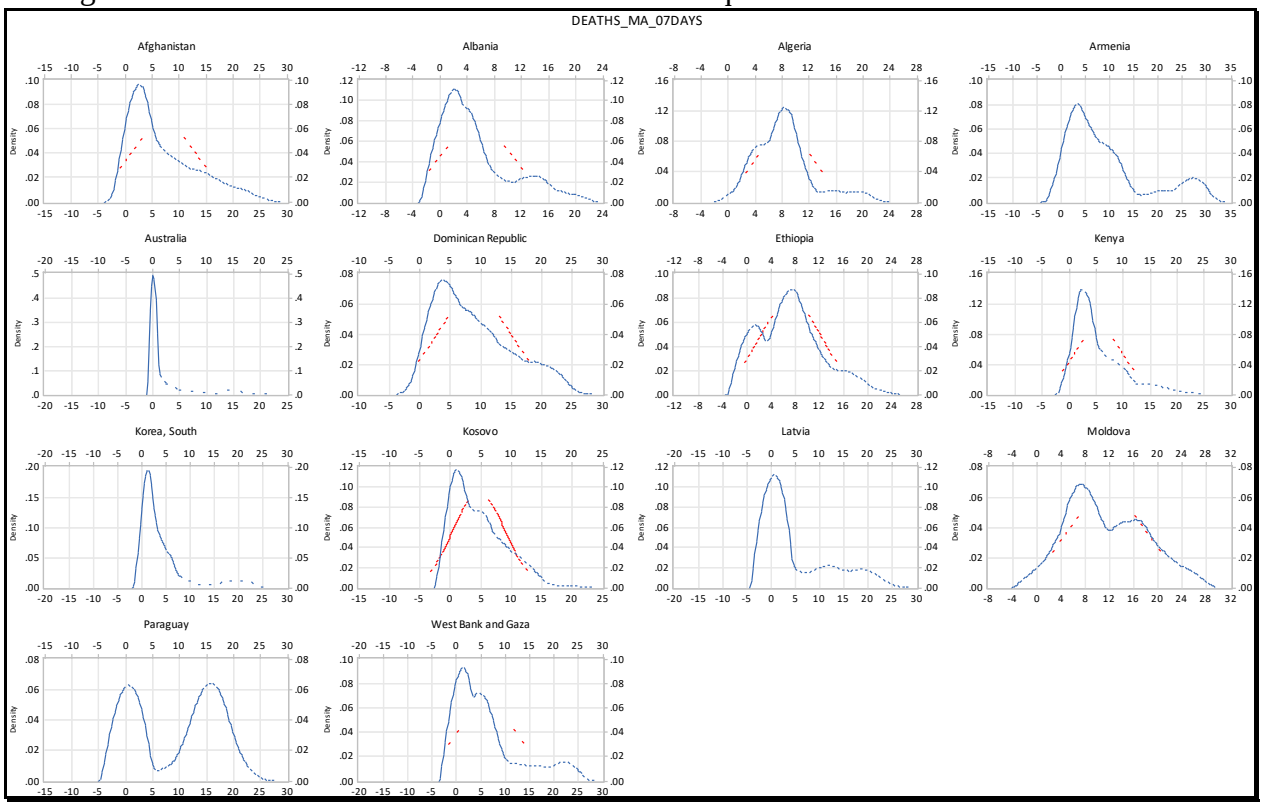


Figure 38 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 10 and Less Than or Equal to 20

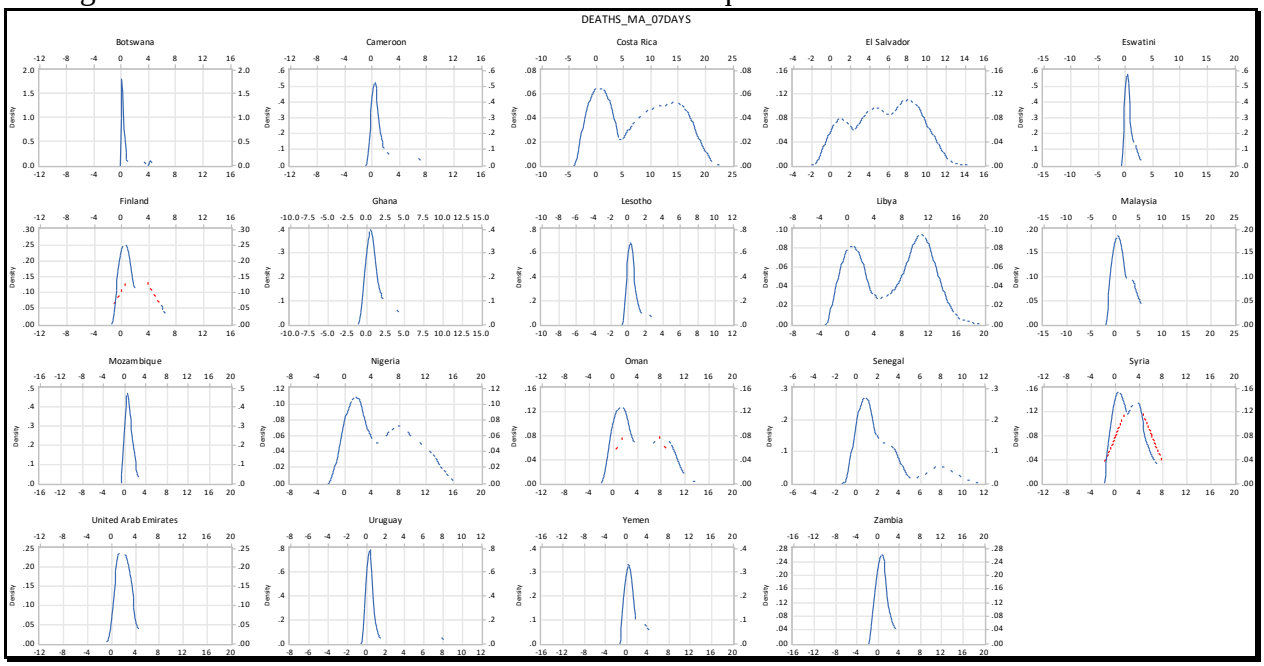


Figure 39 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 5 and Less Than or Equal to 10

