How do governments perform in facing COVID-19?

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Abstract

The issue of coronavirus outbreak in the world, though new, is equally pervasive. It has posed a new and ambiguous challenge to the economic growth of countries around the world. Undoubtedly, the efforts of countries to curb the spread of this virus and reduce the number of deaths are necessary for other strategies that will be taken in other areas, especially in the economic field. Comparing countries only based one the statistics on virus spread and mortality without considering the contextual variables, can be misleading. Thus using dynamic data envelopment analysis, this study calculated the performance of 19 selected countries in two dimensions: inefficiency of preventing coronavirus spread and inefficiency of preventing deaths caused by coronavirus from February 2 to April 12. According to the study, the inefficiency trend of preventing coronavirus spread in Singapore, South Korea, China and Australia are decreasing during the period under review and the inefficiency trend of other countries, which of course differ in terms of inefficiency, are increasing with different slopes. Also, Australia, Finland, Japan, Malaysia, Singapore and Thailand have experienced less inefficiency in preventing deaths caused by coronavirus compared to other countries. Stringency index and global health security (GHS) index have been used as well, to analyze the findings and at the end some suggestions have been presented.

Key Words: Coronavirus, Covid19, DEA, Window Analysis, Efficiency, Government

JEL Classification: C61, I18, H11

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Introduction

During the last months, people and governments in various countries, one after another, have been challenged by the fast spread of COVID-19 and its consequences. The health risk of the virus is undoubtedly the most important challenge in hand that has vast consequences both in the near and far future. It also raises many questions regarding other aspects of the disease, one of which is about the economic consequences. What will be ahead of those countries involved in short-term and long-term? How have been the governments responding to this? And more importantly, in what quality are they handling the negative consequences?

In order to anticipate the future economic status of these countries, their current situation has to be taken into account; which is highly influenced by the response of each government to COVID-19 outbreak. How they have perceived the status change, how they planned to face it, and how at the end they applied their plans, will all be the matters of interest. Since law enforcement and the level of stringency both influence the government performance (Platform, 2015), they should be taken into consideration in this analysis. Moreover, studying the government performance in each country will give a good comparison tool. So the countries can learn from each other in a more systematic way, while they do not repeat the mistakes of the others, or at least try not to do so. In fact, evaluating performance of various governments have been in the center of attention before this pandemic, as the countries like US, Canada, and Australia have been investing in designing performance frameworks (Arah, Westert, Hurst, & Klazinga, 2006). But now it is more important to focus on this topic.

Government performance evaluation requires a careful consideration of the factors that could influence the spread of this disease, such as population density and the percentage of elderly in each of the affected countries (Singh & Adhikari, 2020), (Liu, Chen, Lin, & Han, 2020), (Gaeta, 2020). But regardless of these factors, looking at the raw data and statistics on the spread of the COVID-19 and the mortality caused by it can be misleading, which means a comprehensive analysis is needed. Therefor this research concentrates on the performance of involved governments when facing the spread of coronavirus in their countries.

Aiming to estimate the governments' performance, two dimensions are chosen for the model of this research; prevention of COVID-19 spread and prevention of mortality caused by the disease. While designing our model, a necessary step was considering the similar experiences in the past, one of which was the Spanish flu from January 1918 to December 1920. Comparing the economic consequences of COVID-19 with Spanish flu; the estimates of Barro et al show that there is the possibility of a global economic contraction, because of a reduction in both GDP and private consumption in affected countries. They also state that in short term, there is the possibility of a reduction in real returns on stocks as well as government bills (Barro, Ursúa, & Weng, 2020).

When the health of many people all around the world is at stake because of a disease, eliminating it becomes a global public good (L. C. Chen, Evans, & Cash, 1999), (Dayrit & Mendoza, 2020). While the detailed effects of the current situation is developing to this moment and yet to be studied, the vast influence of the pandemic on the economy of various countries is undeniable. In general, a pandemic would make the involved countries face economic difficulties including a decrease of labor force and a change in the risk of investment (McKibbin & Sidorenko, 2006). But this particular case has influenced G7 and China, which translates into the involvement of 60% world GPD and 40% world manufacturing exports (Baldwin & di Mauro, 2020). Needless to say that the rest of the world is also struggling with COVID-19 now and its effects are even larger. Given the possibility of such a vast impact, the current study tries to respond to the necessity of evaluating how governments have performed in both preventing the spread of the virus and preventing the mortality.

Literature Review

As a public health emergency is occurring, one aspect of it is how one's mind perceives the crisis, and more importantly, when it is taken seriously. To put it simply, in the early stage of this pandemic, many citizens seemed to underestimate it (Baldwin & di Mauro, 2020). So, on top of taking care of people's lives, the behavior of involved citizens turns out to be an additional challenge for the governments. In order to overcome this outbreak, it is not only the behavior of the disease itself that has to be studied, but also the behavioral patterns of people in involved countries (Haushofer & Metcalf, 2020). Hence this multi-dimensional issue in hand needs to be taken care of with multi-dimensional studies.

The consequences of previous viruses like Ebola on one hand, and the various scenarios of what comes ahead because of this pandemic on the other hand, show the necessity of prioritizing global investment in healthcare; as it is necessary to avoid further costs caused by COVID-19,(Yazbeck & Soucat, 2019) (McKibbin & Fernando, 2020). Without doing so, the developing countries with high population density will face higher costs than the others (McKibbin & Fernando, 2020).

Considering the level of development and its influence on the current crisis, the institutional structure of the economy in involved countries is also worthy of note. As more inclusive institutions associate with a higher level of economic development (Acemoglu, Gallego, & Robinson, 2014), they also lead to better outcomes for healthcare system (Miller, Toffolutti, & Reeves, 2018). Here, the situation we aim to analyze is subject to an ongoing crisis that is very new and rather shocking to the world. So the model is designed to take one step toward evaluating how various countries with various qualities of healthcare system are responding to the pandemic.

When concentrating on health system and how efficient it has been, the expectations about the system vary from those of totally normal situations. Before this pandemic, what one had in mind about proper access to healthcare system was mainly based on the normal conditions (Dayrit & Mendoza, 2020). However, studying the effects of a pandemic communicable disease requires a model that takes into account the critical situation of now; in which the efficient respond of governments play a more important role than before.

The different expectations aside, we need to consider that the healthcare systems are trying so hard to overcome this pandemic, but they are not fundamentally different than some months before COVID-19 outbreak. So, when analyzing their success in handling the situation, it is useful to go back to the criticisms that have been made before. In low-income developing countries, providing proper public healthcare has been challenging before (Woolcock, 2018). In some developed countries, however, the challenge is at a different level and for other reasons. In the United States of America, the absence of universal healthcare seems to cause an inequality in receiving the primary healthcare for all the Americans (Rashford, 2007). The inequality of accessing healthcare is also addressed by the researchers in other countries like Taiwan (Kuo & Lai, 2013). The extraordinary nature of this situation translates into a shock to the global economy as well as the health system. As these two go hand in hand, we have to pay a close attention to both of them. Therefore, an economic analysis can help find a way out of this crisis only if the valuable points made by the previous studies that worked on the weaknesses of the health system are considered.

In a qualitative analysis of government performance, Bardhan concentrates on Chinese governance system in three main aspects; internal organization of government, corruption, and de-centralized structures. He mentions that in analyzing the former, the behavior of government regarding information transparency must be considered, as suppressing the information regarding a shock to the economy like COVID-19 affects the dimensions of the crisis(Bardhan, 2020). Thus, we try to apply inclusive criteria that show the governments' efficiency in dealing with this shock.

