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Global Spread & Determinants of Initial Phase of COVID-19 Pandemic

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Global Spread & Determinants of Initial Phase of COVID-19 Pandemic

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COVID-19 virus being highly lethal has spread so swiftly across the globe that it has infected more than three million persons within a short time-span of 107 days covering 209 countries since January 13, 2020. In fact, infections among masses are growing rapidly and recovery rate is slow but improving. Inability to produce a reliable vaccine is posing threats to the survival of mankind. In such situation, this study, aiming at providing a global overview, examines pace and pattern of regional spread (across continents) of this virus. An effort is also made to locate the best and the worst nations as per their performance in combating spread of COVID-19 virus. Similarly, an examination of factors determining a country's exposure to COVID-19 infection and mortality is a prime concern of this paper.

Keywords: COVID-19, Pandemic, Global spread, Determinants, Infections, Mortality

1. Introduction

Since World War – II, the whole world has never been so afraid, uncertain and insecure as it is today when it is experiencing an invisible threat of a deadly infection from COVID-19 virus which is highly contagious[3] and lethal[4]. Existing scientific knowledge has no prior clue about this virus which is posing challenges in developing a safe vaccine to prevent its infection. Within a short time-span of 107 days, it has infected more than three million persons. Panic caused is so widespread that various nations, with few exceptions, are forced to observe either full or partial lockdown to protect their population from virus contamination. The economic activity has come to a grinding halt. Hardly any sector is left that is not experiencing the pangs of this global pandemic. In fact, the emanating losses to income, employment and human lives across sectors and geographies are so significant that it is compared worse situation than the 'great depression' of 1930s.

Recently, emerging literature, in form of blogs, commentaries, etc., has addressed onslaught of COVID-19 virus (Gill, 2020;Rediker and Rediker, 2020; Wignaraja, 2020;Subacchi, 2020; Dapice, 2020; Stockwin, 2020; Loayza and Pennings, 2020). It discusses not only its economic and sectoral impact but also various policy issues along with raising various global and local concerns. Despite this, a comprehensive analytical analysis of COVID-19 pandemic to yield a global perspective about pace and pattern of growth and incidence has been somewhat missing which left a dearth of serious analytical studies on the topic. In such situation, two prime questions continue to prevail: first, how diverse has been the exposure of different countries to COVID-19 pandemic and with what pace, different regions of the world have witnessed its onslaught (in terms of infection) and outcomes (in terms of fatality); second, what key variables condition a country's exposure to infection and fatality?

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[3] WHO, on 23.01.2020, estimated its transmissibility between 1.4 and 2.5; other studies estimated it between 3.6 and 4.0, and between 2.24 and 3.58. It has been higher than common flu (1.3) and SARS (2.0).

[4] At this stage, WHO considers it pre-mature to estimate 'Case Fatality Ratio' as it may change due to virus' mutation possibilities. However, as on 24.01.2020, out of 10.04 lakh closed cases, deaths account for 20 percent (1.97 lakh).

The study proceeds with a brief literature review (section 2) and a discussion on database and methodology (section 3). An overview of global spread follows (section 4). 'Worst' and 'Best' performing nations are located (section 5). Key determinants of COVID-19 infection and death outcomes are identified (section 6) and the final section documents main conclusions.

2. Brief Literature Review

Since the origin of coronavirus from Wuhan (China), a volume of literature has appeared.[5]This literature has been largely related to medical science and epidemiological research. Nonetheless, given the economic undertones of COVID-19 pandemic, there has also emerged a plethora of literature on various economic aspects. This literature may be classified into three main categories. First one deals with the adverse impact of this pandemic on global economies and different sectors. Examination of future growth prospects in post-COVID-19 regime is also a key concern of this set of literature. Second strand examines the nature and effectiveness of public policy at times of COVID-19 crisis and the third strand focuses on issues related to global cooperation.

In fact, mankind has always remained vulnerable to deadly infectious diseases caused by a variety of pathogens.[6]In contrast to earlier experiences, spread of COVID-19 virus across the globe has been so swift that it has infected population across many countries in a very short span of time which forced World Health Organisation (WHO) to declare it a global emergency (Sohrabi, 2020). National governments had to close their borders to arrivals from countries with infections; businesses, schools and other place of economic activity faced closures; masses had to undergo self-quarantine and much more. There prevails a gloomy economic situation to such an extent that IMF (2020)projected that there will be contraction in global economic activity by minus three percent in 2020 – a deceleration that would be worse than that experienced during the 2008-09 financial crisis. In such situation, the unemployment rates have risen across countries. With almost no work and income, the masses are experiencing economic insecurity.

Based on different scenarios, Sumner et al. (2020) has observed that the onslaught of COVID-19 pandemic may pose a real challenge to UN Sustainable Development Goal of ending poverty by 2030 as the global poverty could increase for the first time since 1990 and in some cases, the effort made may reverse all earlier made efforts. Under most extreme scenario, the world may see an increase in poor people by 420 to 580 million. It is also observed by Jackson et al. (2020) that there has been growing uncertainty in the corporate world as corporations are postponing investment decisions. The workers are laid off. The firms are also filing for bankruptcy. Similarly, Bartik et al. (2020) while examining the impact of COVID-19 on small businesses, observes that a significant proportion of the businesses are temporarily closed, and the employment count got reduced considerably than the pre-COVID-19 period. The study highlights the financially fragile state of small businesses.

[5] A simple random search for COVID-19 on Google Scholar has provided 1,24,000 hits (on June 03, 2020).
[6] Loss to human lives caused by Ebola, Nipah, Zika, SARS, MERS, H1N1, HIV, Marburg and other viruses is a vivid example of such vulnerability of mankind to these deadly pathogens.