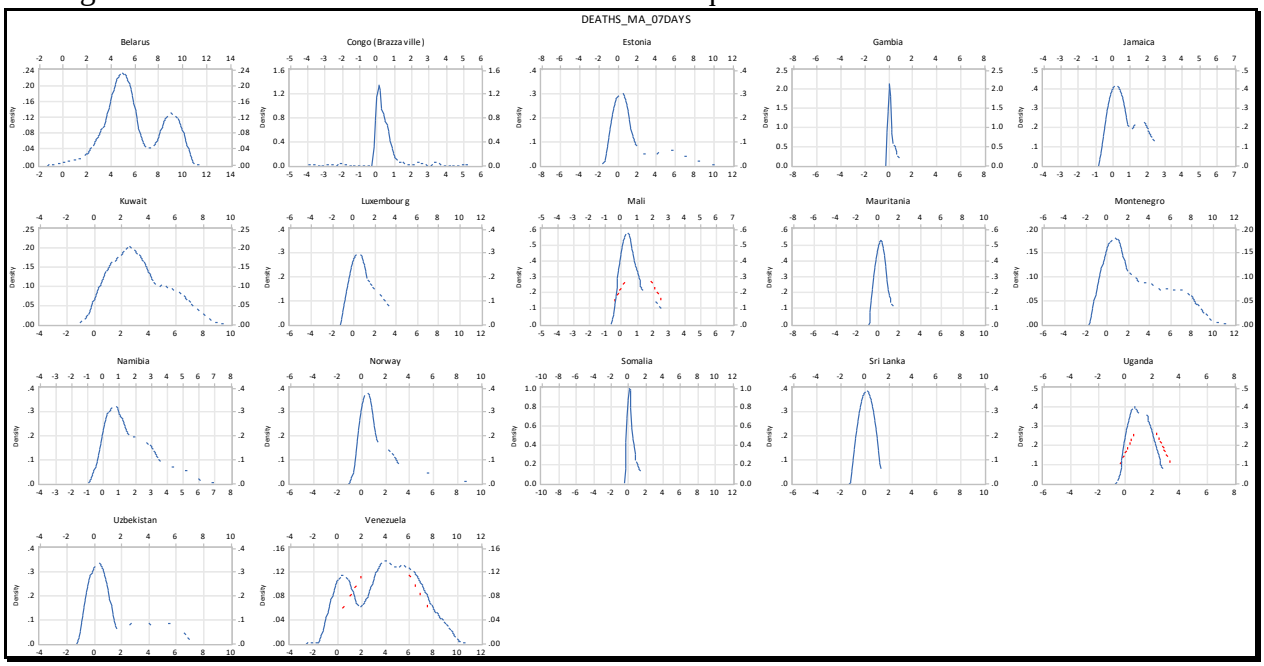


Figure 40 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Greater Than 3 and Less Than or Equal to 5

