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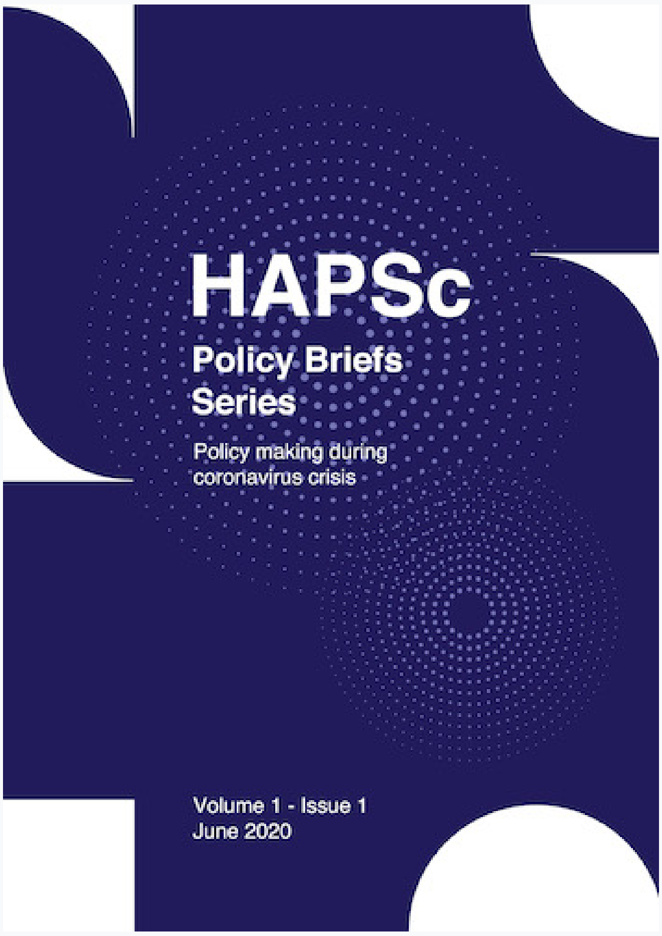

Effects of Policy Responses to the Spread of Covid-19 Pandemic

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Effects of Policy Responses to the Spread of Covid-19 Pandemic[1]

Helen Briola[2] & Konstantina Briola[3]

Abstract

Covid-19 is a new invisible threat that has affected almost all countries of the world. In this paper we study the effects of policy responses to the spread of coronavirus pandemic. For this purpose, we utilized the dataset of Oxford Coronavirus Government Response Tracker (OxCGRT) and we examined the correlation of policies with the number of daily coronavirus cases in five countries (Greece, Italy, Spain, Sweden and United Kingdom). In order to achieve that, we calculated Kendall Correlation Coefficient and Spearman Correlation Coefficient as well as p-value for the statistical importance of our data. Our results indicate that the policies have a direct impact on the spread of Covid-19.

Introduction

Covid-19 is a new and invisible threat, having spread to almost all countries of the world (Domanović, 2020). Indeed, there is a continuous increase in the number of confirmed cases and deaths associated with the coronavirus. It has turned the world upside down and changed every aspect of our lives: how we live and interact with each other, how we work and communicate, how we move and travel (CCSA, 2020). The outbreak has already caused a significant human misery and great economic turmoil. A recent study by the Asian Development Bank suggests that the global cost of the COVID-19 pandemic is expected to range from $2 trillion to $4.1 trillion in global GDP (Asian Development Bank, 2020).

During the crisis, all governments around the world have implemented a number of policies, in order to prevent further spread of the virus. However, some countries did not promptly take appropriate measures to limit the spread of it, which may justify the existence of increased cases.

In this research, we study the correlation of Covid-19 cases with the policies adopted by each country. The time factor plays a key role in this process. Our data were collected from January 1, 2020 to June 3, 2020. In this context, we focused on specific European countries (Greece, Spain, Italy, United Kingdom and Sweden). We took these countries by sampling because of the variety of policies they followed (Sweden that did not take strict measures, Italy and Spain that did not take immediate action,

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and Greece that took immediate action). What we assume is that if the correlation of the number of cases with the different policies of countries is high, then the policies have a direct impact on the spread of the virus.

Related Work

With the outbreak of the pandemic, a huge international mobilization has been created by networks of researchers and other experts investigating various aspects of Covid-19 (from diagnosis and surveillance, to its impact on the socio-economic environment). In this context, the research interest in the spread of the disease and the impact of different control measures have emerged.