Public policy at such times of crisis has emerged as a significant tool to combat the onslaught of COVID-19 pandemic. Kimura et al. (2020) identify and isolate the effects of pandemic shock from the economic shock. It finds that without a policy response, the social costs of pandemic remain significant and they may have immediate economic effect and if persistent, the pandemic shock may aggravate scale of economic shock in 'no relief' situations. Hale, et al. (2020) note that there has been a variation in government response to COVID-19 crisis. Some nation states could observe complete lockdown / stoppage of economic activity whereas some could not even afford a minimal. Obviously, such action depended on the state of the economy. However, at such times, it has been the policy of quarantine and testing that has played a key role in controlling spread of infections. In fact, the initial response of public policy to combat spread of infections has been limited.[7]China adopted the stringent measures to contain its spread whereas in other nations, lockdown strategy was adopted.

While quantifying the impact of stringent containment measures, Deb et al. (2020) finds that containment measures have had an impact equivalent to the loss of about 15 percent in industrial production over 30-days following the implementation of containment measures. It finds the effective role of discretionary fiscal and monetary policy measures on mitigating the costs. Despite being associated with large economic costs, it finds stay-at-home requirements and workplace closures as the most effective among other measures in curbing both infections and deaths. In case of Germany, Weber (2020) observes that measures like cancellation of mass events, school and childcare closures and curfews has been instrumental in flattening the COVID-19 infection curve. But, it finds limited evidence for additional effects of the closure of service sectors in public life.

In case of Singapore, Quah (2020) observes that it has been the blend and perfect coordination of economic policy, assured political leadership and expert evidence-based domain knowledge that has played a key role in providing effective response to COVID-19 crisis. While examining the case of South Korea, Cheong (2020) finds that it was government's strategy to opt for a large-scale test-and-tracing approach that played a key role in slowing the rate of infection. Given the strength of South Korea's biotech industries and efficient medical services system, it was possible to develop COVID-19 test kits very quickly. Production lines were set swiftly, and massive testing played a key role. In addition to it, Kim (2020) points out that it has been the civil society organisations that played a critical role in monitoring the situation closely and thus, helping the authorities to reach the most vulnerable groups. Similarly, in case of Taiwan, Shih-Chung (2020) points out that since the SARS outbreak, Taiwan has been in a state of constant readiness. Besides efficient administration, it has harnessed technology, expanded testing capacity, scope of its surveillance and inspections, rationing system of mask purchases and so on.

Given the extremely costly nature of such measures, Piguillem and Shi (2020) tried to find out the optimal policy. It finds testing as an important strategy that may generate sizeable welfare gains along with eliminating the need for indiscriminate quarantines. Singh (2020b) also upholds the need for frequent testing for the Indian economy. Singh

[7] Initial discovery of virus by Wuhan doctor was suppressed by Chinese authorities as it may create paranoia. In USA, President Trump, in his public speeches, continued to term it as seasonal flu. Other nation governments also could not predict and project the potential loss to human lives and livelihoods.

(2020a) opines that the global governance institutions and national governments should modify public policy to provide for immediate needs of health care both in normal and pandemic times without burdening financially the victims. It urges for engaging talented scientists in public research institutions. Similarly, it raises concerns over prevailing inequality, rising unemployment rates and falling share of wages in national income.

Similarly, researchers have also examined the role of global cooperation in such times of crisis. Beck and Wagner (2020) emphasizes the fact that the nature of COVID-19 pandemic is global both per se and in terms of spillovers from containment policies. So, any pursuit of national containment policies poses the risk of international inefficiencies and the direction of inefficiency depends not only on the stage of the epidemic but also on mobility and economic integration of that nation with the world. Jones et al. (2020) finds limited response of European Union (EU) in terms of financial scope, technical detail on health and political ambition. It points out that Europe collectively has various assets beyond aid that it should use to respond to global crisis. These resources range from EU purchasing power to world class health expertise, research and pharmaceutical development along with manufacturing industry. Adopting a rapid multidimensional action, EU should provide a truly integrated approach to global crisis.

In brief, it may be said that the emerging literature on COVID-19 pandemic is very diverse and insightful. Nonetheless, what has been missing so far is a thorough analysis of the initial phase of onslaught of COVID-19 pandemic. Within this, an analysis of potential determinants of infections and deaths holds significance. Such research gap is bridged by this study.

3. Data Base & Methodology

To keep track of real-time changes in world's experience of COVID-19 pandemic, various agencies are currently engaged in collecting nation-wise statistics on COVID-19 infections which is, in fact, a cumulative total of till-date cases reported by countries.[8] This sum of infection cases includes both 'Active Cases' and 'Closed Cases'. 'Active Cases' indicate those who are currently suffering from COVID-19 infection. These cases are further bifurcated into mild and critical cases. Similarly, 'Closed Cases' encompass those who have either recovered or deceased due to COVID-19 infection. Besides this, information is also available on number of tests conducted by each nation.

Based on this database, the study examines nation-wise pattern of COVID-19 infections, testing and deaths. It needs to be noted that the study has examined COVID-19 data till April 27, 2020 when a global count of 3 million cases across 209 countries is reached. Besides reporting infections and deaths in absolute numbers, their estimates per million population across nations are also presented primarily to consider variation in population size across nations. To examine growth trend, 'Compound Daily Growth Rate' (CDGR) is estimated where initial period is represented by the day when first case of COVID-19 infection was reported in that particular country. In case of Deaths, the 'Fatality Rate' is estimated as the share of deaths in total closed cases. In case of testing, nation-wise variation in number of tests per million population is reported. In addition, an estimate of tests conducted per single COVID-19 infection is also made.

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[8] Such data may be collected from https://www.worldometers.info/coronavirus/

While examining the COVID-19 performance across nations, the study considers it unfair to term any nation as the 'Worst' and the 'Best' performer even based on some anecdotal evidence. For this, it devises objective criteria by considering the aspects of infection and mortality. These criteria are reported in Table 1.

Table 1: Criteria for Defining Best and Worst Countries

Aspect	Indicator	Indicator	National Rank	
			Worst	Best
Infection	I	COVID-19 infections per million population	High	Low
	II	Tests (No.) to detect a single COVID-19 infection	Low	High
Mortality	III	Share of deaths in total closed cases	High	Low
	IV	Deaths per million population	High	Low

Source: Constructed by authors.