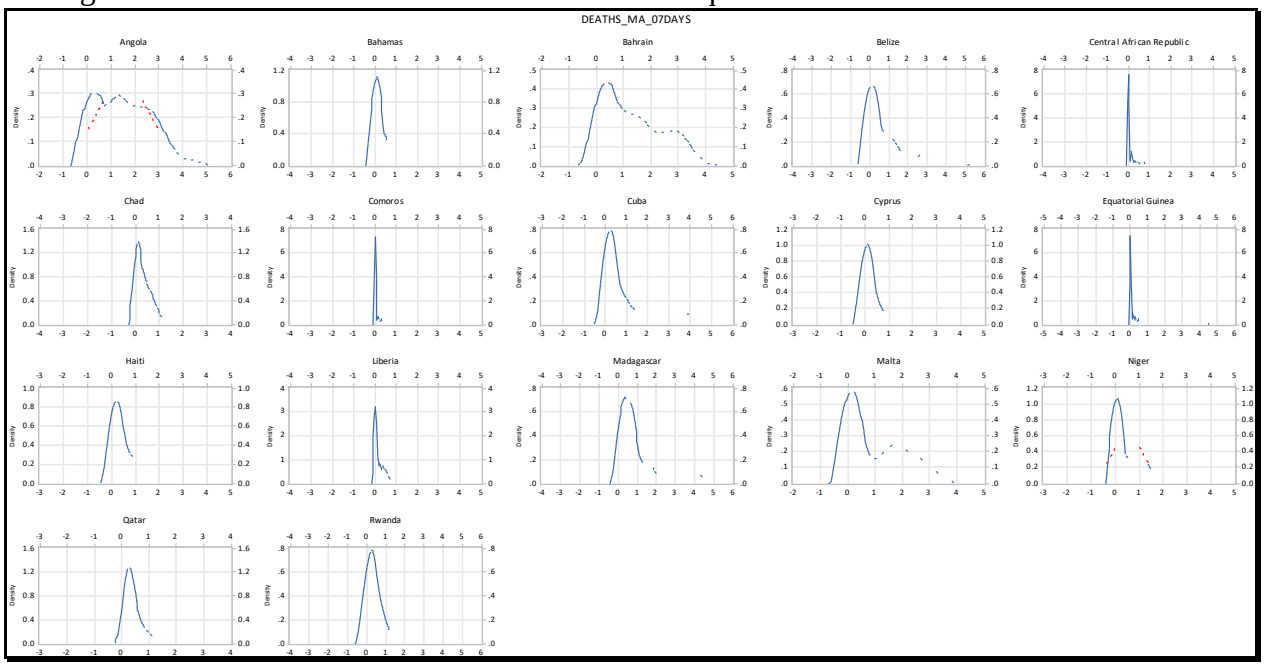
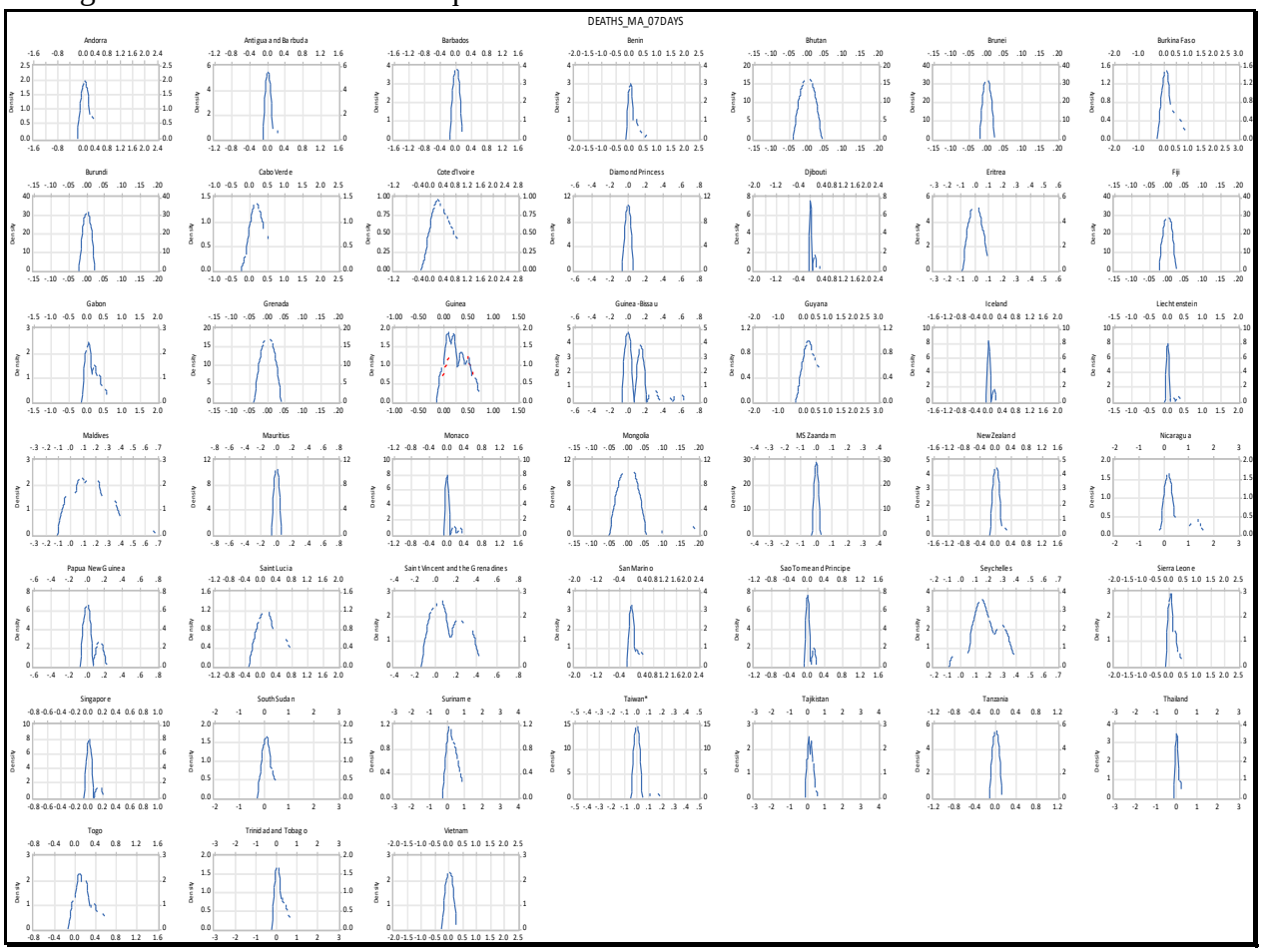


Figure 41 Kernel Density and Theoretical Normal Distribution: Countries with 7-day Moving Average of Deaths Less Than or Equal to 3



8 Appendix B: Some Examples of COVID-19 Data Issues

As health officials deal with a new virus, a definition may become an issue. Here, there are some examples of these issues. There are definitely many other countries in similar situations presented here..

8.1 Actual and Reported Deaths in the US and Other Countries

A cursory look at data for the US and other countries reveal a pattern because of reporting time and not actual deaths (Figure 42). In the US, there are jumps in number of deaths on Wednesdays.

8.2 Different Definitions of "Recovered" are Used

Recovered numbers are consistently lower in the United Kingdom, Sweden and the Netherlands if compared with deaths (Figure 43). The reason is that there is no follow up of patients after they are discharged from a hospital. According to data reported by the Johns Hopkins University, the United States has zero recovered cases after December 12. The major reason is that California stopped reporting these figures. Belgium and Serbia have taken similar approaches.

