



Geospatial multivariate analysis of COVID-19: a global perspective

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Accepted: 22 September 2021

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Abstract This manuscript presents a geospatial and temporal analysis of the COVID-19 along with its mortality rate worldwide and an empirical evaluation of social distance policies on economic activities. Stock Market Indices, Purchasing Manager Index (PMI), and Stringency Index values are evaluated with respect to rising COVID-19 cases based on the collected data from Jan 2020 to June 2021. The findings for the stock market index reveal the highest negative correlation coefficient value, i.e., -0.2 , for the Shanghai index, representing a negative relation on stock markets, whereas the value of the correlation

coefficient is minimum for Indian markets, i.e., 0.3 , indicating the most impact by COVID-19 spread. Further, the results concerning PMI show that the highest value of the correlation coefficient is for the China i.e., -0.52 , points to the sharpest pace of contraction. This reflects the lower value of the correlation indicating that the economy is on the way of growth, which can be seen from the PMI value of the various countries. The manuscript presents a novel geospatial model by empirically evaluating the correlation coefficient of COVID-19 with stock market index, PMI, and stringency index to understand the effect of COVID-19 on the global economy.

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Keywords Coronavirus · COVID-19 · Economic slowdown · Financial markets · Global economy · Multivariate analysis · Pandemic · Purchasing manager index

Introduction

During this challenging and unprecedented time of COVID-19, the prime concern for each nation is the maintenance of population health. However, it has another significant and prolonged impact on the national economy which is currently being overlooked. Hence, during this pandemic, each country is facing two major challenges: a healthcare challenge and an economic challenge. The global economy has

virtually crashed, with millions of people locked up, and global supply chains were thrown into dire straits. Being a highly infectious disease, the ways of preventing the spread include policy measures such as the enforcement of social distancing, self-isolation at home, the closing of institutions and public services, mobility controls, and even the lockdown of an entire country. These decisions ultimately have dire implications for economies worldwide. To put it another way, effective disease containment requires a country's economy to stop its normal functioning, leading to the economy's financial disruption. Further, this has triggered concerns for a severe and extended global recession. IMF (International Monetary Fund) has forecasted a negative per capita GDP growth for more than 170 countries in 2020 due to this pandemic, declaring it to be the most severe global financial downturn since the Great Depression of the 1930s (Crafts & Fearon, 2010).

The planet has experienced various epidemics, including the 1918 Spanish Flu, HIV / AIDS outbreak, SARS, MERS, and Ebola, which were severe episodes in itself. However, COVID-19 potentially turns out to be the biggest emergency ever recorded in our history. It has already been named a Black Swan event for the global economy by many experts. The first case of COVID-19 was recorded as "unidentified cause pneumonia," as confirmed by the WHO Country Office in China in Wuhan, China, on 31st December 2019. The cases have increased steadily and sharply since then. Further, on 30th January 2020, i.e., within just a 1-month duration, the outbreak was declared an international public health emergency. On 11th February 2020, the WHO coined a name for new coronavirus disease: COVID-19, and on 11th March 2020, this was proclaimed a pandemic crossing boundary internationally. The outbreak of COVID-19 has triggered global concern, with 3,181,642 cases and 2,24,301 deaths affecting 215 countries and territories as of 1st May 2020 (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019>). The graph shown in Fig. 1 represents a constantly rising trend for active COVID-19 cases. The United States of America has the highest number of 1.48 million active cases, the country-wise statistics depicted in Fig. 2. The European countries are worst hit, especially the western European countries as depicted in Fig. 3.

To curtail the virus's progression, the Governments of countries world-wide declared nationwide

lockdown; by far, the toughest measure taken by any government in response to the pandemic. The unforeseen lockdown is projected to harm the economy significantly. There are millions of jobs and livelihoods at stake. Severe restrictions on the transportation of raw materials and finished goods across states are imposed. Countries have sealed borders causing sudden knockout to international commerce and trade. All these interrupt mechanisms of supply and distribution chains in almost all sectors. At the same time, consumer demand has collapsed entirely, as millions remain in lockdown and defer their non-essential investments. The extent of the financial impact is still unpredictable and would depend on the nature and severity of the health crisis, the length of the lockdown, and the way the situation unfolds after the lockdown has been lifted.

Yet, the coronavirus pandemic could trigger a new kind of recession, distinct from the previous reasons for a recession. First, most of the past recessions affected the single side of the supply–demand chain, yet this virus impacted both the chains equally. Also, both production costs and sales rates had dramatically lowered as suppliers and producers themselves offered discounts to obtain orders. Secondly, the effect of past recessions was limited to a particular area only, but this has a widespread impact across the globe.

This manuscript demonstrates how the coronavirus outbreak led to severe consequences in significant sectors of the global economy. The study also attempts to analyze the effectiveness of Government policies for saving citizens' lives using a stringency index. The empirical evaluation performed in the paper examines the effect of containment & Closure policies, economic policies, and healthcare policies (in terms of Stringency Index) on the containment of COVID-19. The global impact of the outbreak on various sectors of the economy (concerning the Stock Market Index) is also presented. An analysis of the effect of the growing number of reported cases of coronavirus on the manufacturing sector (Considering Purchasing Manager Index (PMI)) is made. Further, COVID-19 has led to the shutting down of industries and international trade, so an evaluation of the correlation of commodity prices with respect to COVID-19 cases is also presented. The outcome of this research work is to establish the correlation of active cases with respect to significant indicators of the global economy and