Given the fact that countries with a relatively high per capita income are more exposed to COVID-19 infections due to their relatively more integration with the global economy and hence, the risk of getting infection is higher. At the same time, a nation's ability to provide better health care infrastructure and thus, curtailment of mortality outcomes is also related to its level of economic development. So, a better approach will be to classify countries as per their economic development level.

For classifying countries in different groups, the study relies on the World Bank classification[9] by which the nations across the world are classified into four groups, viz. low-income economies (US $1025 or less), lower-middle-income economies (US $1,026 to US $3,995), upper-middle-income economies (US $3,996 to US $12,375) and high-income economies (US $12,376 or more).

To examine determinants of COVID-19 infections and deaths, four regression models are fitted. While doing so, existence of any unusual and influential data is detected through tools like residual-versus-fitted plots (Figure A1a), leverage-versus-squared-residual plot (Figure A1b) and added-variable plot (Figure A2a, A2b, A2c & A2d). Normality of residuals is checked through kernel density plot (Figure A3), standardized normal probability plot (Figure A4), quantiles of variables against the quantiles of a normal distribution (Figure A5). In addition, we have also conducted Shapiro-Wilk W test for normality. Presence of heteroskedasticity is examined through residual-versus-fitted plot, White's General test and Breusch-Pagan / Cook-Weisberg test. Multicollinearity is checked through variance inflation factor for the independent variables in the linear model. Finally, 'Link test' and 'Ramsey Regression Specification Error Test (RESET)' are performed to check for any omitted variables.[10]

The relationship between infections other variables[11] is depicted in the following equations:

[9] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups, accessed May 09, 2020

[10] These test results are reported in Table A1.

[11] Table A2-A4 presents the summary statistics of Model 1 to Model 4.

$$lnCinf_i = \alpha_0 + \alpha_1 lnPoDem + \alpha_2 lnGSM + \alpha_3 lnIVSiP + \alpha_4 lnETest + \alpha_5 lnEpc + \alpha_6 lnNaEs + \alpha_7 lnWPR + \alpha_8 lnMedAg + \alpha_9 lnSMU + \alpha_{10} lnUPS + \alpha_{11} lnPopDen + \alpha_{12} lnPiEPoV$$

Model-I

where i indicates nation

In Model-I, while examining a nation's exposure to COVID-19 infections ($lnCinf_i$), a set of twelve explanatory variables are considered. These variables are 1) prevalence of democracy[12]($lnPoDem$), 2) government stringency measures[13] ($lnGSM$), 3) international visitors' share in population[14] ($lnIVSiP$), 4) extensive testing[15] ($lnETest$), 5) CO_2 emissions per capita[16] ($lnEpc$), 6) non-agricultural employment share ($lnNaEs$), 7) work-participation rate[17] ($lnWPR$), 8) median age ($lnMedAg$), 9) mobile Users share in population[18] ($lnSMU$), 10) urban population share[19]($lnUPS$), 11) population density[20] ($lnPopDen$) and 12) population in extreme poverty ($lnPiEPoV$).

$$lnCinf_i = \beta_0 + \beta_1 lnGDPpc + \beta_2 lnIVSiP + \beta_3 lnETest + \beta_4 lnNaEs + \beta_5 lnWPR + \beta_6 lnEldPop + \beta_7 lnSMU + \beta_8 lnUPS + \beta_9 lnPopDen$$

Model-II

where i indicates nation

Model-II is alike Model-I except that it excludes four variables, viz. prevalence of democracy, government stringency measures, CO_2 emissions per capita and population in extreme poverty; it substitutes elderly (70+) population share ($lnEldPop$) in place of

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[12] In contrast to authoritarian regime, masses in democratic regimes enjoy more civil liberty and freedom. In such regimes, any strict enforcement even at times of emergency gets protested and delayed as the masses question government to provide rationale for such action. In such situation, it may be hypothesised that democracy may, in fact, aggravate COVID-19 infections unless the masses self-regulate and isolate to take preventive measures. Data on prevalence of democracy refers to year 2018 and is collected from EIU (2019).

[13] These are various lockdown measures taken by nation governments. Its day-to-day account is available at https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker

[14]Originating in Wuhan (China), global spread of COVID-19 infection happened mainly through international travellers who, while travelling, contacted infection. So, a nation with relatively high number of international travellers may be more exposed to COVID-19 infection and vice-versa.

[15]With proper testing, infected persons can be isolated early with minimal regional spread. An early start in this direction is beneficial as every single delay has implications for its rapid spread. So, large number of tests at high testing rate may affect adversely a nation's exposure to COVID-19 infection.

[16] CO_2 emissions per capita along with population in extreme poverty is taken as proxy for GDP per capita as the latter was posing the problem of multicollinearity in the model.

[17] It refers to 15+ population.

[18]Today is the age of information. A lot of information exists on various aspects which may be accessed through internet and better mobile connectivity. Given this, it is expected that in nations with a relatively high usage of mobile phones / internet, there will be a relatively less incidence of COVID-19 infections and vice-versa.

[19]Urban population being more concentrated remains prone to frequent contact in contrast to the rural population that is situated relatively more dispersedly. So, nations with relatively high urban population share may be experiencing high exposure to COVID-19 infections and vice-versa.

[20]COVID-19 infections spread through contact and contamination. Masses living in highly crowded areas are at a higher risk of COVID-19 infection. So, population density (population per square kilometre) may be considered as an indicator which may be positively related to it.

median age and it includes gross domestic product per capita ($lnGDPpc$)for CO_2 emissions per capita and population in extreme poverty.