These recovered figures in the US affect the global figures also. There were 79,966,148 COVID-19 confirmed cases in the world, 1,752,674 deaths, and 45,114,894 recovered, according to Johns Hopkins University, Coronavirus Resource Center (access date and time: 12/26/2020, 11:00 EST). In the United States, there are 18,768,116 confirmed cases, 330,340 deaths, and no figure for recovered cases. However, there are recovered figures for US states, but not for the US. There is a significant drop in the number of recovered. The figure was 46,857,548 two weeks earlier (12/12/2020) in the World and 6,246,605 in the US.

8.3 Different Definitions of "Confirmed" are Used

In Turkey, Ministry of Health used "hospitalizations" as "confirmed" until early December. After that period, the definition included people who tested positive. There is an increase and a surge after that time (Figure 44).

8.4 Dealing with "Outliers"

One of the issues that can come up when using international data is the wide range of figures, especially during a pandemic when some basic definitions may not be clear to data collecting agencies. At this point, there is no easy way to clarify all the reasons for differences. A pragmatic approach may be to exclude outliers, with a well specified way. For example, a country with less than 100 deaths may not be included in analysis. This may look like a reasonable approach, but it may have problems. For example, Singapore had a relatively low number of deaths because of their relatively successful handling of the pandemic, at least until now. There is no reason to exclude Singapore from our analysis. Therefore, all available data are used.

8.5 Data Issues Revealed by Descriptive Statistics

There are data issues mostly related to reporting. These can be seen in summary statistics. For example, there are many countries with minimum daily death numbers which are negative (Table 6). On top of the list Spain has negative 1918 as the minimum. This is probably due to data revisions and changes in definitions. Note: The decrease of 1918 in total number of deaths data was on May 25th, 2020. The web page had this information. European Centers for Disease Control and Preventions, which stopped releasing daily numbers on December 14, 2020, also had the same data. Download historical data (to 14 December 2020) on the daily number of new reported COVID-19 cases and deaths worldwide (europa.eu). Some have very large maximum numbers. Ecuador is an exmaple. There are many others. These can be seen with very large skewness and kurtosis numbers.

Table 6 Descriptive Statistics for Daily Deaths, 1/22/2020-3/10/2021, Deaths>0

COUNTRY	Mean	Median	Maximum	Minimum	Range	Std. Dev.	Coefficient of Variation	Skewness	Kurtosis	Observations
Spain	192.92	90.0	1623	-1918	3541	274.2	1.4	0.0	13.8	373
Kyrgyzstan	4.32	1.0	727	-443	1170	47.2	10.9	8.2	186.1	342
Sweden	35.76	5.0	474	-232	706	68.2	1.9	2.9	16.0	366
France	230.02	130.5	1438	-217	1655	284.6	1.2	1.8	6.2	390
Belgium	61.22	33.0	496	-117	613	79.1	1.3	2.0	8.1	365
Switzerland	27.18	7.0	171	-106	277	39.6	1.5	1.6	5.4	371
Mozambique	2.44	1.0	58	-34	92	5.5	2.2	3.4	45.7	290
Congo (Brazzaville)	0.38	0.0	24	-31	55	2.6	6.8	-1.7	88.1	343
Germany	198.52	48.0	1734	-31	1765	293.4	1.5	2.0	6.8	367
Italy	262.53	195.0	993	-31	1024	256.8	1.0	0.7	2.2	384
Netherlands	43.45	29.0	234	-18	252	45.0	1.0	1.1	4.0	370
Bosnia and Herzegovina	15.16	6.0	86	-11	97	20.1	1.3	1.6	4.8	355
Cyprus	0.66	0.0	8	-7	15	1.4	2.2	1.9	11.9	354
Denmark	6.58	3.0	60	-6	66	9.0	1.4	2.0	7.8	362
Estonia	1.93	0.0	14	-6	20	3.0	1.5	1.6	5.1	351
Venezuela	4.01	4.0	12	-6	18	2.9	0.7	0.0	2.6	349
Ireland	12.33	4.0	220	-5	225	21.3	1.7	3.9	29.3	365
Angola	1.49	1.0	12	-3	15	1.8	1.2	1.6	7.2	347
Czechia	63.23	9.0	295	-3	298	75.3	1.2	0.8	2.3	354
Libya	6.79	5.0	37	-3	40	7.6	1.1	1.3	4.8	343
Monaco	0.07	0.0	3	-3	6	0.4	5.4	2.7	33.3	347
Serbia	12.98	6.0	69	-3	72	16.3	1.3	1.6	4.7	356
Finland	2.19	0.0	43	-2	45	4.1	1.9	4.2	33.1	355
Luxembourg	1.86	0.0	29	-2	31	3.6	2.0	3.5	19.3	362