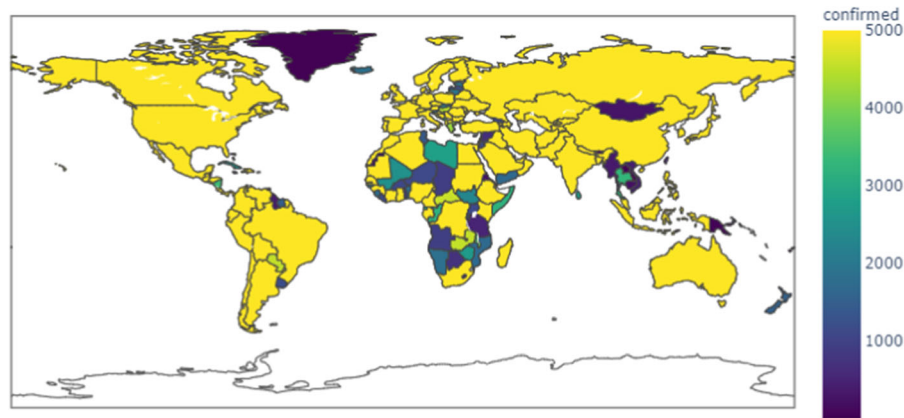


Fig. 1 Trend of COVID-19 Cases

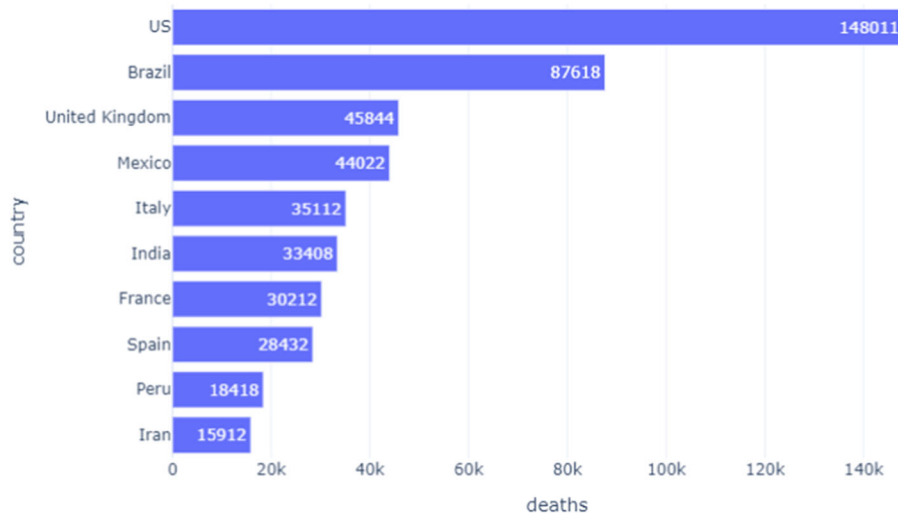


Fig. 2 Country Wise Statistics of COVID-19

present a geospatial model to analyze the spread of COVID cases across the world.

The manuscript has been organized as follows. Section 1 gives a brief introduction of the COVID-19 and its association with the global economy. The impact of similar outbreaks in history is discussed in Sect. 2. Section 3 is dedicated to the related work, and the proposed empirical model is presented in Sect. 4. Results and discussion are explained in Sect. 5, and finally, the conclusion is given in Sect. 6.

Temporal Analysis of Earlier Outbreaks

The cause & effect of previous economic recessions is comprehensively documented (Bagliano & Morana, 2012; Bentolila et al., 2018; Bezemer, 2011; Jagannathan et al., 2013; Mian & Sufi, 2010; Stiglitz, 2010). For example, the 1997 Asian debt crisis was triggered by the drop of the Thai baht, leading to a regional financial crisis and recession in Asia (Radelet et al., 1998). The global recession of 2008 was triggered by low inflation that created real estate losses, followed by subprime mortgages, poor lending standards, and regulatory frameworks in the banking sector (Allen & Carletti, 2010). The 2016 recession in Nigeria was triggered by multiple factors like a plunge in crude oil

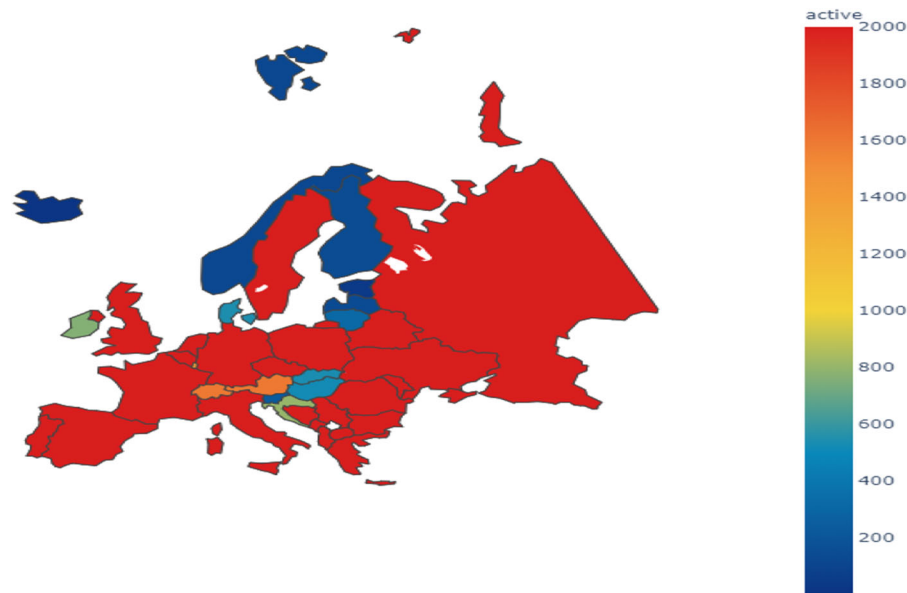


Fig. 3 Active Cases of COVID-19 in European Countries

prices, payments deficit balance, the introduction of a fixed-float exchange rate system, a rise in petrol prices, pipeline vandal activities, and vulnerabilities in infrastructure. The most recent 2010 recession in Greece was provoked by the effects of the global financial crisis, systemic flaws in the Greek micro and macroeconomy, and a lack of stability in monetary policy as a Eurozone member (Rady, 2012).

From pre-historic to the modern era, human history is replete with deadly infectious disease outbreaks, which ravaged large swathe of regions and wiped out civilizations. Over the last two centuries in the wake of the industrial revolution leading to urbanization and globalization, pandemics are becoming more regular events than ever. Degradation of natural ecosystems changed land use patterns combined with high population density, faster global travel, and economic integration to spread these highly contagious disease outbreaks to newer countries/regions. Study shows that global pandemics of past can be grouped into two types: one with high virulence resulting in higher mortality but with lower infectiousness and the second characterized with higher infectiousness and lower virulence where infection quickly spreads to larger regions, but mortality is lower. A negative impact on economies will be higher when the pandemic is highly infectious, even if it has lower virulence (Verikios et al., 2011). Negative impact on socio-economic

activities results due to direct and indirect damages wherein indirect damages are attributed to fear-driven behavioral changes in the public.