Various factors are said to affect the risk level of COVID-19 outbreak; and the population characteristics is one of them. Due to the nature of COVID-19, the population age plays a role in the spread of the disease, as the elderly mortality because of the virus seems to be higher than young patients (Liu et al., 2020) (Z. Chen et al., 2020) (Shim, Tariq, Choi, Lee, & Chowell, 2020). In China, to begin with, the potential risk factor of older people was higher (Zhou et al., 2020) (Verity et al., 2020). Also, in Italy 42·2% of the patients who passed away were 80–89 years old, and 32·4% of them were 70–79 years old, and the mean mortality age was 81 until March 12th (Remuzzi & Remuzzi, 2020). also In other countries like US, UK, Brazil, and Nigeria the mortality risk is much higher for older people (Dowd et al., 2020). In addition to age structure, population density is considered to affect the risk of spreading this disease. For instance, in Milan area that the population density is high, the virus has a high growth rate (Gaeta, 2020).

Public health infrastructure, particularly laboratory capabilities would be the other factor that is said to have an influence on the current pandemic (Smith & Fraser, 2020). For example, one of the challenges that Wuhan dealt with was the limited capacity of testing (Xie et al., 2020). A laboratory capacity limitation can easily lead to an underestimation of the fertility rate (Sohrabi et al., 2020), which then leads to an underestimation in macro-level analysis of the disease's impacts.

A necessity in the process of designing the model for government performance evaluation was to review the methods that have been used in this area before. The measurement of government performance in previous studies has been examined under topics such as government efficiency, governments' performance, Public Sector Performance (PSP) and Public Sector Efficiency (PSE) by application of a verity ranges of methods such as ratio analysis, Least-squares Regression (LSR), Total Factor Productivity (TFP), Stochastic Frontier Analysis (SFA), and Data Envelopment Analysis (DEA) (Ozcan, 2008), (Afonso, Schuknecht, & Tanzi, 2010), (Hauner & Kyobe, 2010), (Asandului, Roman, & Fatulescu, 2014) (Ahmed et al., 2019). Generally, these methods are known as benchmark analysis techniques. These techniques are about the measurement of the output(s) level that are provided for inputs level, which are used based on the benchmark (Peacock, Chan, Mangolini, & Johansen, 2001). Benchmarks Analysis Techniques mainly fall into two main categories include parametric methods and non-parametric methods.

To choose a method for estimating government performance in this specific pandemic, it is important to keep in mind that the disease is very new to the human societies, and as a result the body of research is still young. But a comparison between various methods in previous research on health economics and healthcare system efficiency led to paramedic methods and amongst them DEA was chosen based on the advantages it provides here. (DEA) is the method mainly used in measuring healthcare system efficiency (Stefko, Gavurova, & Kocisova, 2018), (Ozcan, 2008), (Asandului et al., 2014), (Galterio, Helton, Langabeer 2nd, & DelliFraine, 2009), (Dacosta-Claro & Lapierre, 2003). In general, this non-parametric method gives the chance to estimate the inefficiency of healthcare system and it allows for using multiple inputs and outputs simultaneously (Ozcan, 2008), (Stefko et al., 2018).

In this particular research, DEA is chosen for three reasons. First, it allows to measure efficiency, comparing the best practice and not the average one. Second, it neither requires the use of a pre-specified functional form nor distributional assumptions about error terms. And finally, it does not require as much data as other parametric methods do (Emrouznejad & Podinovski, 2004), which makes it stand out because the world is still in an early stage of dealing with this disease. Thus, a two-stage DEA model is applied in this study to identify the efficient and inefficient performance of governments in each dimension. Using the results, the research then compares different countries and analyzes their characteristics and policies to highlights improvement capacities.

One last point that is considered in this study is to provide a comparable time frame due to the different time of virus spread in different countries. In the results analysis section, the research describes the performance of governments in preventing the outbreak. An important aspect is the level of public support for the implementation of these laws and another one is the law enforcement applied by the governments, because the legal tools like quarantine need to be secured by the law enforcement in involved countries (Wilder-Smith & Freedman, 2020), (Gostin, Friedman, & Wetter, 2020). Also, as the level of strictness can have an influence on the results of a policy (Fadlallah et al., 2018), the strictness of applied policies is another aspect to consider in analyzing the results. Accordingly, the research conclusion provides suggestions for the policymakers as well as other researchers. We try to address some of the questions that need to be answered, as we are still in the beginning of this road.

Methodology

Although in small cases, the performance of a system could be presented by relative criteria, but with increasing the dimensions and complexity of the system, other performance measurement approaches have been developed. Data Envelopment Analysis is a data-oriented method and is widely used as a data-driven approach for evaluating and enhancing performance (Cook & Zhu, 2006).

In 1978, Charnes, Cooper and Rhodes introduced DEA as a non-parametric approach based on linear programming technique. A DMU is a decision-making unit in order to transform multiple inputs into output(s) (Emrouznejad & Podinovski, 2004), and evaluating the performance of a unit by comparing its performance with the best performing units of the sample. Unlike the parametric models and based on a set of inputs and outputs, DEA is used to optimize each DMU individually, calculating an empirical efficient frontier (Mantri, 2008).

The technical component of economic efficiency refers to the ability of a DMU to either maximize output(s) as technology and inputs usage needed or minimize inputs use as technology and output/service production required. (Fried, Lovell, Schmidt, & Schmidt, 2008). Thus the analysis of technical efficiency could have an output augmenting orientation or an input conserving orientation. An input- oriented DEA manages the input reduction, which is necessary for the measure to become efficient, keeping the output constant. On the other hand, an output oriented measure is related to output expansion, holding the input constant. Moreover, a non-oriented measure quantifies the improvements when both inputs and outputs can be modified simultaneously Input or output orientation is selected based on those ones over which the managers have the most control. (Coelli, Rao, O'Donnell, & Battese, 2005)

DEA gives inputs/outputs targets for inefficient units as benchmarks, since the outputs and inputs of such a virtual unit are linear combinations of corresponding outputs and inputs of all other units. Specifically, the benchmark represents the peer group for the inefficient DMU (Thanassoulis, Portela, & Despic, 2008).

The performance measurement is indicated by efficiency score. Based on evaluation of relative efficiency of the suggested set of units, the analysis expresses the interaction between inputs and outputs to be changed in order to maximize the efficiency of the target DMU. Moreover, the benchmark for each inefficient DMU at the level of its individual combination of inputs and outputs is considered with DEA. Furthermore, the main features of DEA are as follows: First, it classifies each DMU as inefficient or efficient (the DMU that makes up the efficient frontier), based on individual observations, instead of mean values. Then, DEA incorporates inputs and outputs with different units of measures identifying optimal production and consumption values. The next DEA feature is to determine the inefficiency measure for every unit away from the frontier and work without converting all inputs and outputs in monetary units. Finally, considering discrepant values as comparison parameters for DMUs are mentioned (De Souza, Moreira, Avelar, de Faria Marques, & Lara, 2014). Based on a CCR model, the efficiency of k -the decision making unit DMU_k $(k = 1,2,\ldots,n)$ to determine the weight coefficients of output and input variables to which the value of the relationship will be maximized is as follows:

$$(\max)\, h_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}}$$

Subject to:

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1, \quad j = 1,2,\ldots,n \qquad (1)$$

$$u_r \ge 0, \quad r = 1,2,\ldots,s$$

$$v_i \ge 0, \quad i = 1,2,\ldots,m$$

where: h_k - the relative efficiency of the k -the decision-making unit; n - the number of decision-making units; m - the number of inputs; s - the number of outputs; v_i - weight coefficients for input i ; u_r - weight coefficient for output r ; x_{ij} - the amount of input i for the j -the decision-making unit, (DMU_j); y_{rj} - the amount of output r for the j -the decision-making unit, (DMU_j) .The linear programing technique is supposed to make the efficiency of the unit as large as possible. In other words, DEA mentions the weights of inputs and outputs leading to the calculated efficiency. Then, the unit is efficient if the efficiency is equal to 1 and of course inefficient for lower than 1 level. So, the efficient units combine inputs better than inefficient ones or the efficient units follow to produce more outputs using a given combination of inputs.