Malta	1.00	0.0	7	-2	9	1.4	1.4	1.3	4.3	337
Philippines	31.13	18.0	259	-2	261	35.8	1.2	2.3	10.9	403
Australia	2.42	0.0	59	-1	60	5.7	2.3	4.7	36.3	375
Austria	24.11	7.5	218	-1	219	34.6	1.4	2.0	7.0	364
Belize	0.93	0.0	16	-1	17	2.0	2.1	3.8	22.0	339
Burma	9.28	0.0	48	-1	49	11.9	1.3	0.9	2.4	345
Cuba	1.00	0.0	6	-1	7	1.5	1.5	1.4	3.8	358
Haiti	0.74	0.0	7	-1	8	1.4	1.9	2.2	7.5	338
India	433.39	355.0	2003	-1	2004	368.7	0.9	0.8	2.9	365
Japan	21.46	9.0	248	-1	249	29.8	1.4	2.4	12.2	392
Kazakhstan	9.11	1.0	324	-1	325	32.1	3.5	6.6	53.4	350
Nigeria	5.65	4.0	31	-1	32	5.7	1.0	1.4	5.0	353
Somalia	0.97	0.0	20	-1	21	2.5	2.6	3.7	20.2	337
Tajikistan	0.29	0.0	8	-1	9	0.8	2.9	5.0	37.3	313
Vietnam	0.16	0.0	3	-1	4	0.6	3.6	3.7	17.1	223
US	1407.43	1111.5	4465	0	4465	1003.5	0.7	1.0	3.4	376
Peru	135.29	101.0	4143	0	4143	309.2	2.3	11.2	141.0	356
Ecuador	44.49	26.0	3852	0	3852	205.3	4.6	17.7	328.6	362
Argentina	145.00	112.5	3351	0	3351	210.5	1.5	9.8	147.4	368
Mexico	539.19	490.0	3050	0	3050	409.4	0.8	1.7	9.1	357
Brazil	753.92	713.0	2286	0	2286	445.3	0.6	0.2	2.6	359
United Kingdom	338.44	200.0	1826	0	1826	381.5	1.1	1.4	4.6	370
Bolivia	34.25	26.0	1656	0	1656	90.6	2.6	16.6	297.6	347
China	11.68	0.0	1290	0	1290	68.9	5.9	15.8	289.2	413
Chile	59.90	45.5	1057	0	1057	77.4	1.3	7.5	87.3	354
South Africa	146.17	100.0	844	0	844	158.2	1.1	2.0	7.4	349
Poland	126.37	23.0	674	0	674	174.5	1.4	1.4	3.7	364
Russia	248.66	172.0	624	0	624	183.8	0.7	0.5	1.8	357
Nepal	10.07	5.0	619	0	619	38.6	3.8	13.9	213.0	299
Iran	157.84	125.0	486	0	486	113.9	0.7	1.3	4.2	386
Indonesia	103.92	87.0	476	0	476	80.6	0.8	1.1	4.3	365
Colombia	171.68	179.0	400	0	400	114.7	0.7	0.1	2.1	354
Lebanon	14.15	4.5	351	0	351	26.8	1.9	6.2	70.1	366
Pakistan	37.37	31.0	313	0	313	35.1	0.9	2.2	13.8	358
Portugal	46.29	16.0	303	0	303	64.8	1.4	2.2	7.6	359
Ukraine	79.68	46.0	297	0	297	78.8	1.0	0.9	2.6	363
Sudan	5.28	0.0	278	0	278	18.2	3.5	10.9	149.4	363
Turkey	81.41	67.0	259	0	259	65.8	0.8	1.1	3.3	359
Canada	60.84	41.0	244	0	244	57.5	0.9	0.9	2.8	367
Bulgaria	30.13	8.0	221	0	221	45.1	1.5	2.0	6.2	365
Tunisia	23.23	2.0	217	0	217	33.0	1.4	1.8	7.6	357
Romania	59.76	44.5	213	3	210	48.7	0.8	1.1	3.5	354
Slovakia	23.41	0.0	204	0	204	37.8	1.6	1.7	5.3	348

Congo (Kinshasa)	2.01	0.0	196	0	196	10.6	5.3	17.5	320.1	355
Hungary	45.22	11.0	193	0	193	55.2	1.2	1.0	2.6	361
Iraq	36.68	24.5	122	0	122	33.1	0.9	0.5	1.9	372
Greece	18.87	5.0	121	0	121	27.8	1.5	1.8	5.3	365
Israel	16.71	12.0	101	0	101	16.7	1.0	1.7	6.8	356
Egypt	30.24	20.0	97	0	97	23.2	0.8	0.9	2.9	368
Croatia	15.76	3.0	92	0	92	22.1	1.4	1.5	4.2	357
Morocco	23.78	16.0	92	0	92	23.8	1.0	0.8	2.7	366
Jordan	14.63	2.0	91	0	91	21.0	1.4	1.5	4.5	349
Malawi	3.19	0.0	73	0	73	8.2	2.6	4.7	30.7	338
Zimbabwe	4.22	0.0	70	0	70	9.5	2.3	3.7	18.5	353
Oman	4.64	2.0	67	0	67	7.1	1.5	3.7	24.5	345
Zambia	3.32	0.0	67	0	67	6.4	1.9	4.1	32.0	343
Slovenia	10.80	2.0	66	0	66	15.4	1.4	1.4	3.8	362
Bangladesh	23.73	23.0	64	0	64	13.9	0.6	0.1	2.2	358
Cameroon	1.61	0.0	64	0	64	6.1	3.8	6.7	56.0	351
Guatemala	18.12	15.5	61	0	61	14.7	0.8	0.6	2.6	360
Kosovo	4.74	3.0	61	0	61	6.4	1.3	3.0	21.2	353
Lithuania	9.52	1.0	61	0	61	14.1	1.5	1.5	4.3	352
Panama	16.32	13.0	61	0	61	12.4	0.8	1.1	3.9	365
Costa Rica	7.98	4.0	58	0	58	10.1	1.3	1.7	6.8	357
Saudi Arabia	18.59	15.0	58	0	58	13.8	0.7	0.6	2.3	352
Honduras	12.29	9.0	56	0	56	11.6	0.9	1.5	5.3	350
Botswana	1.20	0.0	54	0	54	5.3	4.5	6.3	49.3	345
Georgia	10.60	1.0	53	0	53	14.4	1.4	1.2	3.3	341
Yemen	2.10	1.0	52	0	52	4.9	2.3	6.5	57.1	315
Azerbaijan	8.97	3.0	47	0	47	12.1	1.3	1.8	4.9	363
Afghanistan	6.92	4.0	46	0	46	8.1	1.2	1.8	6.6	354
North Macedonia	9.16	6.0	46	0	46	8.8	1.0	1.5	4.9	354
Latvia	5.05	1.0	44	0	44	8.1	1.6	1.9	6.2	342
Armenia	9.25	6.0	41	0	41	8.9	1.0	1.3	4.0	350
Kenya	5.42	3.0	41	0	41	6.0	1.1	2.0	8.5	350
Korea, South	4.29	2.0	40	0	40	6.0	1.4	2.4	9.8	385
Dominican Republic	8.91	7.0	39	0	39	7.8	0.9	1.2	4.3	359
Moldova	11.68	11.0	33	0	33	7.2	0.6	0.3	2.2	358
Paraguay	9.54	12.0	33	0	33	8.3	0.9	0.1	1.7	355
Equatorial Guinea	0.30	0.0	32	0	32	2.4	8.0	10.8	127.7	323
El Salvador	5.59	5.0	31	0	31	3.9	0.7	0.9	7.2	345
Algeria	8.31	8.0	30	0	30	4.9	0.6	1.1	5.0	364
West Bank and Gaza	6.27	4.0	30	0	30	7.3	1.2	1.4	4.1	350
Ethiopia	7.25	7.0	28	0	28	6.2	0.9	0.8	3.2	340
Ghana	1.85	0.0	28	0	28	3.6	1.9	2.7	13.2	355