Spanish Flu (1918), Asian Influenza (1957), Hong Kong Influenza (1968) are recognized as the major Influenza outbreaks of the twentieth century (Kilbourne, 2006). Non-Influenza outbreak, which had a global impact on is HIV AIDS pandemic in 1981, others like plague, cholera, smallpox were restricted to different regions of Africa, Asia, and European Continents. There has been macroeconomic analysis about the impact of these outbreaks on the availability of labor force, manufacturing output, supply, and demand channels.

In the study titled “Global Macroeconomic Consequences of Pandemic Influenza Analysis,” Lowy Institute for International Policy, Sydney, Australia suggests that Spanish Flu caused GDP loss of 3 percent in Australia, 15 percent in Canada, 17 percent in the United Kingdom, 11 percent in the United States (McKibbin & Sidorenko, 2006). According to another study based on different regions’ mortality rates, authors have predicted that the 1918 Spanish Flu Pandemic led to an 18% drop in state manufacturing output in the US (Correia et al., 1918).

Similarly, the 1957 Flu pandemic led to a GDP loss of 3 percent in Canada, Japan, the UK, and the United States. Hong Kong flu influenza pandemic in 1968 led

to US\$23 billion–US\$26 billion direct costs included in hospitalization, procurement of pharmaceutical products, and indirect cost that contained absenteeism in the labor force in the United States (Kavet, 1977).

During the first two decades of the twenty-first century, outbreaks in 2003, Swine flu in 2009, MERS in 2012, Ebola virus epidemic in West Africa in 2013 had a global impact. Economic impact analysis of SARS suggests that countries at the epicenter of the outbreak, like Hong Kong, China, Singapore lost billions of dollars of their GDP due to a downward turn in FDI, Export, Tourism (Food, accommodation), etc. (Keogh-Brown & Smith, 2008). In the Swine flu influenza, a H1N1 pandemic in 2009, South Korea had 3,082,113 cases, which represents 6.6% of the country's population, reported a direct and indirect socio-economic loss of US\$1.09 billion (Kim et al., 2013). The MERS epidemic of 2012, which started in the Middle East, spread into 22 countries. In 2015 MERS reached South Korea which soon became the largest outbreak outside the Middle East, where the study on the economic impact shows altered consumer spending behavior post-outbreak (Jung et al., 2016), and the tourism industry was reported a loss of US \$2.6 billion (Joo et al., 2019).

Related studies

The evolution and spread of COVID-19 have badly disrupted the economy of each country across the globe. The global risk factors have increased substantially in response to this pandemic leading to a highly unpredictable and volatile market. Moreover, the spread of this virus is highly uncertain and quite complex to anticipate. Hence, policymakers find it challenging to formulate any strategy to minimize its effect on the national economy. Numerous researchers and mathematicians are fascinated by understanding this virus's impact on macroeconomics and financial markets worldwide. Resultantly, various researchers have suggested different approaches in order to evaluate the effect of COVID-19 on finance by exploring different aspects. Table 1 summarizes the latest work done in this area.

From the research review tabulated in Table 1, it can be safely concluded that the research done by various researchers to establish the spatial correlation of the pandemic needs to be explored more to find the impact

of spatial and temporal coordinates on the spread of the disease (Cordes & Castro, 2020; Guo et al., 2005; Hale et al., 2020). The same findings also lend a helping hand to administrative bodies to act accordingly in order to minimize the loss in terms of human life and finance.

Empirical evaluation

This section presents the empirical evaluation of the influence of social distance policies on economic activities. Several cases are presented to demonstrate the impact of COVID-19 and social distancing policy on the global economy. Stock Market Indices and Purchasing Manager Index are evaluated concerning rising COVID-19 cases. Further, the Oxford University Research team proposed a novel stringency index that combines various govt responses is evaluated to find the correlation with fresh COVID-19 cases (McKibbin & Fernando, 2021). A detailed description of the methodology followed is given below in Fig. 4.

Data collection

The stock market data of five countries, i.e., The USA (S&P 500), UK (FTSE 100), Italy (FTSE-MIB), China (Shanghai), and India (BSE-Sensex), are collected from Jan 2020 to June 2021. The thin sample period enables us to explore the direct (and immediate) effect of social distancing policies on the stock market and the level of general market/business activity at the onset of the coronavirus crisis. The indices data are downloaded from the yahoo finance web portal, and data related to Coronavirus incidences are downloaded from worldometer.com. The data related to PMI are collected from the online source available at <https://ihsmarkit.com/>. Data related to the stringency index is collected from the Oxford Government Response Tracker website. Geospatial modeling is done using R statistical tool.

Evaluation variables

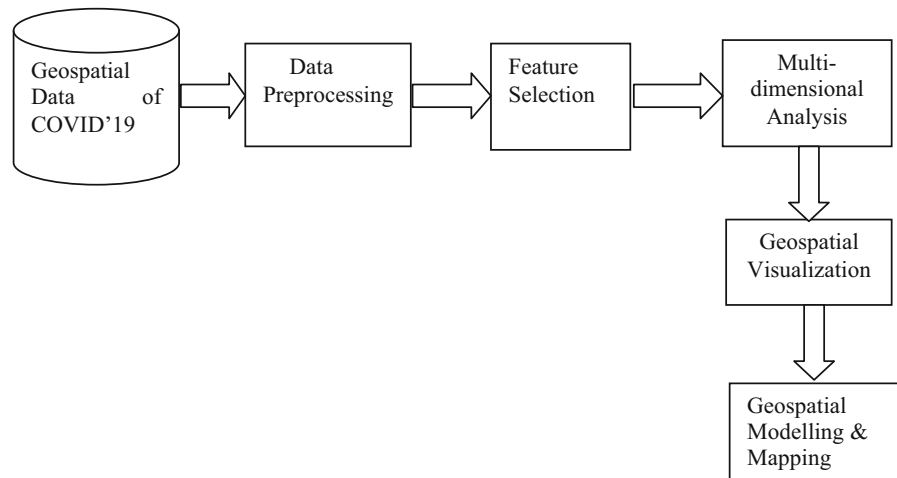
Evaluation variables are classified as response variables and input variables. The input variable is the number of COVID-19 confirmed cases and the stringency index. Response variables, i.e., the output variables impacted by the COVID-19 spread evaluated