Specifically, in Taghrir et al. (2020) it is reported that the measure of mass quarantine in China, has been effective in controlling the spread of disease. Respectively, studies showed that policies such as mass quarantine, travel restriction and large-scale monitoring of suspected cases were successful in reducing the epidemic size (Ai, 2020; Yang et al. 2020). Also, according to research about the impact of different control measures by the Chinese government (Fang et al. 2020), stricter government control policies (types 3 and 4[4]) have been associated with a slower increase in the infected population.

Similar surveys have been conducted for other countries worldwide. One of these is by Jarvis et al. (2020), which revealed that the physical removal measures adopted by the United Kingdom's public, have greatly reduced the contact level and is estimated to have a significant impact in reducing the transmission of COVID-19. Finally, another study Jüni et al. (2020), taking data from 144 geopolitical regions worldwide, showed that public health interventions (mass gatherings, school closures, social distance measures) were strongly associated with reduced epidemic growth.

Dataset

In response to the rapid spread of COVID-19, all governments around the world have implemented several policies. As a result, a wide range of responses have been created by governments covering all areas of policy such as: restriction and closure policies (e.g. school closures and traffic restrictions), financial policies (e.g. income support) and health system policies (e.g. test schemes).

The Oxford Coronavirus Government Response Tracker (OxCGRT), in order to study which policies can be effective in controlling the epidemic, systematically collects information on many different

[4] The coding of measures is explained in Table 1.

common political responses received by governments, which are concentrated in 17 indicators (such as school closure and travel restrictions) (Hale et al. 2020).

However, government policies seem to differ from country to country, along with the degree of emergency measures. To see the differences in the severity of the measures that each country has implemented separately, OxCGRT creates a score for each indicator. For the purposes of our study, we will refer and use 6 of these indicators as well as the coding of measures as presented in Table 1.

Table 1. Coding of Measures

Policy	Coding of Measures
School Closure	0 - No measures 1 - Recommend closing 2 - Require closing (only some levels or categories) 3 - Require closing all levels
Workplace Closure	0 - No measures 1 - Recommend closing (or work from home) 2 - Require closing (or work from home) for some sectors or categories of workers 3 - Require closing (or work from home) all-but-essential workplaces (e.g. grocery stores, doctors)
Restrictions on gatherings	0 - No restrictions 1 - Restrictions on very large gatherings 2 - Restrictions on gatherings between 101-1000 people 3 - Restrictions on gatherings between 11-100 people 4 - Restrictions on gatherings of 10 people or less
Stay at home requirements	0 - No measures 1 - Recommend not leaving house 2 - Require not leaving house with exceptions for daily exercise, grocery shopping, and ‘essential’ trips 3 - Require not leaving house with minimal exceptions (e.g. allowed to leave only once a week, or only one person can leave at a time, etc.)
Restrictions on internal movement	0 - No measures 1 - Recommend not to travel between regions/cities 2 – Internal movement restrictions in place
International travel controls	0 - No measures 1 - Screening 2 - Quarantine arrivals from high-risk regions 3 - Ban on arrivals from some regions 4 – Ban on all regions or total border closure

Experiment

In this paper, we study the correlation of policies with the number of daily Covid-19 cases. Specifically, we study the relationship of these two variables (policies and number of cases) using two correlation coefficients: Spearman's rho and Kendall's tau, both of which are commonly used nonparametric methods of detecting associations between two variables (Taylor, 1987: 409).

Spearman's correlation coefficient as well as Kendall are non-parametric statistical measure, and we use them to measure the strength of association between two variables. Their values range from -1 to +1, where the value $r = 1$ means a perfect positive correlation and the value $r = -1$ means a perfect negative correlation. So, there is considered a strong correlation if the correlation coefficient is greater than 0.8 and a weak correlation if the correlation coefficient is less than 0.5.

In the context of null hypothesis testing we are using p-value in order to quantify the idea of statistical significance of evidence. The p-value can take any value between 0 and 1. Values close to 0 indicate that the observed difference is unlikely to be due to chance, whereas a p-value close to 1 suggests no difference between the groups other than due to chance. In general, the smaller the p-value, the stronger the evidence against the null hypothesis (Dahiru, 2008).