Norway	1.75	0.0	27	0	27	3.5	2.0	3.2	16.2	362
Lesotho	1.26	0.0	25	0	25	3.4	2.7	4.1	23.1	245
Malaysia	3.32	1.0	25	0	25	4.6	1.4	1.9	6.9	359
Eswatini	2.00	0.0	24	0	24	4.2	2.1	3.0	12.6	329
Albania	5.44	4.0	21	0	21	5.6	1.0	1.1	3.4	365
Syria	3.11	3.0	20	0	20	3.2	1.0	1.5	6.6	347
United Arab Emirates	3.80	2.0	20	0	20	4.2	1.1	1.8	5.8	356
Montenegro	3.12	2.0	18	0	18	3.4	1.1	1.1	3.7	353
Nicaragua	0.50	0.0	18	0	18	1.9	3.8	5.2	33.9	349
Senegal	2.72	2.0	18	0	18	3.2	1.2	1.6	5.4	344
Liberia	0.25	0.0	17	0	17	1.1	4.4	11.2	163.6	341
Uruguay	1.95	0.0	17	0	17	3.2	1.7	1.9	5.8	348
Uganda	1.45	1.0	16	0	16	2.5	1.7	3.1	14.1	230
Bahamas	0.54	0.0	15	0	15	1.4	2.6	4.8	39.7	344
Gambia	0.43	0.0	14	0	14	1.4	3.2	5.6	42.5	353
Mauritania	1.28	0.0	13	0	13	2.2	1.7	2.3	8.9	346
Namibia	1.84	1.0	13	0	13	2.2	1.2	1.7	6.6	244
Sri Lanka	1.47	0.0	13	0	13	2.4	1.6	1.9	6.2	348
Comoros	0.47	0.0	12	0	12	1.4	2.9	4.1	24.7	309
Belarus	5.98	6.0	11	0	11	2.5	0.4	0.0	2.3	345
Kuwait	3.35	3.0	11	0	11	2.5	0.7	0.8	3.1	341
Mali	1.03	0.0	11	0	11	1.6	1.6	2.4	10.5	347
Chad	0.47	0.0	10	0	10	1.1	2.4	4.6	31.5	317
Madagascar	1.01	0.0	10	0	10	1.8	1.7	2.1	7.4	298
Jamaica	1.30	0.0	9	0	9	1.8	1.4	1.6	5.2	357
Rwanda	0.95	0.0	9	0	9	1.5	1.6	2.1	7.9	285
Suriname	0.51	0.0	9	0	9	1.1	2.2	4.2	26.2	342
Uzbekistan	1.78	1.0	8	0	8	2.3	1.3	1.0	2.8	349
Bahrain	1.32	1.0	7	0	7	1.5	1.2	1.2	4.1	360
Central African Republic	0.22	0.0	7	0	7	0.9	4.2	5.6	37.3	292
Niger	0.51	0.0	7	0	7	1.1	2.1	2.8	12.7	351
Qatar	0.76	0.0	7	0	7	1.2	1.5	1.9	7.0	348
Sierra Leone	0.25	0.0	7	0	7	0.7	2.8	4.6	34.7	322
Trinidad and Tobago	0.40	0.0	7	0	7	0.9	2.1	3.2	17.3	351
Andorra	0.32	0.0	6	0	6	0.7	2.3	3.2	16.5	354
Benin	0.24	0.0	6	0	6	0.8	3.5	4.4	24.6	339
San Marino	0.21	0.0	6	0	6	0.6	3.1	4.5	29.3	373
Tanzania	0.06	0.0	6	0	6	0.5	7.9	9.7	105.6	345
Antigua and Barbuda	0.07	0.0	5	0	5	0.4	5.4	8.7	103.2	338
Burkina Faso	0.40	0.0	5	0	5	0.9	2.2	2.8	11.1	358
Gabon	0.26	0.0	5	0	5	0.7	2.7	3.3	15.9	356