Table 1 A review of the state-of-art work in the analysis of COVID Data

Citation	Technique	Dataset	Observation	Conclusion
Baek et al. (2019)	G-Cubed Model	Evolution of COVID-19 by exploring 7 scenarios	Even a controlled outbreak hugely impacts the global economy in minimum time	The county's government plays a crucial role by minimizing the extent of contagion and thereby reducing the social and economic costs
Ramelli and Wagner (2020)	Descriptive Statistics, Firm Characteristics	Effect of COVID-19 on the stock price	An exponential rise in the telecom and healthcare industries, and a collapse in entertainment, energy, and transportation industries	The underperformance by international stocks, particularly China-oriented stocks, is noticed during the outbreak phase. This underperformance grew stronger and spread across the aggregate market during the "Fever" phase (last week of February and early March)
Zhang et al. (2020), Fornaro and Wolf (2020) and Baker et al. (2020)	Conceptual Analytical Approach	Impact of COVID-19 on Financial Markets	The outbreak of COVID-19 disrupts the supply persistently even beyond the end of the epidemic	This outbreak results in a demand-driven slump, thus leading to stagnation
Fernandes (2020)	Statistical Analysis	Impact of spending and household consumption in response to this epidemic virus	Household drastically alter their spending behavior	During the initial phase, a sudden and sharp increase in retail and food items is observed, followed by a sudden decline in spending
Kotikot et al. (2020)	Statistical Analysis	global economic costs of COVID-19 across 30 countries	The uncertain and unpredictable trend due to COVID-19 might lead to a great recession in the history of the global economy	The study concludes that each month of crisis costs around 2.5% to 3% of global GDP
Yuan et al. (2013 and Franch-Pardo et al. (2020)	Geospatial correlation	Impact of geographical region on the spread of COVID-19	The disease can be significantly modeled using geospatial correlation	Geospatial analysis can be effectively employed as a tool for analysis of COVID'19 spread
Kang et al. (2020)	A survey of 63 research articles	Spatial-statistical and geospatial aspect of the pandemic	Several factors such as statistical, temporal, geospatial play an important role for understanding the COVID'19 spread	The multidimensional review of the pandemic performed here concludes that it is imperative to perform the analysis of disease from multiple perspectives so as to curb the spread in an effective manner

Table 1 continued

Citation	Technique	Dataset	Observation	Conclusion
Ramírez and Lee (2020)	Moran's I statistic considering 6 various definitions of neighborhood	spatio-temporal pattern and its spatial correlation in the various cities of china during Jan 16, 2020 to Feb 06, 2020	Estimated the impact of the social, temporal, and environmental variables for the disease	The study concludes that spatial analysis may prove to be a prime tool to control the spread of pandemic and hence must be performed rigorously
Rex et al. (2020)	Spatial patterns of pandemic	Dataset of Colorado, the incidences during March 14 to April 8, 2020, considering various conditions and social determinants	The study revealed that those prime social determinants are asthma, population density, and financial conditions etc	Multidimensional analysis of the COVID'19 data is required for the better understanding of the pandemic

**Fig. 4** Framework for Proposed Methodology

are the stock market index, Purchasing Manager Index (PMI), and Commodity Market Index. PMI is a prominent index based on the monthly survey of purchasing managers of enterprises. It reflects the confidence of people in the market and covers almost every link of enterprises, comprising purchasing, logistics, manufacturing, etc. The PMI threshold is 50 units; any value lesser than that reflects recession; the higher the value, the stronger the economy is. Table 2 shows the PMI values of the countries since the COVID-19 outbreak.

Further, a team of researchers at Oxford University introduced a novel index called stringency index, providing a methodical way to track the stringency of various policy decisions of governments across various countries. The index evaluates 17 indicators of

government decisions, representing closure policies, economic policies, health-related policies. Eight of the indicators represent the policy decisions (C1-C8) on containment and closure, e.g., lockdown, social distancing, the closing of schools, and educational institutions. Four economic policy indicators (E1-E4) track record of financial policies, such as foreign aid, no deduction in salary, or income support, and five health indicators (H1-H5), consider health care policies, for instance, testing of COVID-19 cases or healthcare investments, etc. The index records the number and severity of government policies and does not represent the 'scoring' based on the efficacy of a country's response. Table 3 shows the details of the factors used in the calculation of the stringency index (McKibbin & Fernando, 2021).

Table 2 PMI Index value of Countries since COVID-19 outbreak

	USA	UK	Italy	China	India
First COVID-19 Case	Jan 21, 2020	Jan 29, 2020	Jan 31, 2020	Nov 17, 2020	Jan 30,2020
Dec-19	47.8	47.4	46.2	50.2	52.7
Jan-20	51.9	50	48.2	55.3	51.2
Feb-20	50.7	51.7	47.7	54.5	40.2
March-20	48.5	47.8	40.3	51.8	50
April-20	36.1	32.6	31.1	27.4	49.2
May-20	39.8	40.7	45.4	30.8	50.9
June-20	49.8	50.1	47.5	47.2	51.2
July-20	50.9	53.3	51.9	46	52.8
Aug-20	53.1	55.2	53.1	52	53
Sep-20	53.2	54.1	53.2	51.8	52.9
Oct-20	53.4	53.7	53.8	58.9	53.5
Nov-20	56.7	55.6	51.5	51.3	54.9
Dec-20	57.1	57.5	52.8	51.4	53
Jan-21	59.2	54.1	55.1	57.7	51.4
Feb-21	58.6	55.1	56.9	57.5	50.8
March-21	59	58.8	60	55.1	50.5
April-21	60.7	61.2	61	55.3	51.9
May-21	61.8	66.1	62.3	50.5	52
June-21	61.7	64	62.1	48	51.7