Our approach consists of five experiments (one for each country) and the procedure can be summarized in the steps below:

1. Merge the policies of the country we want to correlate and the daily cases based on date.
2. Normalize the values.
3. Compute Kendall correlation coefficient between each country's specific policy and daily number of cases.
4. Compute Spearman correlation coefficient between each country's specific policy and daily number of cases.
5. Compute p-value for each policy.

For the purpose of this study we used the general-purpose programming language Python in order to preprocess the data and compute correlations and p-values, since it is commonly used for this kind of computations.

Results

The table below presents the policies to address the virus (School Closures, Workplace Closures, etc.), as well as the differences in the severity of the measures that each country has implemented separately (0 = No measures to 3 or 4=Strict measures). Also, in the data, a percentage of austerity of all the measures followed by each country is presented (Stringency Index). Based on the policies we have listed in the table below, we note that Italy has taken the tightest measures and Sweden the most tolerant measures. However, if we take into account the Stringency Index, which includes additional policies from those we have included, Spain has the highest percentage (79.1%) and Sweden the lowest percentage (32.4%).

Table 2. Severity of measures in each country

Countries	School Closures	Workplace Closures	Restrictions on gatherings	Stay at home requirements	Restrictions on internal movement	International travel controls	Stringency Index
Greece	2,3 (Median 3)	1,2 (Median 2)	3,4 (Median 3)	2	2	3	72.2%
Italy	3	1,2,3 (Median 3)	4	1,2,3 (Median 2)	1,2 (Median 2)	1,2,3 (Median 3)	69.9%
Spain	3	1,2,3 (Median 2)	1,4 (Median 4)	2	1,2 (Median 1)	1,4 (Median 4)	79.1%
Sweden	1	1	2,3 (Median 2)	0	1 (Median 0)	3 (Median 3)	32.4%
United Kingdom	3	1,2 (Median 2)	4	1,2 (Median 1)	1,2 (Median 1)	0	66.67%

Note: In multi-level policies and in the stringency index, we have used the median since the day the first case occurred

Our results indicate that there is a strong correlation of the number of coronavirus daily cases and the policies that each country followed and can be summarized in the figures below.

Figure 1. Kendall Correlation Coefficient for each policy response of each country