Data envelopment analysis exploits the ability to calculate the efficiency of N decision making units in T time periods. To overcome this limitation of DEA, several options are available (Fried et al., 2008):

Estimation of a single grand frontier for all of data as a pool: efficiency trends in short run when the technology doesn't vary and analyzing decision making of unit's efficiency is preferred, this method can be considered a good option. In long run with technological change assumption, this method may be untenable (Fried et al., 2008).

Estimation of T separate frontier for T periods: Choosing this method when we want to compare the performance of decision-making units at any time which should reflect local progress of DMUs but when excessive variation of local frontier c, can impose the volatility of efficiencies, can be problematic (Fried et al., 2008).

Window DEA analysis: This name and the basic concept are introduced by G. Klopp (1985) who developed these techniques in his capacity as chief statistician for the U.S. Army Recruiting Command (Cooper, Seiford, & Zhu, 2011). Charnes et al. (1985) proposed a dynamic DEA to measure the efficiency level of DMUs with respect to its own performance over time as well as comparison with other DMUs in defined window (Pulina, Detotto, & Paba, 2010). In this method with estimation of a sequence of overlapping pooled panels, each polled panel consists of a few time known as "window" and the efficiency of each DMU is calculated in each period in each window. This method provides a compromise between the estimation of a single grand frontier for all of data as a pool and the estimation of T separate frontier for T periods.

Malmquist index: this index as a "comparative statics" analysis, quantifies the productivity change of a DMU between two time periods as a "comparative statics" analysis by define Catch-up and Frontier-shift terms. The catch-up (or recovery) term relates the efficiency change that a DMU improves or worsens its efficiency, while the frontier-shift (or innovation) term reflects technical change that is the change in the efficient frontiers between the two time periods (Cooper et al., 2011). The efficiency and technology change between two periods calculate as follows:

$$\text{Efficiency Change (EC)} = \left(\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t}(x^{t}, y^{t})}\right), \qquad (2)$$

$$\text{Technical Change (TC)} = \left(\frac{D^{t}(x^{t+1}, y^{t+1})}{D^{t+1}(x_0^{t+1}, y^{t+1})} \times \frac{D^{t}(x^{t}, y^{t})}{D^{t+1}(x^{t}, y^{t})}\right)^{1/2}, \qquad (3)$$

In this study, due to the use of weekly data in short run and the possibility of comparing each country's performance with its own and other countries' performance during the time periods on one hand, and the impossibility of changing technology over this time on the other hand, a window data envelopment analysis model has been used with window width one. This model actually works as the estimation of a single grand frontier for all of data as a pool for using data envelopment analysis over time.

Data and variables

In this study, according to the available data, the performance of governments was measured in two dimensions: controlling the prevalence of Coronavirus and preventing the mortality caused by Coronavirus.

Due to data limitation, only 19 countries were selected for which, coronavirus cases information existed at least for a period of 70 days in internationally reputable databases. The selected countries are Australia, Canada, China, Finland, France, Germany, India, Malaysia, Russia, Singapore, Sweden, Thailand, The United States, Italy, Spain, Japan, Philippines, Korea South and The United Kingdom.

Models:

Model (1): Inefficiency of preventing coronavirus spread

In the first step, a DEA model with one (undesirable) output and two inputs was designed to investigate the inefficiency of countries in preventing the spread of coronavirus.

Output: corona confirmed cases in each time

The data on cases of coronavirus are weekly and start on February 2 and last until April 12. Coronavirus cases in selected countries over this time period are shown in table (1).

Table (1): Confirmed coronavirus cases in selected countries

	Time Period										
Country	2/2	2/9	2/16	2/23	3/1	3/8	3/15	3/22	3/29	4/5	4/12
Australia	12	15	15	15	27	76	297	1549	3984	5687	6315
Canada	4	7	7	9	24	64	252	1469	6280	15756	24298
China	16630	39829	70513	77022	79932	80823	81003	81435	82122	82602	83134
Finland	1	1	1	1	6	23	244	626	1240	1927	2974
France	6	11	12	12	130	1126	4499	16018	40174	92839	132591
Germany	10	14	16	16	130	1040	5795	24873	62095	100123	127854
India	2	3	3	3	3	39	113	396	1024	3588	9205
Italy	2	3	3	155	1694	7375	24747	59138	97689	128948	156363
Japan	20	26	59	147	256	502	839	1101	1866	3139	6748
Korea, South	15	25	29	602	3736	7314	8162	8961	9583	10237	10512
Malaysia	8	16	22	22	29	99	428	1306	2470	3662	4683
Philippines	2	3	3	3	3	10	140	380	1418	3246	4648
Russia	2	2	2	2	2	17	63	367	1534	5389	15770
Singapore	18	40	75	89	106	150	226	455	844	1309	2532
Spain	1	2	2	2	84	673	7798	28768	80110	131646	166831
Sweden	1	1	1	1	14	203	1022	1934	3700	6830	10483
Thailand	19	32	34	35	42	50	114	599	1388	2169	2551
United Kingdom	2	3	9	9	36	273	1140	5683	19522	47806	84279
US	8	11	13	15	74	518	3499	33276	140909	337072	555313

Source: Johns Hopkins University (coronavirus resource center), 2020

Inputs: Population and Population density are the most important that could affect the coronavirus cases in each country. The number of Corona cases is directly related to the population of countries. Population density is measured by the number of human inhabitants per square kilometer. Given the emphasis on social distancing for reducing the spread of the virus, it is expected that the higher the population density in a country is, the higher the chances of spreading the virus are. Among the selected countries in our study, China and India have the largest populations, and Finland and Singapore have the lowest populations. In our sample, Singapore and

India have the highest population density and Australia and Canada have the lowest population density. Table (2) shows the status of the first DEA model's inputs and output for each country.

Model (2): inefficiency of preventing deaths caused by coronavirus

Other objective that was investigated in this research is calculating the inefficiency of countries in reducing the mortality of coronavirus cases. Based on this, a dynamic DEA model with an (undesirable) output and three inputs is designed as follows:

Output: Coronavirus confirmed deaths

The coronavirus confirmed death is limited to four weeks due to zero mortality cases in some selected countries, starting March 22 and continuing until April 12. The total number of deaths at the end of each week is shown in the table (2):

Table (2): Coronavirus deaths in selected countries

Country/Region	3/22/2020	3/29/2020	4/5/2020	4/12/2020
Australia	7	16	35	60
Canada	21	64	259	714
China	3274	3304	3333	3343
Finland	1	11	28	56
France	674	2606	8078	14393
Germany	94	533	1584	3022
India	7	27	99	331
Italy	5476	10779	15887	19899
Japan	41	54	77	108
Korea, South	111	152	183	214
Malaysia	10	35	61	76
Philippines	25	71	152	297
Russia	1	8	45	130
Singapore	2	3	6	8
Spain	1772	6803	12641	17209
Sweden	21	110	401	899
Thailand	1	7	23	38

Country/Region	3/22/2020	3/29/2020	4/5/2020	4/12/2020
United Kingdom	281	1228	4934	10612
US	417	2467	9619	22020

Source: Johns Hopkins University (coronavirus resource center), 2020

Inputs: Undoubtedly, one of the factors influencing the number of coronavirus deaths is the way countries operate in preventing the coronavirus spreading. Therefore, the countries' inefficiency in preventing the coronavirus spread, which is the result of the first model, was used as an input in the second model. According to a study by (Jung et al., 2020) , which estimates the average time from illness onset to death 20.2 days, the inefficiency **of preventing coronavirus spread** with three time intervals has been used as an input in the second model.