Table 3 Factors for the calculation of Stringency Index

Sr. no	Name	Type	Sectoral/ Geographical
1	Closing of Schools	Containment	Geographical
2	Closure of Workplaces	Containment	Geographical
3	Public Events Cancellation	Containment	Geographical
4	Social Distancing	Containment	Geographical
5	Closing of Public Transport	Containment	Geographical
6	Lock down in Home	Containment	Geographical
7	Inter State Movement Restrictions	Containment	Geographical
8	International Travel Restrictions	Containment	Geographical
9	Income Support	Economic	Sectoral
10	Debt Relief	Economic	Sectoral
11	Fiscal Incentives	Economic	Sectoral
12	International Funds	Economic	Sectoral
13	Public information campaign	Health	Geographical
14	Testing Policy	Health	Geographical
15	Contact Tracing	Health	Geographical
16	Emergency Investment in Healthcare	Health	Geographical
17	Investment in COVID-19 Vaccines	Health	Geographical

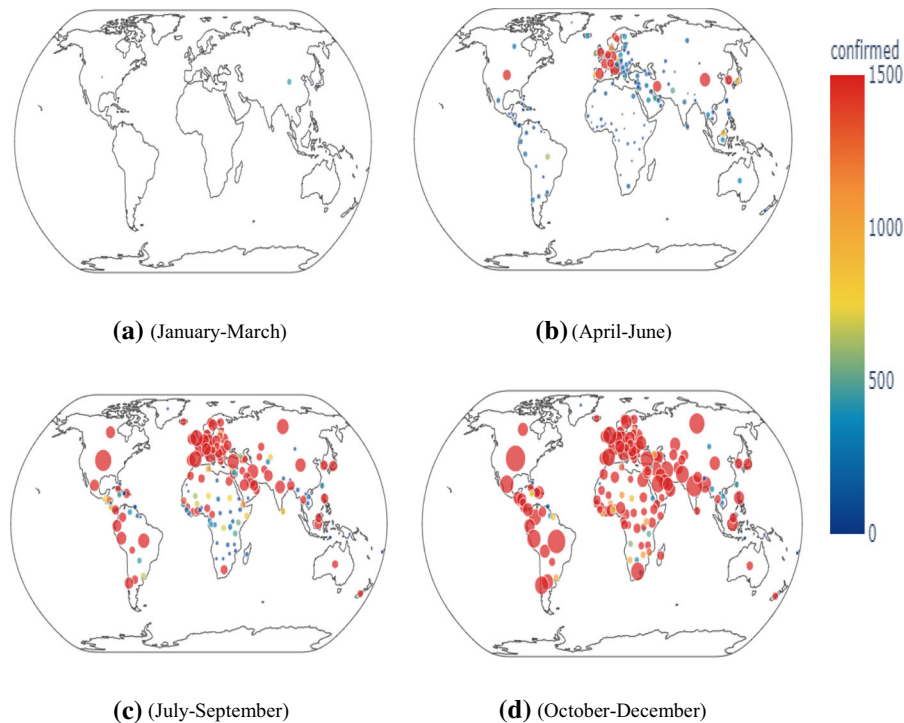


Fig. 5 Active Cases of COVID'19 worldwide over the span of year 2020

Empirical evaluation

This section presents the results of the empirical model in terms of correlation. The impact of COVID-19 on a stock market index, PMI, commodity market, and Stringency Index are presented in the following subsection:

Spatiotemporal analysis of COVID spread

Figure 5 presents the spatiotemporal analysis of COVID'19 cases worldwide in chronological order over the span of the year 2020. As it is evident from Fig. 5a, initially, the cases seem to be originated only around China and its neighboring countries. Later, it spread to Europe, Australia, and the United States of America. Till mid Feb, the spread was in control. However, later as depicted in Fig. 5b, west Asia, mainly Iran and Iraq, became the disease's hotspot. Italy was also beginning to show the trend during this time of the year. In Fig. 5c, around the mid-year, Europe had the most active cases. The disease was spread in the USA at that moment. Figure 5d depicting the trend at the later part of the year, where it can be

seen that the USA, UK, Spain, Italy, Germany, France are showing the maximum active cases. Geospatial modeling enables the administrative authorities of various countries to perceive the situation well in advance so that precautionary steps could be taken to curb the spread.

Mortality analysis of COVID'19 over time

Figure 6 presents the spatiotemporal analysis of COVID'19 mortality worldwide in chronological order over the span of the year 2020. As it is evident from Fig. 6(a), initially, there were no deaths reported except in China. Later, it spread to Europe, Australia, and the United States of America as depicted in Fig. 6(b). Gradually the disease caused mortality all over the world.

Correlation of COVID-19 with stock market indices

The value of the Pearson correlation coefficient represents the intensity of association among variables. In this analysis, correlation matrices of S&P