Iceland	0.10	0.0	5	0	5	0.5	5.0	7.2	65.6	359
South Sudan	0.34	0.0	5	0	5	0.9	2.6	3.0	11.9	300
Cote d'Ivoire	0.59	0.0	4	0	4	0.9	1.6	1.6	5.2	347
Djibouti	0.19	0.0	4	0	4	0.6	3.4	3.8	18.0	335
Guinea	0.31	0.0	4	0	4	0.6	2.0	2.3	9.2	330
Guinea-Bissau	0.16	0.0	4	0	4	0.6	3.6	4.5	26.0	319
Guyana	0.56	0.0	4	0	4	0.9	1.5	1.4	3.9	364
Liechtenstein	0.16	0.0	4	0	4	0.6	3.5	4.5	25.5	341
New Zealand	0.07	0.0	4	0	4	0.4	5.0	6.5	54.3	347
Saint Lucia	0.39	0.0	4	0	4	0.8	2.1	2.3	8.0	121
Sao Tome and Principe	0.10	0.0	4	0	4	0.4	3.9	5.6	43.5	314
Thailand	0.23	0.0	4	0	4	0.6	2.7	3.2	13.6	375
Barbados	0.11	0.0	3	0	3	0.4	3.7	4.4	24.4	340
Cabo Verde	0.44	0.0	3	0	3	0.7	1.7	1.8	5.8	352
Eritrea	0.09	0.0	3	0	3	0.4	4.8	5.4	33.1	79
Taiwan*	0.03	0.0	3	0	3	0.2	7.8	10.4	132.7	389
Togo	0.26	0.0	3	0	3	0.6	2.2	2.3	8.4	349
Diamond Princess	0.03	0.0	2	0	2	0.2	6.5	7.1	56.9	385
Maldives	0.20	0.0	2	0	2	0.4	2.1	1.8	5.4	316
Mauritius	0.03	0.0	2	0	2	0.2	7.0	7.7	67.1	355
MS Zaandam	0.01	0.0	2	0	2	0.1	18.5	18.5	342.0	344
Papua New Guinea	0.07	0.0	2	0	2	0.3	3.9	4.2	21.6	227
Saint Vincent and the Grenadines	0.15	0.0	2	0	2	0.4	3.1	3.1	12.1	55
Seychelles	0.23	0.0	2	0	2	0.5	2.3	2.2	7.0	66
Singapore	0.08	0.0	2	0	2	0.3	3.7	3.9	19.0	355
Bhutan	0.02	0.0	1	0	1	0.1	7.9	7.7	60.0	62
Brunei	0.01	0.0	1	0	1	0.1	10.7	10.6	114.0	348
Burundi	0.01	0.0	1	0	1	0.1	10.5	10.4	108.7	332
Fiji	0.01	0.0	1	0	1	0.1	10.5	10.4	109.5	223
Grenada	0.01	0.0	1	0	1	0.1	8.2	8.0	65.0	67
Mongolia	0.04	0.0	1	0	1	0.2	4.8	4.6	22.0	72
All	42.95	1.0	4465	-1918	6383	185.1	4.3	10.1	149.7	60992

Source: Johns Hopkins University COVID-19 Resource Center. Coronavirus COVID-19 (2019-nCoV) (arcgis.com). Access Date: March 11, 2021.