The number of population, as well as the population aged 65 and above (% of total population) in each country, are other inputs used in the second model.

Table (3): inputs statistical data in selected countries

Country	Population	Population Density (people per square kilometer)	Age 65 and above (% of population)
Australia	24992369	3.2	15.7
Canada	37058856	4.1	17.2
China	1392730000	148.3	10.9
Finland	5518050	18.2	21.7
France	66987244	122.3	20.0
Germany	82927922	237.4	21.5
India	1352617328	454.9	6.2
Italy	60431283	205.5	22.8

Country	Population	Population Density (people per square kilometer)	Age 65 and above (% of population)
Japan	126529100	347.1	27.6
Korea	51635256	529.7	14.4
Malaysia	31528585	96.0	6.7
Philippine	106651922	357.7	5.1
Russia	144478050	8.8	14.7
Singapore	5638676	7953.0	11.5
Spain	46723749	93.5	19.4
Sweden	10183175	25.0	20.1
Thailand	69428524	135.9	11.9
UK	66488991	274.8	18.4
US	327167434	35.8	15.8

Source: World Bank, 2018

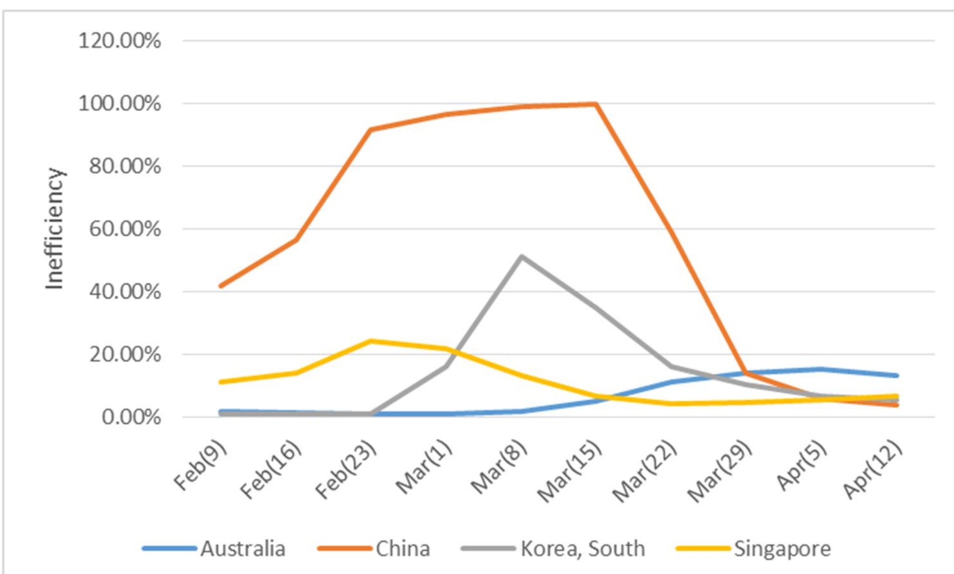
Results and discussions

Inefficiency of preventing coronavirus spread

The study used a dynamic data envelopment analysis model within the Malmquist index to calculate the inefficiency of preventing coronavirus spread of each country at the end of each week. Based on the inefficiency trend, countries could be categorized in 5 groups as follows:

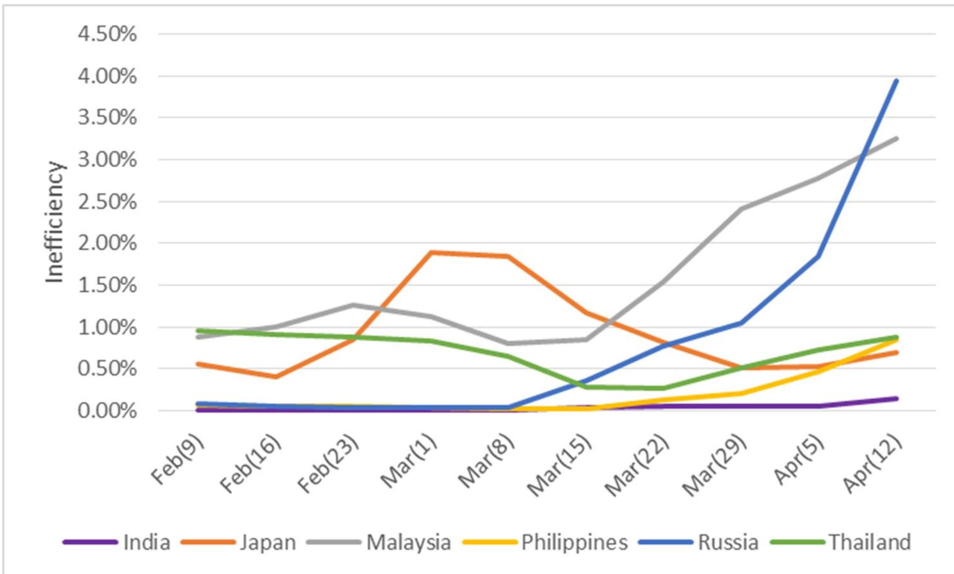
The first group includes countries whose inefficiency of preventing coronavirus spread is declining. Australia, China, South Korea and Singapore fall into this category. However, Australia has experienced low inefficiency compared to the other three countries from the beginning. Changes in the inefficiency of these countries in different time periods are shown in the chart below:

Figure 1. Inefficiency trend of preventing coronavirus spread in the first group



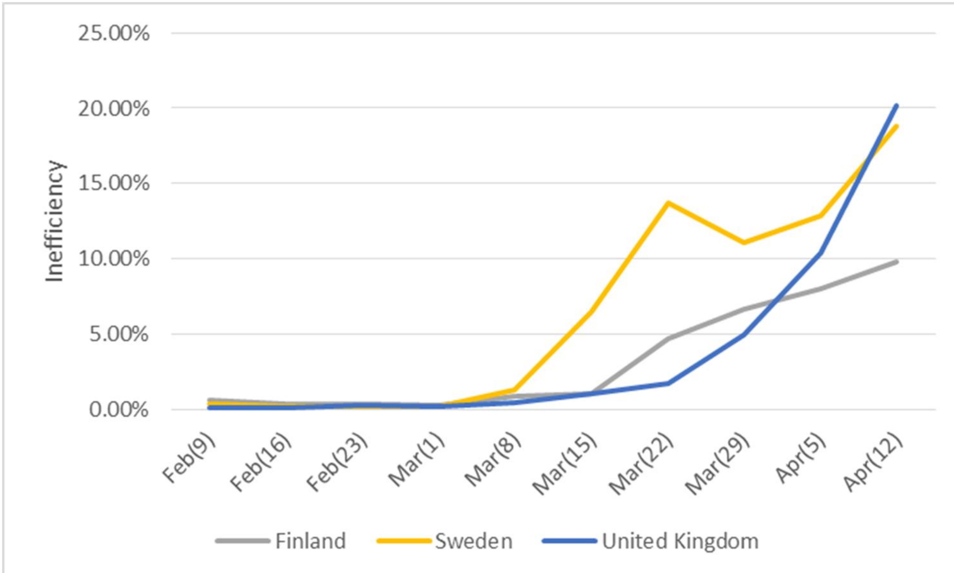
The second group includes countries that experience very low inefficiency in preventing the spread of the virus, but their inefficiency is increasing. India, Japan, Malaysia, the Philippines, Russia and Thailand fall into this category. The chart below shows the changes in inefficiency over time:

Figure 2. Inefficiency trend of preventing coronavirus spread in the second group