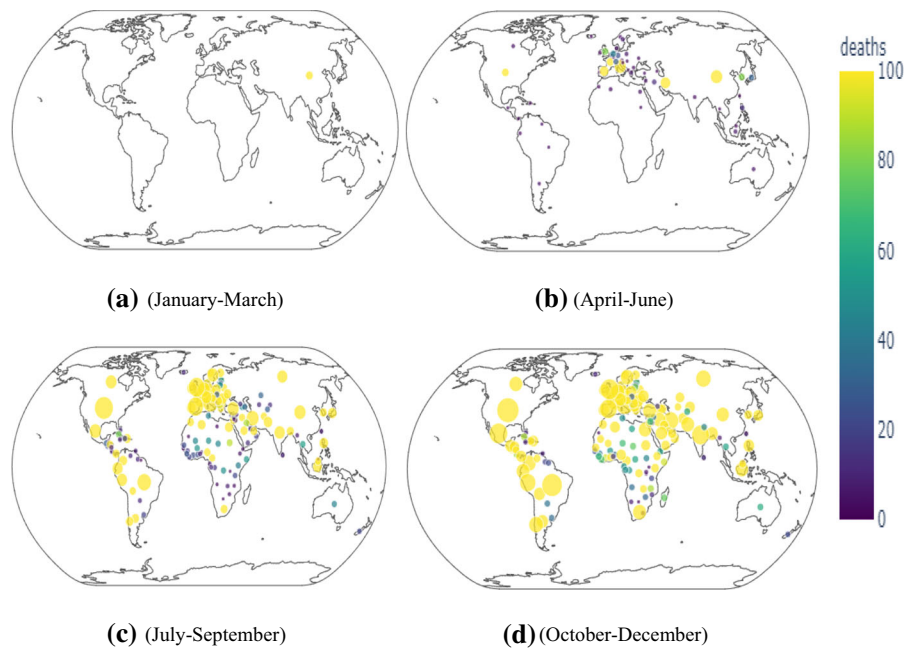


Fig. 6 Mortality Analysis of COVID'19 worldwide over the span of year 2020

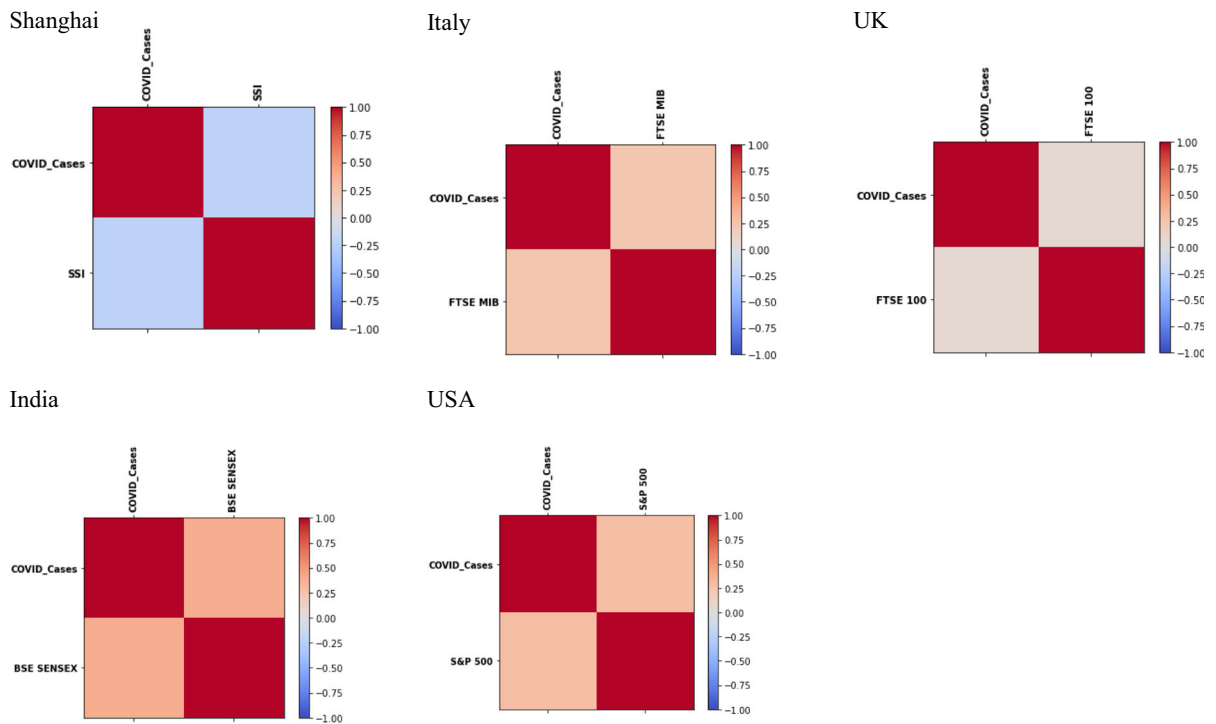


Fig. 7 Correlation Matrices of Stock Market Indices with respect to COVID-19 cases

500, FTSE 100, FTSE-MIB, Shanghai, and BSE-Sensex concerning COVID-19 cases are demonstrated in Fig. 7, respectively. The coefficient is calculated as given below in Eq. 1:

$$\rho(x, y) = \frac{Cov(x, y)}{\sigma_x \sigma_y} \quad (1)$$

Here, $\rho(x, y)$ represents the correlation between two datasets and $Cov(x, y)$ represents the covariance between x and y . Further, σ_x, σ_y indicates the standard deviation of x and y .

The intensity of color demonstrates the correlation index. The blue color represents a weaker correlation, while the as the color bar goes up, correlation increases. As shown in the graphs, Shanghai has the minimum correlation (light blue color), while the Indian markets demonstrates the minimum value of correlation coefficient.

Further, Table 4 demonstrates the correlation coefficient's value; negative values represent the negative association between variables, while positive values represent the positive impact of variables on each other. The highest negative value, i.e., -0.21168 , is for the Shanghai index, representing a negative impact on stock markets, whereas the value of the correlation coefficient is maximum for Indian markets, i.e., 0.395196 , indicating the most impact by COVID-19 spread.

Correlation of COVID-19 with PMI

After stringent policies like Nationwide lockdown, business activities were put to a halt, further impacting the industrial sector to an all-time low. The worst-hit pandemic has taken a toll on all industries. Correlation matrices of PMIs of the countries with respect to COVID-19 cases are demonstrated in Fig. 8, respectively. The USA has shown the darkest value i.e., the

Table 4 Correlation Coefficient of COVID-19 cases with respect to Stock Market Index

Country	Correlation coefficient value
Shanghai	-0.21168
Italy	0.232354
UK	0.066231
India	0.395196
USA	0.283734

highest correlation, while China shows the lightest value explaining the lower correlation between the values. The lowest value of China is explained by the fact that the economy of China is on the path of recovery after the fiasco of COVID-19. Table 5 represents the value of the correlation coefficient.

The PMI index for the selected countries dropped down to below 50; the value for UK and Italy tumbled to ~ 30 . Table 5 shows the impact of restrictions imposed by the virus with respect to PMIs. The results show that the highest value of the correlation coefficient is for the China i.e., -0.522799 , points to the sharpest pace of contraction. This reflects the lower value of the correlation indicating that the economy is on the way of growth, which can be seen from the PMI value of above 50 for China.