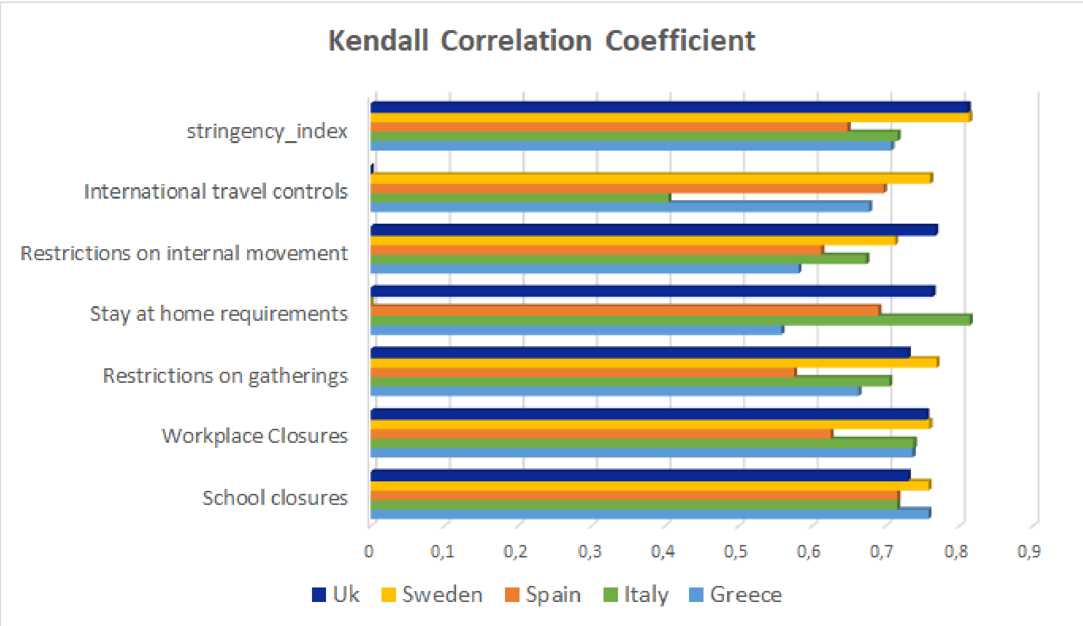
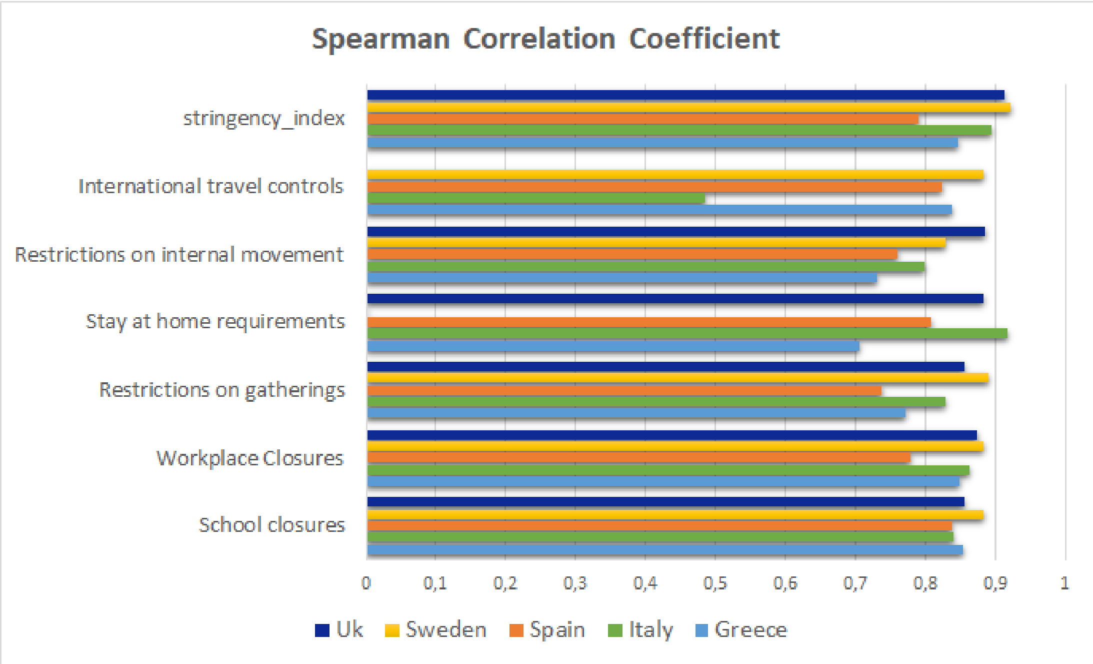


Figure 2. Spearman Correlation Coefficient for each policy response of each country

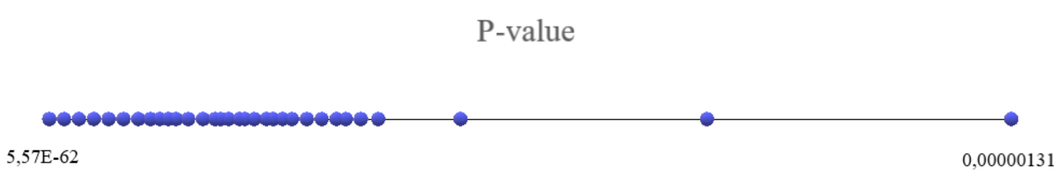


As we observe from the figures above both correlation coefficients are high enough but Spearman Correlation Coefficient is higher than Kendall. Moreover, school closures and workplace closures seem to affect the number of daily cases and have a high correlation coefficient in most of the countries. Furthermore, international travel controls have a quite low correlation coefficient for Italy, however, this could be explained by the fact that Italy did not take immediate action.

In our experiment we could not calculate correlation coefficients for "Stay at home requirements" in Sweden and "International travel controls" in United Kingdom, since, as it is explained in Table 2, these countries did not apply these policies at all (since June 3, 2020) so correlation coefficient could not be calculated.

In order to evaluate the statistical importance of our results we also calculated p-values for each policy in each country. Our results can be summarized in Figure 3.

Figure 3. P-values for each policy response of each country



As we notice from the figure above, p-values range from 5.57E-62 (the lowest p-value) to 0.00000131 (the highest). These results indicate strong evidence against the null hypothesis, as there is less than a 5% probability the null is correct (and the results are random), since all of them are less than 0.05.