Model-III

$$lnCdeaths_i = \gamma_0 + \gamma_1 lnSSiP + \gamma_2 lnPSIU + \gamma_3 lnPoDem + \gamma_4 lnPiEPov + \gamma_5 lnEldPop + \gamma_6 lnUHC + \gamma_7 lnOoPEpc + \gamma_8 lnGHEpc + \gamma_9 lnMCinf$$

where i indicates nation

In Model-III, while examining a nation's experience of COVID-19 deaths ($lnCdeaths_i$), a set of nine explanatory variables is considered. These variables are 1) smokers' share in population[21] ($lnSSiP$), 2) population share of internet users ($lnPSIU$), 3) prevalence of democracy[22] ($lnPoDem$), 4) population in extreme poverty ($lnPiEPov$), 5) elderly (70+) population share ($lnEldPop$), 6) universal health coverage ($lnUHC$), 7) out of pocket health expenditure per capita ($lnOoPEpc$), 8) government health expenditure per capita ($lnGHEpc$) and 9) magnitude of COVID-19 infections[23] ($lnMCinf$).

Model-IV

$$lnCdeaths_i = \phi_0 + \phi_1 lnPSIU + \phi_2 lnPoDem + \phi_3 lnPiEPov + \phi_4 lnEldPop + \phi_5 lnUHC + \phi_6 lnOoPEpc + \phi_7 lnGHEpc + \phi_8 lnMCinf + \phi_9 lnETest + \phi_{10} lnHbeds + \phi_{11} lnGDPpc + \phi_{12} lnDALY$$

where i indicates nation

Model-IV retains all variables considered in Model-III except smokers' share in population. Its ambit is also expanded to include four new variables, viz. 1) extensive testing[24] ($lnETest$), 2) hospital beds per 1000 population[25] ($lnHbeds$), 3) GDP per capita[26]($lnGDPpc$) and 4) disability adjusted life years[27] ($lnDALY$).

Along with COVID-19 information taken from www.worldometers.info/coronavirus/, nation-wise information for most of the variables is collected from World Bank's World Development Indicators except a few such as prevalence of democracy and DALYs.

4. An Overview of Global Spread

A look at the regional pattern indicates that the affluent regions of Europe and North America accounted for a major share of world's COVID-19 infections whereas the poorer regions of Africa accounted for only a marginal share in world infections (Figure 1).

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21 Smoking affects adversely the lungs. As COVID-19 virus too affects the lungs, there lies a high probability of smokers to experience death from COVID-19.

22 Prevalence of democracy may affect negatively the experience of deaths as there lies high possibility for a relatively equitable access to health care facilities in democratic societies.

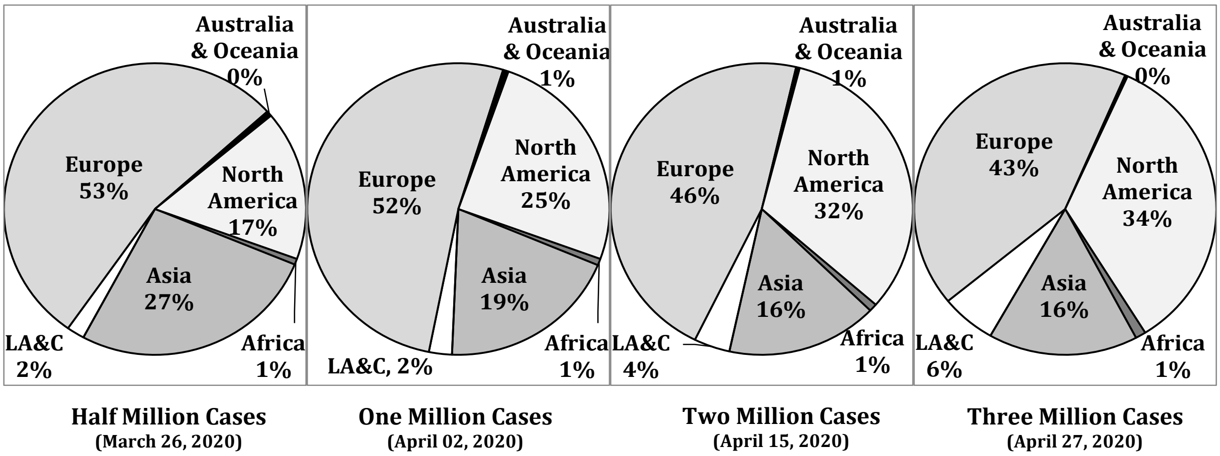
23 A high magnitude of COVID-19 infections may cause panic in society besides putting a pressure on available health resources which may affect positively the death outcomes.

24 With extensive testing, an early diagnosis of COVID-19 infection may be made which may affect adversely the death outcomes.

25 It is a crude indicator of the availability of health infrastructure. To develop safeguards against COVID-19 infections, it is not merely the beds but the intensive care (ICU) beds. As we could gather only the information on hospital beds per 1000 population from World Bank's WDI database, this remains a key weakness in this model.

26 Nation-level data on various indicators is collected from World Bank's World Development Indicators.

27 On experiencing COVID-19 infection, patient's vulnerability to death may increase manifold if there are conditions of co-morbidity.



LA & C = Latin America & Caribbean

Source: Based on https://www.worldometers.info/coronavirus/

4.1 Europe

Europe accounted for a major share in global COVID-19 infections. More than 90 percent of its total infections are found in twelve countries, but it has been more concentrated in Spain, Italy, France, Germany and United Kingdom (Table 2). In fact, the compound daily growth rate (CDGR) of COVID-19 infections across these nations varied from 11.99 percent (in Sweden) to 19.23 percent (in Netherlands). An estimate of COVID-19 infections per million population though reveals a similarly high level across all countries, the magnitude has been relatively lower in Russia (641 cases) in contrast to Spain, Belgium and other nations.