Correlation of COVID-19 with stringency index

Stringency Index can be taken as a measure to track the impact of enforcement of policy measures by the Government on the spread of COVID-19. The response of the governments of different countries has shown a wide variation concerning policy enforcement; some governments quickly intensify initiatives as soon as the epidemic spreads, while in other countries, the rise in intervention rigor tends to lag growth in new cases. Throughout the outbreak period, more stringent policy responses have generally been imposed. However, the pace at which these initiatives are taken plays a critical role in mitigating the spread. As can be seen from Fig. 9, the stringency index shows an upward trend with the increased no. of cases, demonstrating that more restrictions were imposed with the spread.

Table 6 shows the correlation coefficient values to ascertain the correlation of stringency index with respect to no. of COVID-19 cases. A negative value means that the higher the stringency, the lower is the number of cases. India has demonstrated the maximum negative correlation coefficient, meaning the stringency measures can curb the infection.

At the same time, China has shown the minimum correlation coefficient value; it can be attributed to the fact from mid-Feb that China's cases started to decline, and hence the policy measures were less stringent. Hence, the impact of stringency measures was not much on the COVID-19 cases in March as the country was on recovery mode. The country-wise

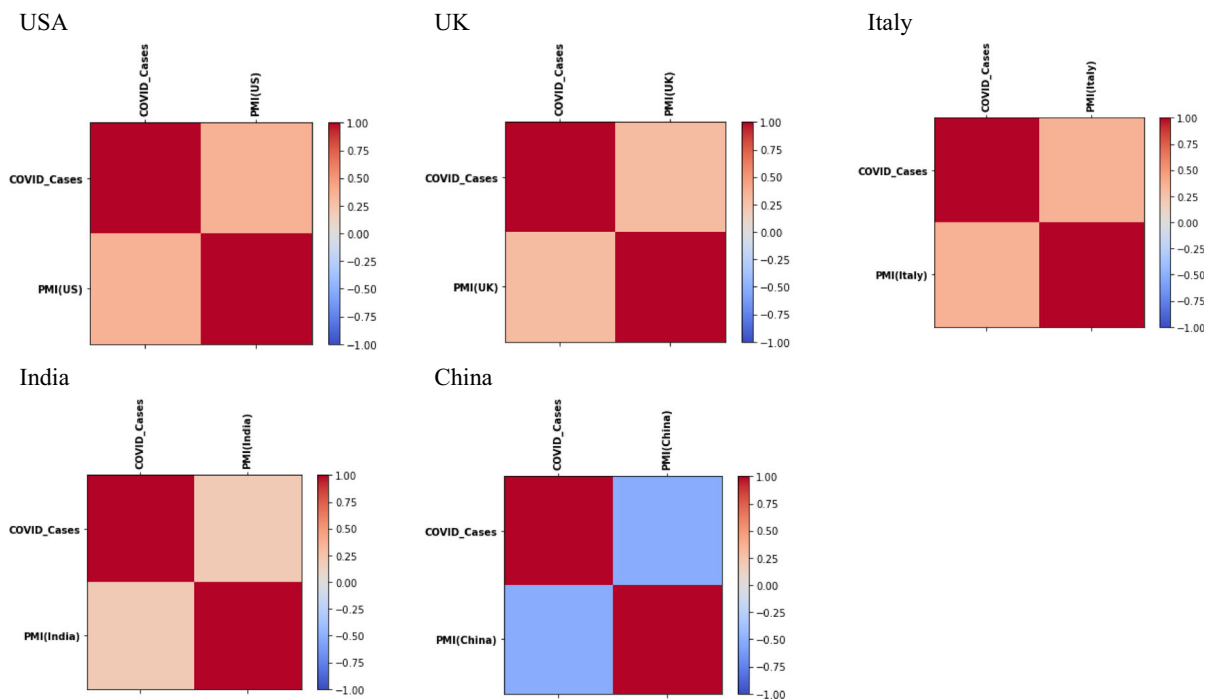


Fig. 8 Correlation Matrices of PMI with respect to COVID-19 cases

Table 5 Correlation Coefficient of COVID-19 cases with respect to. PMI

Country	Correlation Coefficient with respect to PMI
USA	0.366116
UK	0.303371
Italy	0.361367
India	0.197059
China	-0.522799

impact of stringency index with respect to COVID-19 cases is illustrated in Fig. 10.

Conclusion

The novel coronavirus outbreak is probably the most important black swan of 2020. Disruption to industrial

manufacturing and foreign trade flows and international logistics networks may be beyond estimations because of the drag caused by extended shutdowns in production. Overall, market sentiment is weak, and financial volatility is on the peak because the outbreak has adversely affected the prospects for financial recovery. It is far too early and moreover, by its very uncertain nature, it becomes tedious to determine the ultimate impact of COVID-19 on economic activity and commercial revenue. Here, the authors present an empirical model to understand the geospatial impact effect of COVID-19 across the world. For the same, the authors evaluate the correlation coefficient of COVID-19 with stock market index, PMI, commodity market, and stringency index. In order to demonstrate the impact of pandemic, authors have considered different countries viz. India, Italy, USA, UK, and China. An efficient analysis of the pandemic enables the countries to anticipate its impact which helps in devising efficient strategies by the governing bodies so