Conclusions

In this paper we studied the effects of policy responses to the spread of Covid-19 pandemic. For this purpose, we examined the correlation of policies with the number of daily coronavirus cases in five countries (Greece, Italy, Spain, Sweden and United Kingdom) from January 1, 2020 to June 3, 2020 by calculating Kendall Correlation Coefficient and Spearman Correlation Coefficient. Our results indicate that there is a strong correlation of covid-19 daily cases and policies that each country applied. Although, some countries, such as Sweden, did not take strict measures, the correlation coefficients of their policies with daily cases are quite high, which shows that the policies have a direct impact on the spread of the virus.

To put it in a nutshell, from our results it is implied that, even though all policy responses had a great impact in the number of daily cases, some of them stood out for each country. The time that each measure was taken played a critical role on that. In order to be more precise, in Sweden restrictions on gatherings had the highest correlation coefficient whilst in Greece and in Spain school closures had the highest one. Moreover, in UK restrictions on internal movement seems to be the most correlated with the number of daily cases. On the other hand, in Italy stay at home requirements had the highest correlation with the number of covid-19 cases. These results may be due to the fact that each country took measures in a different period of time and the severity of them differs for each one of them.

A possible extension of our work would be the application of our approach in all of the countries in order to examine the effects of policy responses to the spread of coronavirus worldwide. Moreover, we could also study other policy responses such as cancellation of public events or testing policies. Lastly, we could use other correlation coefficients such as Pearson Correlation Coefficient in order to evaluate which correlation coefficient is the best for our approach.

References

Ai, S., Zhu, G., Tian, F., Li, H., Gao, Y., Wu, Y., Liu, Q. and Lin, H. (2020). Population movement, city closure and spatial transmission of the 2019-nCoV infection in China, *medRxiv* 2020.02.04, 20020339.

Asian Development Bank (2020). Asian Development Outlook (ADO) 2020: What Drives Innovation in Asia?. Asian Development Outlook, Philippines.

CCSA (2020). How COVID-19 is changing the world: a statistical perspective. UNCTAD.

Dahiru, T. (2008). P-Value, a true test of statistical significance? a cautionary note. *Annals of Ibadan Postgraduate Medicine*, 6(1): 21-26.

Domanović, D. (2020). Coronavirus disease 2019 (COVID-19) and supply of substances of human origin in the EU/EEA. European Centre for Disease Prevention and Control, Stockholm.

Fang, Y., Nie, Y. and Penny, M. (2020). Transmission dynamics of the COVID-19 outbreak and effectiveness of government interventions: A data-driven analysis, *Journal of Medical Virology*, 92 (6): 645-659.

Hale, T., Webster, S., Petherick, A., Phillips, T. and Kira, B. (2020). Oxford COVID-19 Government Response Tracker. Blavatnik School of Government.

Jarvis, C., Zandvoort, Van K., Gimma, A., Prem, K., Klepac, P., Rubin, G. and Edmunds, W. (2020). Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK, *BMC Medicine*, 18: 124.

Jüni, P., Rothenbühler, M., Bobos, P., Thorpe, K., Costa, da B., Fisman, D., Slutsky A. and Gesink, D. (2020). Impact of climate and public health interventions on the COVID-19 pandemic: a prospective cohort study, *Canadian Medical Association Journal*, 192 (21): E566-E573.

Taghrir, M. Akbarialiabad H. and Marzaleh, Ahmadi M. (2020). Efficacy of Mass Quarantine as Leverage of Health System Governance During COVID-19 Outbreak: A Mini Policy Review, *Archives of Iranian Medicine*, 23 (4): 265-267.

Taylor, J. M. G. (1987). Kendall's and Spearman's Correlation Coefficients in the Presence of a Blocking Variable, *Biometrics*, 43 (2): 409-416.

Yang, Z., Zeng, Z., Wang, K., Wong, S., Liang, W., Zanin, M., Liu, P., Cao, X., Gao, Z., Mai, Z., Liang, J., Liu, X., Li, S., Li, Y., Ye, F., Guan, W., Yang, Y., Li, F., Luo, S., Xie, Y., Liu, B., Wang, Z., Zhang, S., Wang, Y., Zhong, N. and He, J. (2020). Modified SEIR and AI prediction of the epidemics trend of COVID-19 in China under public health interventions, *Journal of Thoracic Disease*, 12 (3): 165-174.