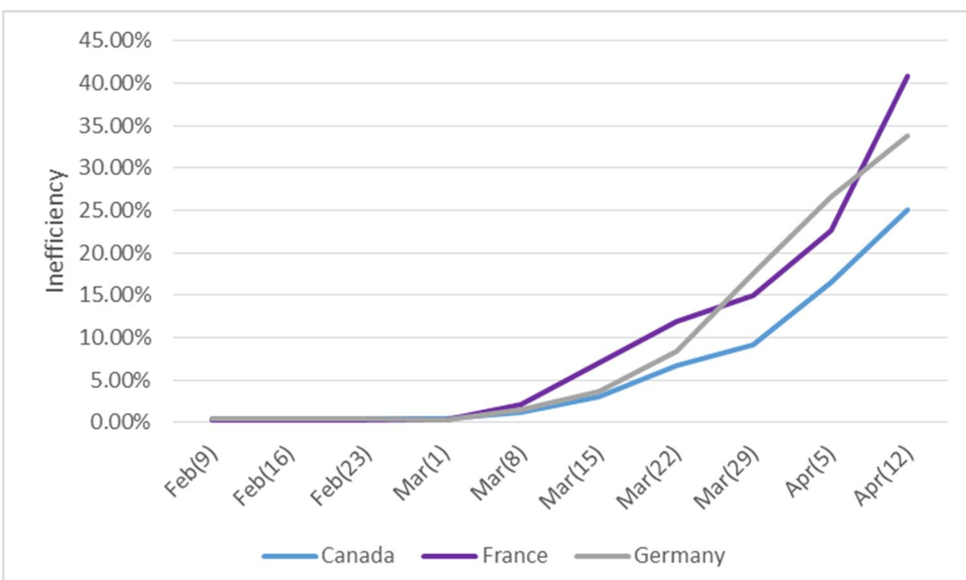
The third group, which includes Finland, Sweden, and the United Kingdom, although relatively inefficient in preventing coronavirus spread, has seen an increase in their inefficiency. The chart below shows the trend of changes in inefficiency in this group of countries:

Figure 3. Inefficiency trend of preventing coronavirus spread in the third group



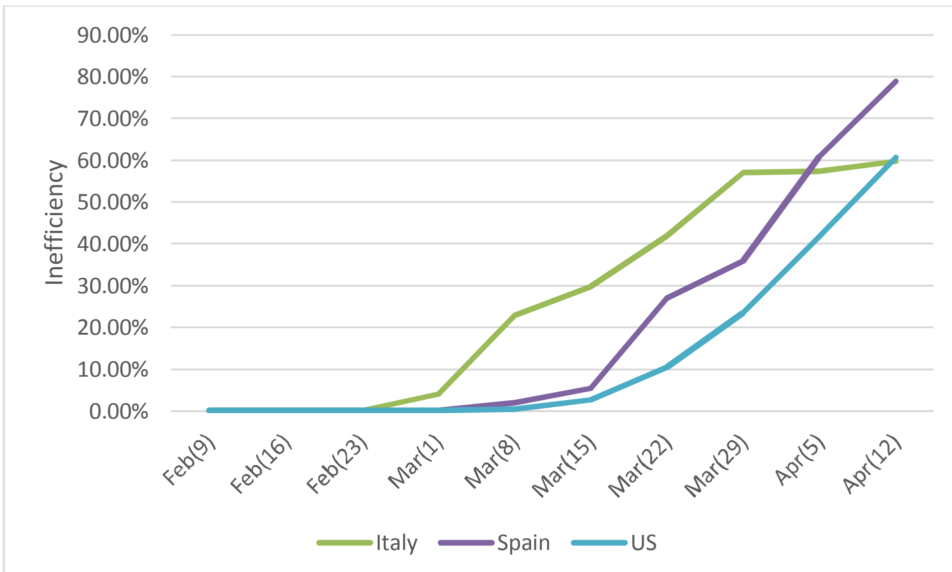
The fourth group, which includes Canada, France and Germany, has lower-than-average inefficiencies, but their inefficiencies are increasing. The process of changing their inefficiency over time is shown in the chart below:

Figure 4. Inefficiency trend of preventing coronavirus spread in the fourth group



The fifth group includes the United States, Italy and Spain, which, despite high inefficiency, continue to see an increase in inefficiency. The chart below shows the trend of changing the inefficiency of these countries during the period under review:

Figure 5. Inefficiency trend of preventing coronavirus spread in the fifth group



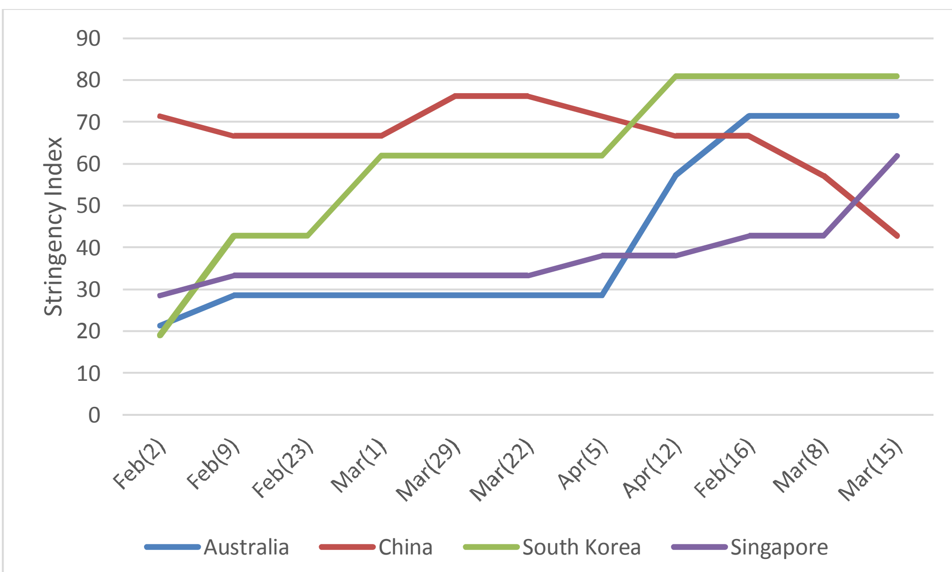
In describing the spread prevention inefficiency, two groups of factors can be considered important: First, the actions that governments take in facing this problem, and second the behavior of the people in each country in response to government actions (regulations, recommendations or campaigns). In general, these two factors could be classified into stringency and enforcement of rules and regulations. Oxford University has developed a stringency index which includes 7 sub-indices with different weights include school closing, workplace closing, public events cancellation, closing public transport, public information campaigns, restrictions on internal movement and international travel controls (Hale & Webster, 2020).

To analyze the stringency degree of laws and regulations in each of the selected countries, we categorized countries in the previous five groups. The question is whether countries with similar Inefficiency of preventing coronavirus spread, have similar behavior in stringency of law and regulations?

To answer this question, the trend of changing the stringency degree of laws and regulations in each of the five groups is shown as below:

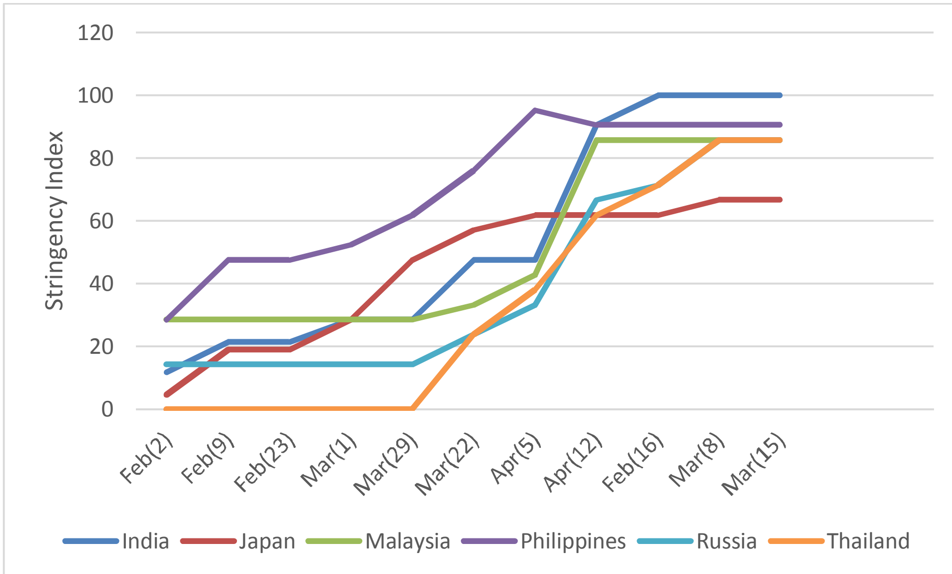
In the first group of countries (Australia, China, South Korea and Singapore) where inefficiency has increased and then the downward trend has taken place, strict policies have been intensified by all countries from one period to the next.