Table 2: Exposure to COVID-19 Pandemic in Europe

Country	COVID-19 Infections (CI)*				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%) #	/M	T/CI
Spain	209.46	16.35	4965	15.31	23521	18.48	510	16.13	28779	5.80
Italy	199.41	15.57	3298	14.14	26977	21.19	446	28.82	29600	8.97
France	164.58	12.85	2541	12.80	23262	18.27	357	33.85	7103	2.80
Germany	158.75	12.39	1898	14.06	6126	4.81	74	4.99	24738	13.1
U.K.	157.14	12.27	2315	13.83	24393	19.16	311	NA	10605	4.58
Russia	87.14	6.80	641	13.06	794	0.62	6	9.30	21511	33.5
Belgium	46.68	3.65	4084	13.83	7207	5.66	633	40.12	19000	4.65
Netherlands	38.24	2.99	2242	19.23	4518	3.55	266	NA	12240	5.46
Switzerland	29.16	2.28	3381	18.04	1665	1.31	194	7.02	29637	8.77
Portugal	24.02	1.88	2385	18.26	928	0.73	93	40.56	35321	14.8
Ireland	19.64	1.53	3979	18.58	1102	0.87	223	10.66	25785	6.48
Sweden	18.92	1.48	1943	11.99	2274	1.79	233	70.09	11833	6.09
Europe	1280.8	100.0	1758	15.28	127289	100.0	167	21.53	17708	10.07

Note 1: *figures are in '000s, as on April 27, 2020.
Note 2: /M implies per million population;
Note 3: # implies that fatality rate is the share of deaths in total closed cases (deaths + recovered).
Note 4: T/CI denotes the number of tests conducted to detect each COVID-19 infection.
Note 5: CDGR = Compound Daily Growth Rate (%)
Source: Same as Figure 1.

Similarly varied has been the COVID-19 mortality pattern across European nations as the death burden has remained more concentrated in countries like Italy, Spain, United Kingdom and France. Germany despite having similarly high levels of infections could control the mortality incidence to just 4.81 percent which indicates its relatively sound health system and the governance ability to respond effectively at times of crisis (Spahn, 2020). In contrast, the fatality rate has been very high in Sweden, Portugal and Belgium.

In fact, the countries in Europe could do a relatively high number of tests per million population. This number has been very high across all countries except France which could do only one-fourth of the tests conducted by equally infected countries of Spain and Italy. It is also observed that in France, the COVID-19 infections have been more concentrated as to detect an infection, it has done, on an average, 2.80 tests in contrast to Russia, Portugal and Germany which have done more tests to detect an infection. In such situation, if France could have done more tests per million population, then its incidence of COVID-19 infections could have been higher.

4.2 North America

North America witnessed a sharp increase in COVID-19 infections. Its global share became double from 17 percent to 34 percent in a month's time (Figure 1). In fact, 95.42 percent of region's total infections took place only in USA where the CDGR is found to be 15.64 percent (Table 3) which indicates that the number of infections doubled in every 6 to 7 days.

Table 3: Exposure to COVID-19 Pandemic in North America

Country	COVID-19 Infections (CI)				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%) #	/M	T/CI
USA	1012147	95.42	3058	15.64	56933	95.45	172	29.1	17231	5.64
Canada	48500	4.57	1285	12.47	2707	4.54	72	12.9	19440	15.13
Bermuda	110	0.01	1766	10.82	6	0.01	96	12.1	27008	15.29
Greenland	11	0.00	194	5.88	-	-	-	-	21138	109.1
St. P & M	1	0.00	173	-	-	-	-	-	-	-
North America	1060769	100	2875	15.70	59646		161	27.4	17460	6.07

St. P & M = Saint Pierre & Miquelon

Note and Source: Same as table 2.

Canada accounting for 4.57 percent of region's total COVID-19 infections also recorded a relatively lower incidence of infections per million population. Such outcome is achieved even when it conducted a relatively large number of tests per million population than the USA. In fact, it seems that the COVID-19 infections are relatively more concentrated in USA than Canada as a single infection could be diagnosed in USA for every 5.64 tests whereas the same figure for Canada stands at 15.13. Similarly, 95.45 percent of the total deaths have taken place in USA. The fatality rate in USA is found to be 29.1 percent whereas the same for Canada stands at 12.9 percent.

4.3 Asia

Asia accounts for about one-sixth of the global COVID-19 cases. Here, the CDGR of infections has been 8.73 percent which indicates, on an average, the doubling of cases in every 8 to 9 days. A set of 18 countries considered here account for 95.19 percent of the region's total COVID-19 infection cases. It may be inferred from Table 4 that about 60 percent of the region's COVID-19 cases are concentrated in countries like Turkey, Iran and China. Among other countries, India remains at the top, given its large population size in the region.

Table 4: Exposure to COVID-19 Pandemic in Asia

Country	COVID-19 Infections (CI)*				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%) #	/M	T/CI
Turkey	112.26	23.20	1331	28.07	2900	16.49	34	7.90	10895	8.19
Iran	91.47	18.91	1102	17.09	5806	33.01	70	7.50	5269	4.78
China	82.84	17.12	58	7.10	4632	26.33	3	5.64	NA	NA
India	29.45	6.09	21	12.40	939	5.34	0.7	11.63	519	24.3
S. Arabia	18.81	3.89	577	19.21	144	0.82	4	5.18	5745	9.96
Israel	15.56	3.22	1801	15.75	204	1.16	24	2.74	34971	19.4
Singapore	14.42	2.98	2556	10.61	14	0.08	2	1.26	20815	8.14
Japan	14.15	2.93	108	9.72	385	2.19	3	16.86	1191	11.1
Pakistan	13.92	2.88	64	15.61	292	1.66	1	8.52	712	11.2
Qatar	11.24	2.32	4138	17.45	10	0.06	3	0.87	30755	7.43
UAE	10.84	2.24	1151	9.29	82	0.47	9	3.92	106904	92.9
S. Korea	10.75	2.22	210	10.26	244	1.39	5	2.68	11869	56.6
Indonesia	9.10	1.88	35	16.23	765	4.35	3	38.14	291	8.37
Philippines	7.78	1.61	73	10.72	511	2.91	5	35.22	820	11.3
Bangladesh	5.91	1.22	39	16.38	152	0.82	0.9	52.72	332	8.47
Malaysia	5.82	1.20	181	8.48	99	0.56	3	2.42	4536	25.1
Kuwait	3.29	0.68	806	13.72	22	0.13	5	1.92	41915	52.1
Thailand	2.93	0.61	42	7.90	52	0.30	0.8	2.00	2551	60.6
Asia	483.78	100.0	106	8.73	17589	100.0	3.85	6.88	1540	14.4

Note and Source: Same as table 2.