Figure 42 Reporting Time May Affect “Actual” Occurrances

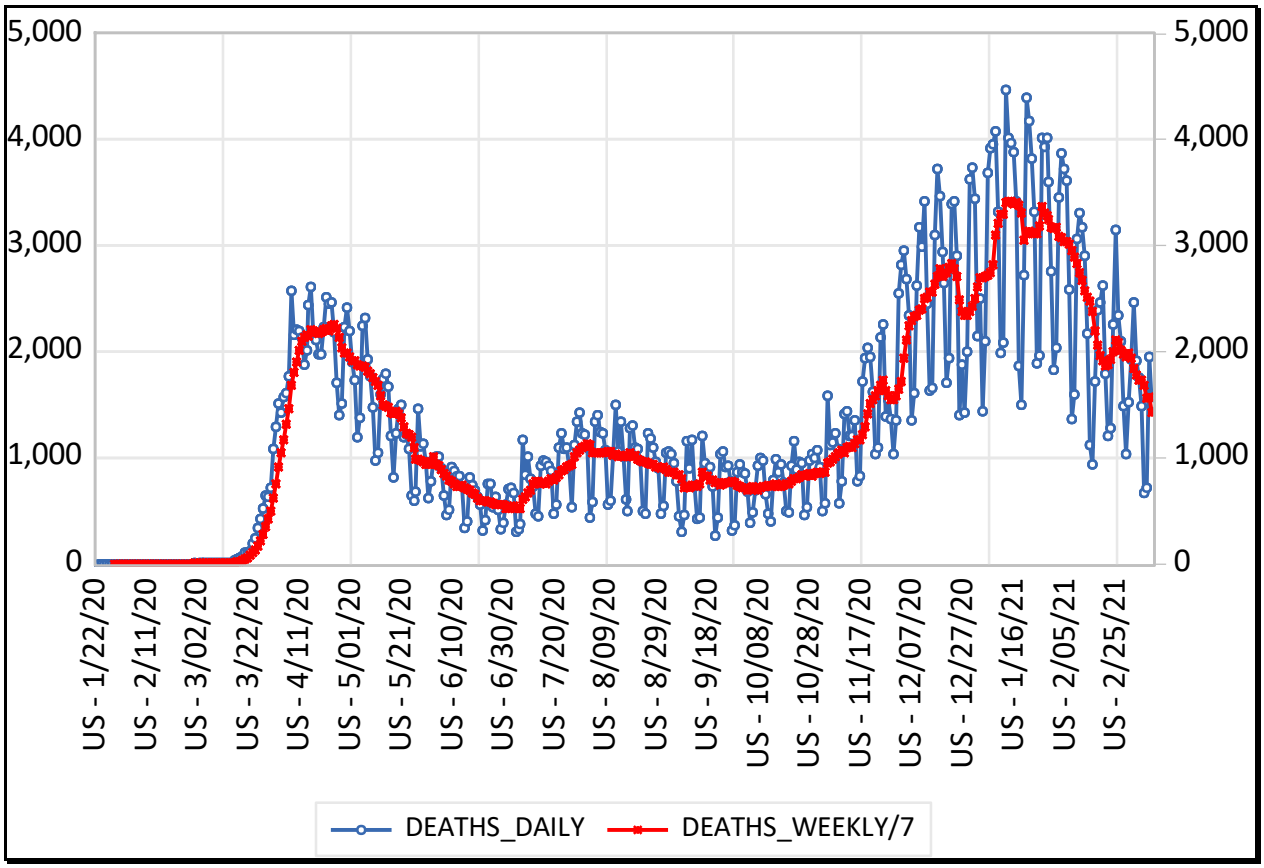


Figure 43 Data on Deaths and Recovered

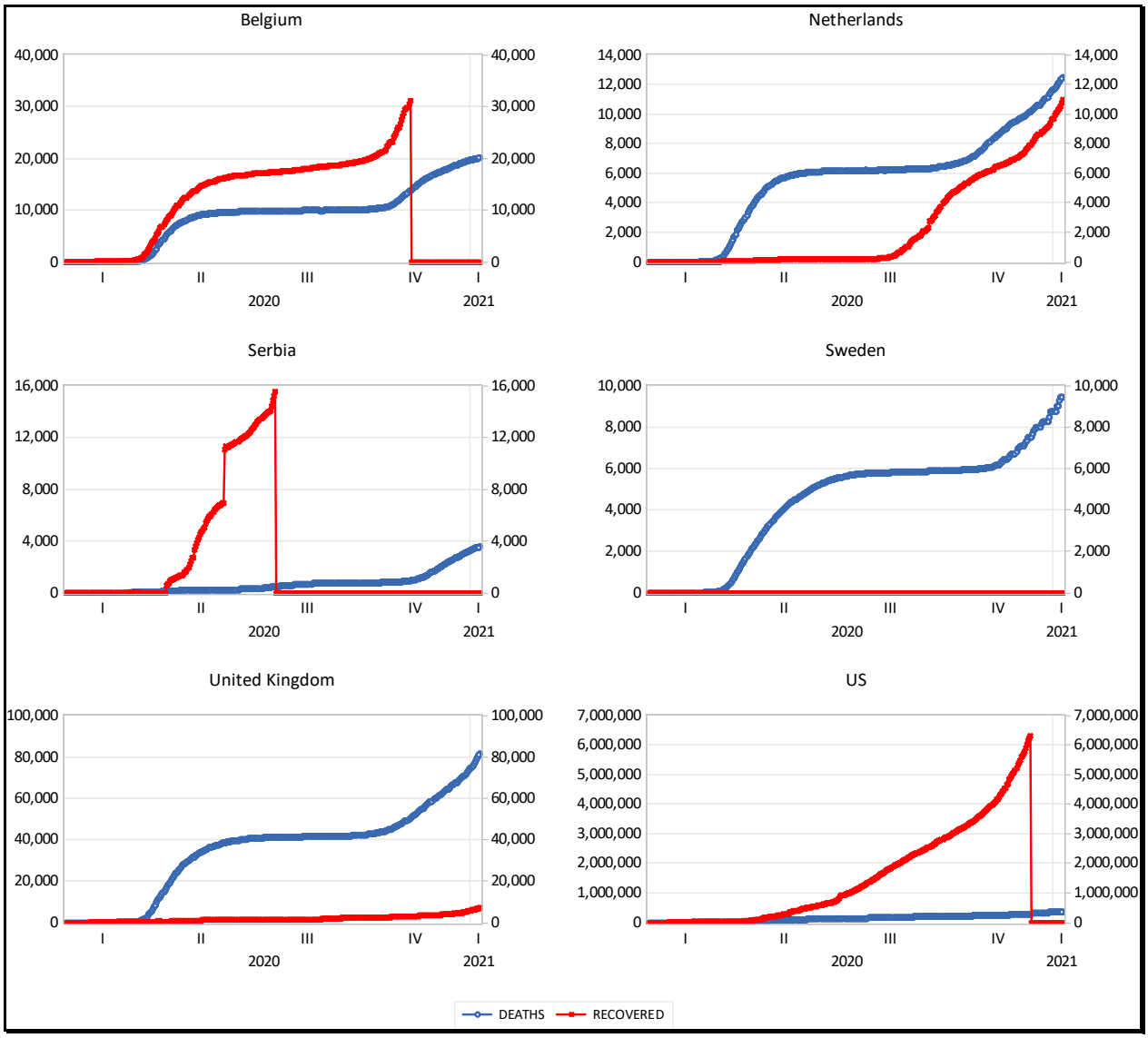


Figure 44 A Change in the Definition of Confirmed – 7-day Moving Average of Daily Numbers (Confirmed Cases– left scale, Deaths- right scale)