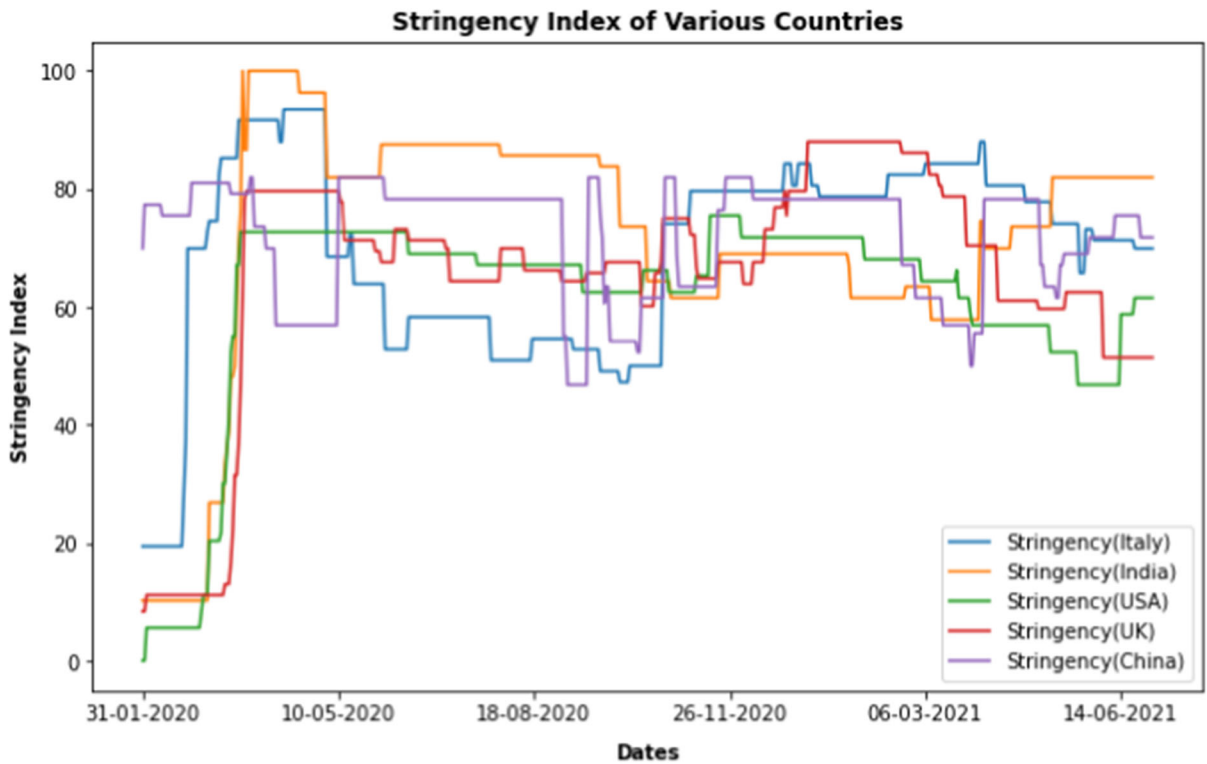


Fig. 9 Stringency Index Comparison of Countries

Table 6 Correlation Coefficient of COVID-19 cases with respect to Stringency Index

Country	Correlation Coefficient with respect to Stringency Index
India	0.155101
Italy	0.488958
USA	0.421814
UK	0.379298
China	0.072343

as to control COVID-19. The obtained correlation coefficient presents the intensity and severity of its impact on the global economy. The analysis establishes that the economic recovery and prospering of a nation necessitates effective policy implementation by the government. For now, COVID-19 has resulted in

declined demand, decreased costs, and disrupted supply chains around the world and thus all industries are still struggling. However, it should be reflected that our current situation is just that: a brief nightmare that one day will pass.

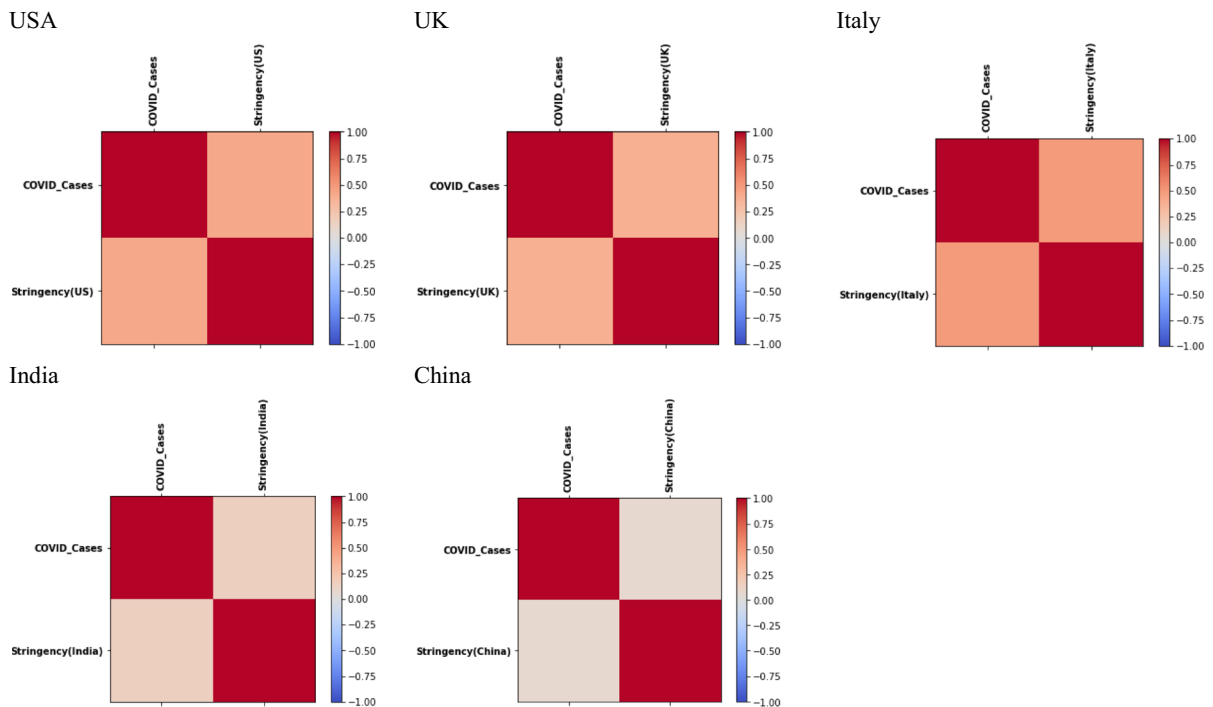


Fig. 10 Correlation Matrices of Stringency Index with respect to COVID-19 cases

Availability of data and material The stock market data of five countries, i.e., The USA, UK, Italy, China, and India are collected from Jan 2020 to Jan 2021 from the yahoo finance web portal. Data related to Coronavirus incidences and stringency index are taken from worldometer.com and Oxford Government Response Tracker website respectively.

Code availability Source code is available at GitHub.

Declarations

Conflicts of interest Authors declare that we do not have conflict of interest.

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