Qatar has recorded the highest number of COVID-19 infections per million population. One may also relate this outcome to Qatar's conducting of many tests to diagnose infection in its population. In fact, a high incidence of testing is found among oil-exporting countries of UAE, Kuwait, Saudi Arabia etc. Being rich, these countries could either develop their own testing facilities or could import testing kits – an aspect on which countries like India suffered a lot. Pakistan could do better than India in testing.

A high variation exists among Asian countries in terms of COVID-19 fatality rate. Bangladesh recorded the highest fatality rate. Among the west Asian countries, the fatality rate has remained the highest for Turkey, Iran and Saudi Arabia in contrast to that observed in Qatar, Kuwait, Israel and UAE. Similarly, it has remained very low in south-east Asian countries of Singapore, Thailand and Malaysia except Indonesia and Philippines which recorded the second-highest levels following Bangladesh. Such disparity within the south-east Asian region indicates varied levels of health sector development (Hashim, et al., 2012; Phua, 2021). In contrast, the fatality rate in Japan is found to be relatively high than that found in India and Pakistan. In fact, doctors in India were the first to suggest some remedy for COVID-19 treatment. Despite having constraints posed by an under-developed health sector, the medical practitioners in India could maintain a relatively low level of fatality rate. But, it has remained higher than that observed in the case of Pakistan.

4.4 Latin America and the Caribbean

Though Latin America and the Caribbean have remained relatively less exposed to COVID-19 infections, region's CDGR of infections has been as high as 18.04 percent which indicate the doubling of cases in every 5 to 6 days. Here, considered nations account for 95.78 percent of the region's infections. In fact, more than one-third of region's infection cases are found mainly in Brazil (Table 5). But, in terms of infections per million population, Panama, Ecuador and Peru are the most affected nations. Regarding testing, there prevails large variation. Chile has done the highest number of tests per million population – it is 5.28 times more than Brazil. Similar is the case with Panama and Ecuador. Mexico, on the other hand, accounting for 8.72 percent of the region's infections did the lowest number of tests.

Table 5: Exposure to COVID-19 Pandemic in Latin America and the Caribbean

Country	COVID-19 Infections (CI)*				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%)#	/M	T/CI
Brazil	67.45	37.86	317	20.00	4603	51.62	22	12.88	1597	5.03
Peru	28.70	16.11	870	21.82	782	8.77	24	8.49	7266	8.35
Ecuador	23.24	13.04	1317	15.60	663	7.44	38	29.86	3487	2.65
Mexico	15.53	8.72	120	17.77	1434	16.08	11	13.63	551	4.58
Chile	13.81	7.75	723	18.93	198	2.22	10	2.63	8434	11.7
Dom. Rep.	6.29	3.53	580	16.59	282	3.16	26	22.12	2074	3.58
Panama	6.02	3.38	1395	19.88	167	1.87	39	26.85	6451	4.62
Colombia	5.60	3.14	110	18.05	253	2.84	5	17.29	1786	16.2
Argentina	4.00	2.25	89	16.28	197	2.21	4	14.73	1148	12.9
L. America	178.15	100.0	274	18.04	8917	100.0	13.73	12.27	2524	9.20

Note 1: *figures are in '00s, as on April 27, 2020.
Other Notes and Source: Same as table 2.

Though region's fatality rate is 12.27 percent, most of the selected countries have recorded a very high fatality rate. Striking examples are of Ecuador, Panama and Dominican Republic where fatality rate has ranged between 22.19 percent to 29.86 percent. Colombia and Argentina remained the other worst affected in this respect. However, the fatality rate has been the lowest in Chile – it has been 11.35 times lower than that witnessed in Ecuador which indicates nothing but the sound availability of health care facility in the country (Bossert and Leisewitz, 2016).

4.5 Africa

Unlike earlier virus outbreaks which remained largely concentrated in Africa, COVID-19's exposure has been much varied across the continent. Overall, the continent accounted for around one percent of the global COVID-19 infections, the cases are more concentrated in countries like South Africa, Egypt, Morocco and Algeria (Table 6). But, Djibouti has been the only African country where more than thousand COVID-19 infections are found per million population which has been the highest. Djibouti has also conducted the highest tests per million population and this figure has been much higher than South Africa which has the highest number of cases. In fact, African nations, barring a few, could not do more testing which indicates primarily their resource constraints.

Table 6: Exposure to COVID-19 Pandemic in Africa

Country	COVID-19 Infections (CI)*				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%) #	/M	T/CI
S. Africa	47.93	14.10	81	17.34	90	6.14	2	5.76	3009	37.2
Egypt	47.82	14.07	47	12.31	337	22.99	3	21.42	879	18.8
Morocco	41.20	12.12	115	16.03	162	11.05	4	18.07	823	7.15
Algeria	35.17	10.35	80	14.08	432	29.47	10	21.71	148	1.85
Cameroon	17.05	5.02	64	15.38	58	3.96	2	6.72	NA	NA
Ghana	15.50	4.56	50	15.26	11	0.75	0.4	6.63	3238	64.9
Nigeria	13.37	3.93	6	13.21	40	2.73	0.2	13.56	53	8.17
Ivory Coast	11.64	3.42	44	16.21	14	0.95	0.5	2.73	NA	NA
Guinea	11.63	3.42	89	16.98	7	0.48	0.5	2.77	NA	NA
Djibouti	10.35	3.04	1048	18.95	2	0.14	2	0.42	12399	11.8
Tunisia	9.67	2.84	82	13.58	39	2.66	3	12.26	1784	21.8
Senegal	7.36	2.17	49	12.51	9	0.61	0.5	2.95	28	0.57
Niger	7.01	2.06	29	18.82	29	1.98	1	7.00	207	7.15
Burkina Faso	6.35	1.87	30	14.39	42	2.86	2	8.22	NA	NA
Somalia	4.80	1.41	30	15.83	26	1.77	2	65.00	NA	NA
Congo	4.59	1.35	38	13.11	6	0.41	1	29.63	NA	NA
Africa	339.9	100.0	25.05	15.36	1466	100.0	1.07	12.05	423	16.9

Note and Source: Same as table 5.