Figure 6. Stringency index trend in the first group



For the second group of countries (India, Japan, Malaysia, the Philippines, Russia and Thailand) with the lowest levels of inefficiency, they have enacted stricter rules and regulations much faster than other countries.

Figure 7. Stringency index trend in the second group



Countries in the third (Finland, Sweden, and the United Kingdom), fourth (Canada, France and Germany), and fifth (United States, Italy and Spain) groups, where inefficiency is on the rise, have not usually tightened rules and regulations from the beginning and have delayed tightening with a delay.

Figure 8. Stringency index trend in the third group

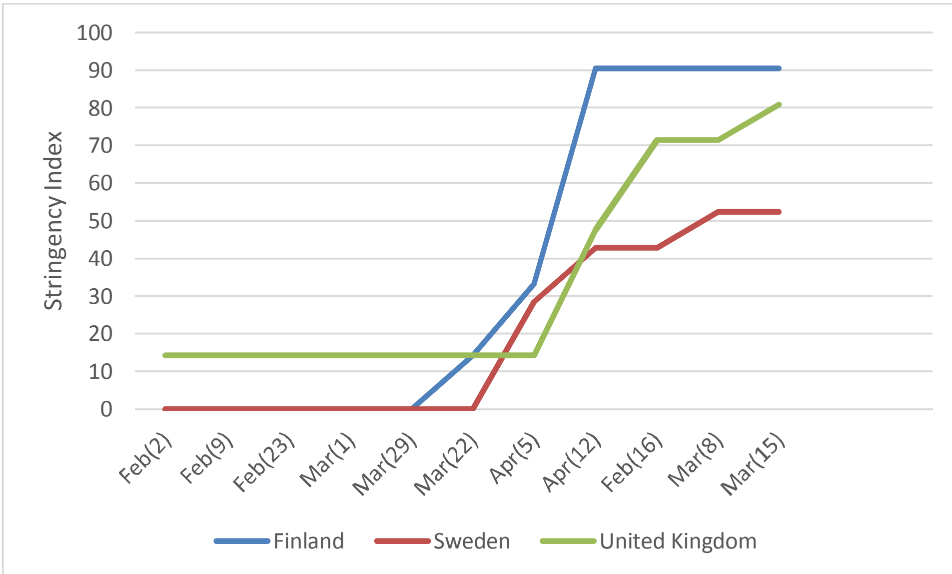


Figure 9. Stringency index trend in the fourth group

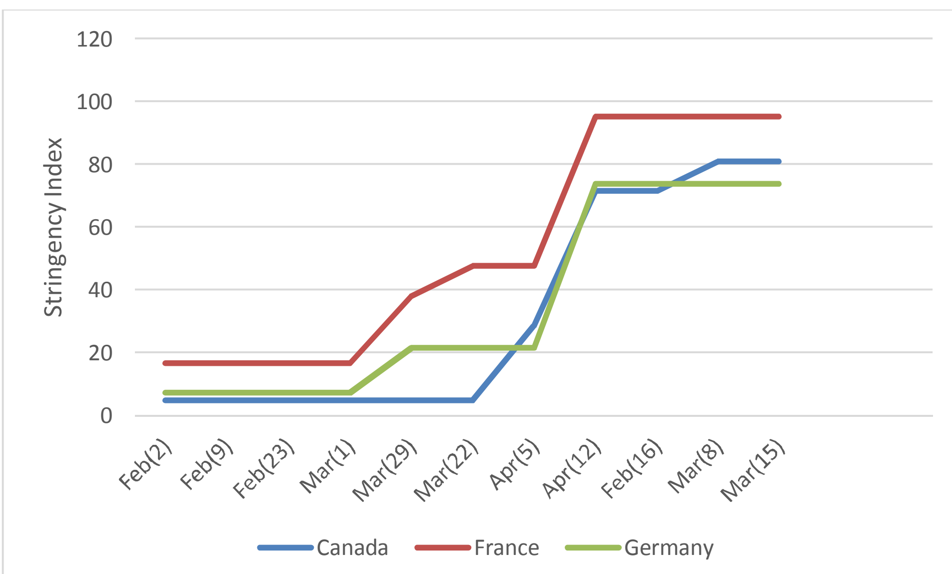
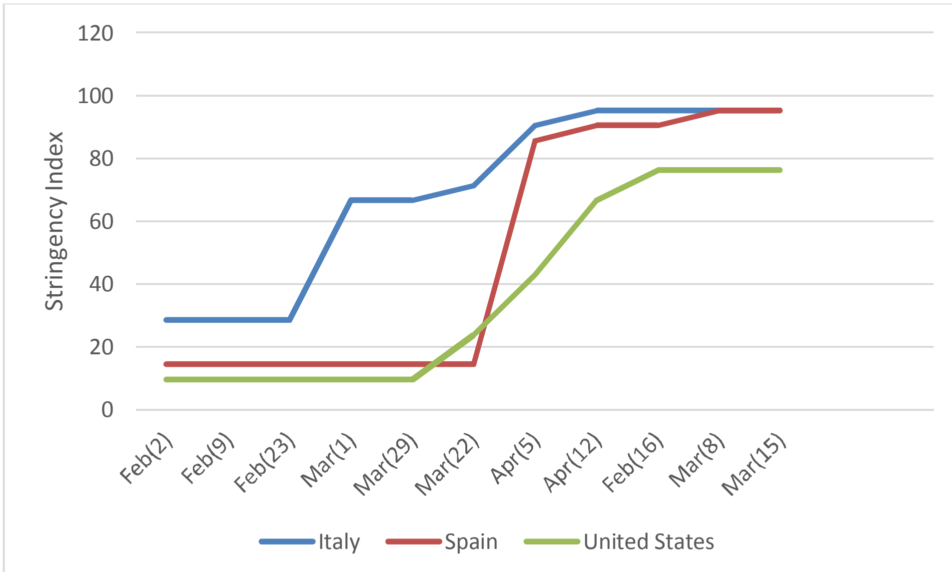


Figure 10. Stringency index trend in the fifth group



Regarding the behavioral analysis of involved people, the way people of each country respond to these new government decisions depend of various factors and can be classified as behavioral analysis. It reflects the enforcement degree of rules and regulations, which will be addressed in our next research.