A large variation exists among African nations regarding COVID-19 fatality rate. It has been as high as 65 percent in Somalia. Other worst affected are Congo, Egypt and Algeria. In Djibouti which has the highest infections per million population, the fatality rate is just 0.42 percent[28] – a level which is even better than Qatar and Singapore. In three other countries of Senegal, Guinea and Ivory Coast, the fatality rate has remained below 3 percent which is quite remarkable.

4.6 Australia & Oceania

Though this region is represented mainly by Australia and New Zealand along with twenty-one small island states situated across Melanesia, Micronesia and Polynesia, the spread of COVID-19 infections, along with Australia and New Zealand, is observed in only four island states. These are Fiji, New Caledonia, Papua New Guinea and French Polynesia. In fact, given its large size, Australia accounts for 81.04 percent of region's total infections. Nonetheless, the infection incidence as measured in terms of per million population places New Zealand as the most vulnerable nation followed by Australia and French Polynesia. CDGR of COVID-19 infections have also been the highest in New Zealand which has also been the outcome of a relatively high number of tests conducted per million population by it. It may also be observed that fatality rate in both Australia and New Zealand has been very low vis-à-vis other nations across the globe (Table 7).

[28] Marks (2020) notes that such low death rate is due to the use of antibiotic Azithromycin (for treatment of bacterial infections) and Chloroquine (anti-malarial drug to reduce fever and inflammation).

Table 7: Exposure to COVID-19 Pandemic in Australia & Oceania

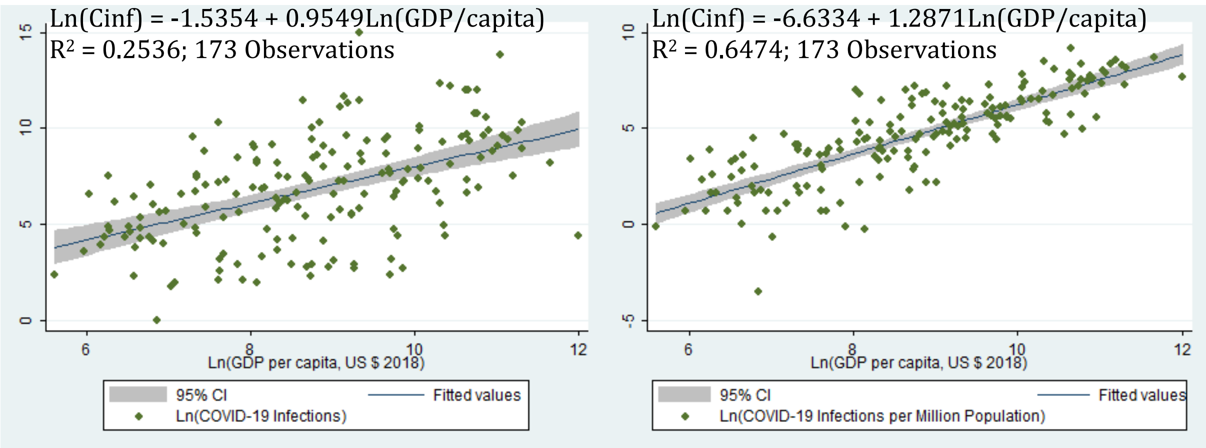
Country	COVID-19 Infections (CI)				COVID-19 Deaths (CD)				Tests	
	Cases	%	/M	CDGR (%)	Cases	%	/M	FR (%) #	/M	T/CI
Australia	6731	81.05	264	8.41	84	81.5	3	1.47	20811	78.84
New Zealand	1472	17.72	305	13.16	19	18.5	4	1.54	26143	85.64
French Polynesia	58	0.70	206	6.76	-	-	-	-	8241	39.91
Fiji	18	0.22	20	7.69	-	-	-	-	1123	55.94
New Caledonia	18	0.22	63	5.80	-	-	-	-	15608	247.5
Papua New Guinea	8	0.10	0.9	5.62	-	-	-	-	68	75.50
Australia & Oceania	8305	100	204	8.66	103	100	2.5	1.47	16350	80.09

Note and Source: Same as table 5.

Thus, there has been a high incidence of COVID-19 infections in the developed countries of North America and Europe whereas the least developed countries of Africa, at large, remained the least affected. Such trend across nations hints at existence of a relation of COVID-19 infections with relative affluence of a nation.[29] Such relation is exemplified through a scatter plot of COVID-19 infections vis-à-vis per capita gross domestic product (figure 2). Here, scatter plots of GDP per capita with both COVID-19 infections in absolute terms and as ratio of per million population are presented.

Figure 2: Scatterplots Indicating Relation of COVID-19 Infections with GDP per capita