Inefficiency of preventing deaths caused by coronavirus

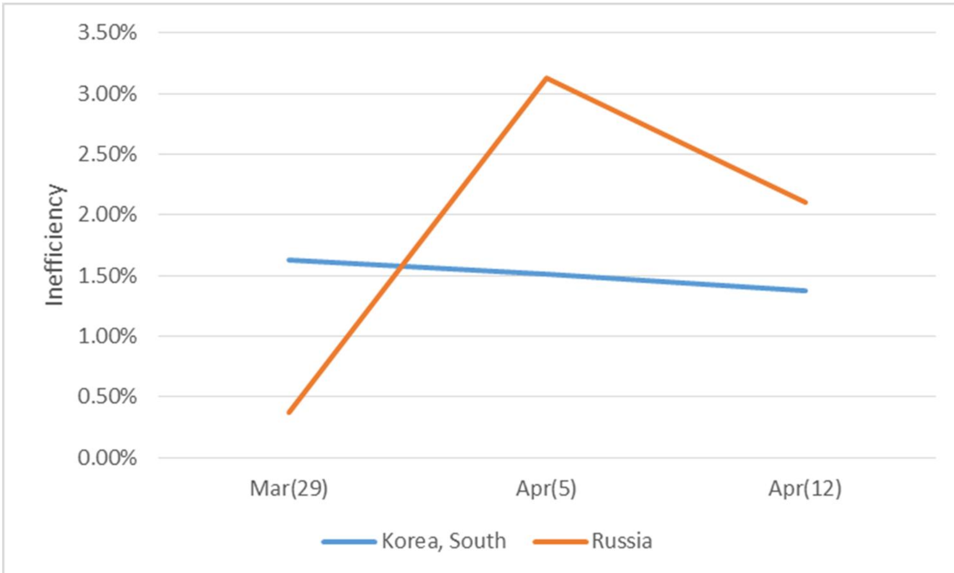
Due to data limitation, the countries' death prevention inefficiency is calculated in a 3 time period (4-week data) as follows:

The first period is the week ending March 29, the second period is the week ending April 4 and the third period is the week ending April 12.

According to the Inefficiency of preventing deaths caused by coronavirus calculation, countries can be classified into 5 groups as follows:

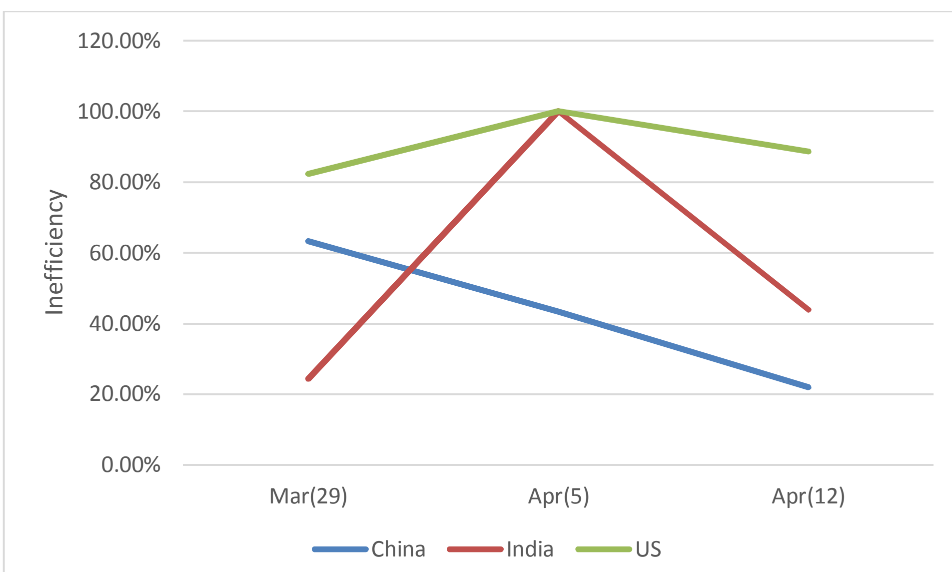
The first group, which includes South Korea and Russia, has low inefficiency compared to other selected countries and has a declining inefficiency trend in the periods.

Figure 11. Inefficiency trend of preventing coronavirus deaths in the first group



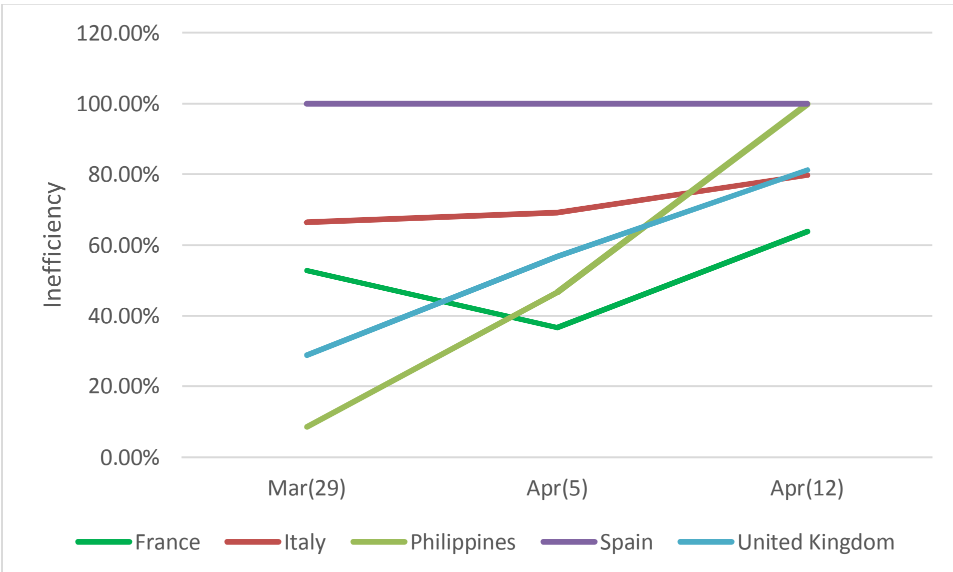
The second group, which includes the three countries of China, India and the United States, has experienced high inefficiency, but by the end of the period, their inefficiency has decreased.

Figure 12. Inefficiency trend of preventing coronavirus deaths in the second group



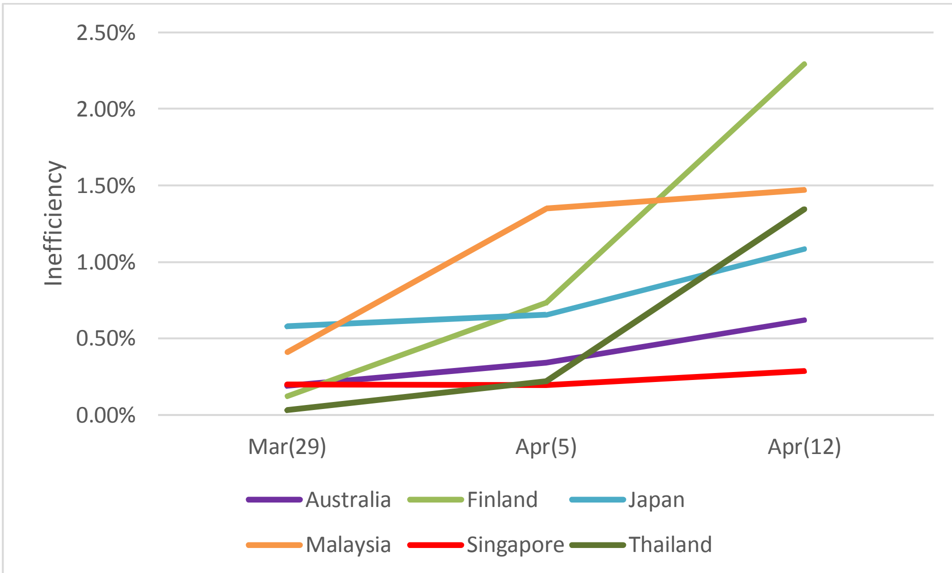
The third group includes France, Italy, Spain, the Philippines and the United Kingdom, whose inefficiency is rising at higher levels than in other countries. However, for the Philippines, the inefficiency trend is more than other countries, and Spain has had the highest level of inefficiency among the selected countries in all three periods.

Figure 13. Inefficiency trend of preventing coronavirus deaths in the third group



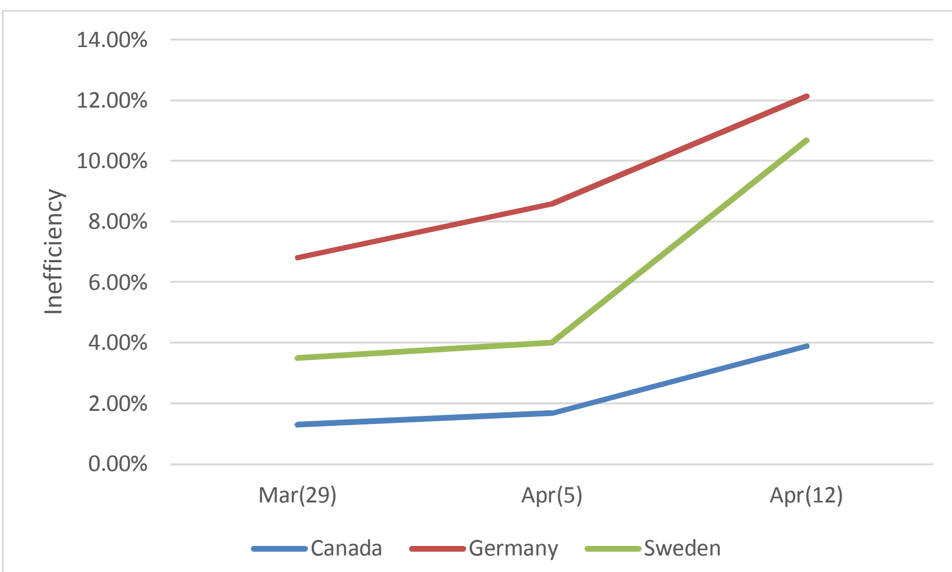
The fourth group includes Australia, Finland, Japan, Singapore, Malaysia, and Thailand. The inefficiency of these countries is very low and there is little growth in their inefficiency. In this group, Finland and Thailand have higher inefficiency growth than other countries in the same group.

Figure 14. Inefficiency trend of preventing coronavirus deaths in the fourth group



The fifth group includes Germany, Canada and Sweden, whose inefficiency is low but higher than the fourth group and their inefficiency is increasing. In this group, Sweden has a higher inefficiency growth rate than other two countries.

Figure 15. Inefficiency trend of preventing coronavirus deaths in the fifth group



When it comes to saving the patients already suffering from the disease, healthcare system with its capabilities in particular is involved. It plays the key role in different stages of a pandemic, from surveillance to controlling the disease and helping the patients recover from it. In 2018, the Joint External Evaluation have indicated that many countries are not fully prepared for a possible pandemic in the future (Gupta et al., 2018). Now that the world is battling against COVID-19, even though each healthcare system indicates some level of inefficiency, the differences in the capabilities of healthcare systems become vivid.

The selected countries in this study have different levels of death prevention inefficiency; ergo different levels of capability in saving COVID-19 patients. As explained before, the previous performance of the healthcare system, its strengths and weaknesses, all come together to describe their current inefficiency in saving lives. Going back to see their performance in the past, a comprehensive index is Global Health Security (GHS) index that compares 195 countries.(Johns Hopkins Center for Health Security with NTI and the Economist Intelligence Unit, 2020) In its overall score, GHS 2019 defines three main groups of most prepared, more prepared, and less prepared countries. In addition to previous preparedness, a comparison between these groups in the current situation is also needed to explain their different performance. The table (4) shows that some of the most prepared countries based on GHS 2019 are now facing an increasing inefficiency death prevention caused by the virus, while some other not ranked as most prepared have managed to decrease this type of inefficiency. Also, the healthcare policies that are applied seem to be more or less similar, as the majority of countries have decided to allocate additional funds to the hospitals.

Table (4): Healthcare policies comparison

Group	Countries	Current healthcare-related policies	GHS 2019
Group 1	South Korea	• Tested over 14 000 people per day • Drive-through testing and phone booth testing was introduced	Most prepared
	Russia	• Emergency hospitals set up by local authorities	More prepared
Group 2	China	• Healthcare workers are exempt of personal income tax • Medical equipment are exempt from registration fees • Supporting medicine-related research	More prepared
	India	• Hospitals deferred elective surgeries • USD 2 billion allocated for treating COVID-19 patients • Restrictions on diagnostic testing kits export	More prepared
	US	• Allocated $3 billion on relevant research • Cover costs of testing for all Americans • home hospitalization and distance monitoring	Most prepared
Group 3	France	• Allocated financial support to the healthcare system and equipment • Postponing non-urgent surgeries to free the facilities for COVID-19 patients • Developing a military health service hospital	Most prepared
	Italy	• Funds allocated to healthcare system • Prioritizing COVID-19 patients for using hospital facilities • Increased medical equipment and material • Encouraging retired medical personnel to work	More prepared
	Spain	• Relevant medical research are fee exempt • Allocated fund for covering healthcare expenditure • Allocated funds to R&D • Government price intervention in medicines • Easing purchase of relevant medical goods	More prepared
	Philippines	-	More prepared
	UK	• Allocated funds to National Health Service • Waived VAT tax on medical imports like ventilators and testing kits	Most prepared
Group 4	Australia	• Allocated funds to healthcare system • Prioritizing hospital equipment for the COVID-19 patients • Cancelling elective surgeries • Allocated funds to mental health services	Most prepared

Group	Countries	Current healthcare-related policies	GHS 2019
		• Government partnership with private health providers	
	Finland	• Allocated funds to healthcare system • restrictions on the sales of medical supply	Most prepared
	Japan	• Allowing forced hospitalization • The government covering medical care costs • Allocating funds for increasing test capacity • Prioritizing medical service for vulnerable groups	More prepared
	Singapore	-	More prepared
	Malaysia	-	More prepared
	Thailand	-	Most prepared
Group 5	Germany	• Allocated funds for needed equipment • Expand hospital capacities • Postponing elective treatments • Additional funds for health insurance	More prepared
	Canada	• A boost to medical research funding • Increasing health spending transfers	Most prepared
	Sweden	• Government prepared for extra costs in health and medical care and allocating grants • Paying sickness benefit for the first day of sickness	Most prepared

Source: OECD, 2020

As the table shows, a simple comparison is not sufficient to find out which policies and methods are better than the others. Similar policies and mechanisms can lead to various outcomes in different countries. What can be said for now is that in the absence of COVID-19 medicine, the sooner the patients are diagnosed, the higher the chances are for the healthcare system to be able to save them. So while the hardworking medical experts all around the world are trying to find the proper medicine but have not yet achieved it, the role of other factors has to be tested to see which ones would facilitate the diagnosis procedure and which ones would cause a delay in it. For example, countries like Australia and US have been criticized for not being able to provide enough testing kits in some regions (Tanne et al., 2020), which is understandable due to the high rate of virus spread. But the factors such as medical shortage and the mechanisms that each country applies as a respond still have to be analyzed and evaluated. These are the factors that will be taken into consideration in our next research.

Conclusion and Suggestions

According to the measurements, the inefficiency of preventing coronavirus spread and preventing coronavirus deaths can provide a beneficial pattern to determine critical success factors in benchmark countries. Paying attention to the policies in two groups of countries in this benchmarking is useful; first countries with a stable low inefficiency in two dimensions and the second countries that have managed to reduce inefficiency after a period of high inefficiency.

Also the capability of analyzing current situation needs various aspects, one of which is the behavioral analysis of people involved. How the governments are handling COVID-19 can only be comprehensively analyzed when we take into account how well they communicate with their people. This means the way people perceive this reality and how their behavior is forming around it is a necessity for future studies. Thus, we aim to take the next step toward a comprehensive analysis by focusing on this aspect in our upcoming research.

The current analysis has taken one step towards finding the proper mechanisms that can help the governments improve their performance regarding this pandemic. However, further research must be conducted to find out which policy would work in which context. We hope to take this further, and we encourage other researchers to do so as well.

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