Figure 1: Regional Distribution (%) of COVID-19 Cases across the World



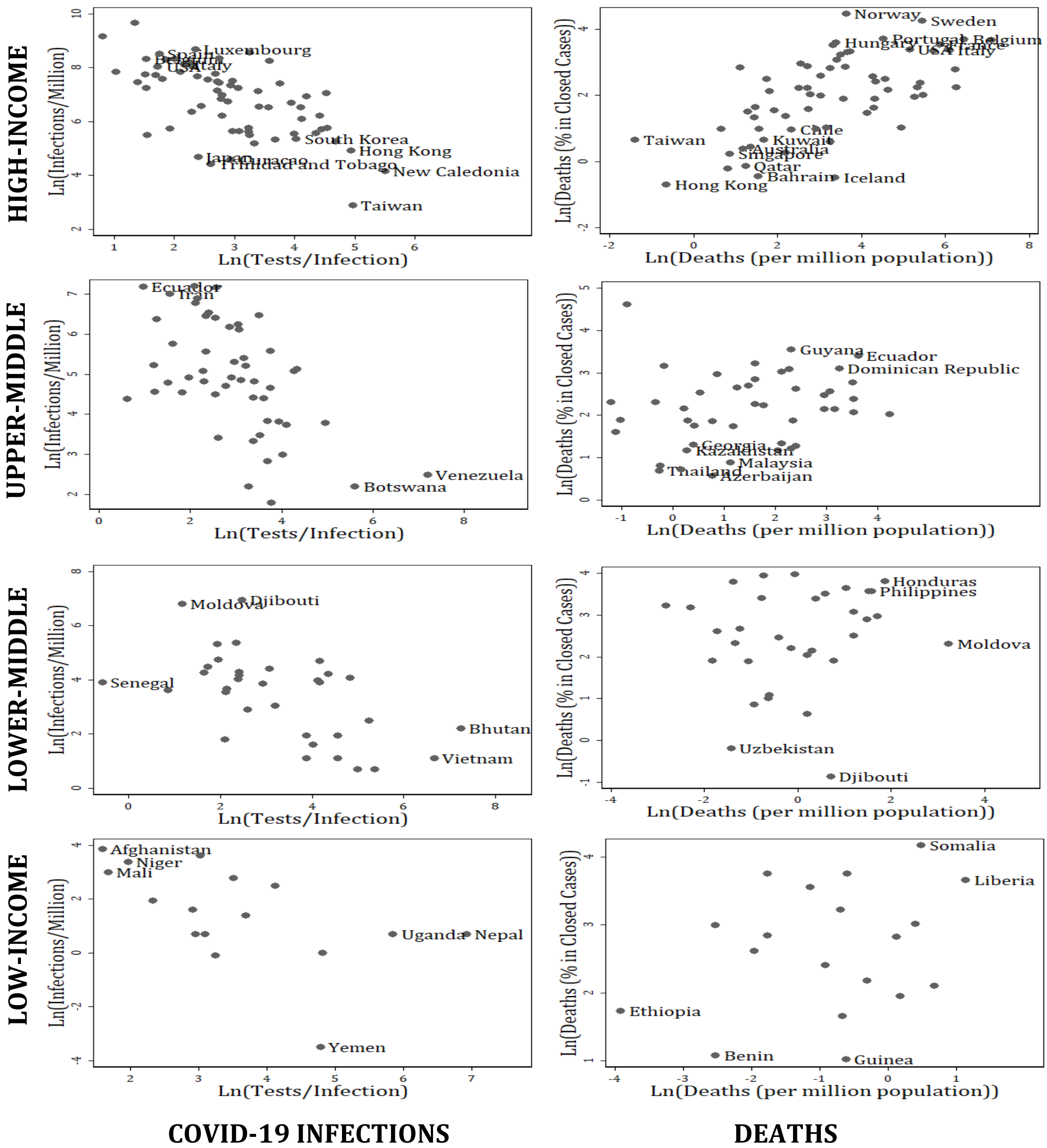
Source: Estimates based on data collected from worldometer, WDI

[29] Developed countries being relatively more open in terms of trade, travel, tourism etc. remain highly susceptible to COVID-19 infections that spread through contact and contamination.

5. Worst and Best Performers in Tackling COVID-19 Pandemic

Given such spread of COVID-19 infections across the globe, it is meaningful to identify nations who performed best and the worst in not only containing COVID-19 infection but also in curtailing mortality. It is observed that among the low-income countries, Nepal and Uganda has been the best performers in containing spread of infections whereas Afghanistan, Niger and Mali have emerged as worst. Similarly, in case of deaths, Ethiopia and Benin has been the best whereas Somalia and Liberia have been the worst (figure 3).

Figure 3: 'Best' and 'Worst' Performing Nations across Different Income Levels



Source: Same as Figure 1

Among lower-income countries, Bhutan and Vietnam has been the best in containing infections whereas Senegal, Moldova and Djibouti remained worst. Similarly, for deaths, Uzbekistan and Djibouti emerged as best performers and Moldova, Honduras and Philippines remained worst performers. Among middle-income countries, Venezuela and Botswana have been the best in containing infections whereas Ecuador and Iran remained worst. Thailand, Azerbaijan, Malaysia, Kazakhstan and Georgia emerged as the best in containing deaths whereas Guyana, Ecuador and Dominican Republic remained the worst. Among High-income countries, Taiwan, New Caledonia, Hong Kong and South Korea appeared best in containing infections whereas Luxembourg, Spain, USA, Italy remained worst. For containing deaths, Hongkong, Taiwan, Bahrain, Qatar remained the best and Belgium, Italy, Portugal, USA, Sweden etc. have been the worst.

6. Determinants of COVID-19 Infections and Fatalities

a. COVID-19 Infections

Model 1 results depicted in table 8 indicate that the relation between COVID-19 infections and the prevalence of democracy across nations is positive and significant. Similarly, a positive and significant relation is observed between a nation's level of CO_2 emissions which being a proxy for nation's affluence indicate that the affluent nations are significantly exposed to COVID-19 infections. In the same vein, a negative and significant relation is observed between the incidence of chronic poverty and the infections. Median age has also emerged significant which indicate that the nations with a relatively high median age at a high risk of infection.

Table 8: Regression Coefficients Explaining COVID-19 Infections

Indicator	Variable	Coefficient (S.E.)	
		Model 1	Model 2
GDPpc	GDP Per Capita	-	0.837 (0.142)*
PoDem	Prevalence of Democracy	1.173 (0.464)*	-
GSM	Govt. Stringency Measures	0.282 (0.685)	-
IVSiP	International Visitors Share in Population	0.081 (0.07)	0.060 (0.060)
ETest	Extensive Testing	-0.670 (0.102)*	-0.536 (0.080)*
Epc	CO_2 Emissions per capita	0.515 (0.220)**	-
NaEs	Non-Agricultural Employment Share,%	-0.498 (0.812)	0.832 (0.579)
WPR	Work-Participation Rate (15+ Age)	-0.330 (0.522)	-0.003 (0.443)
MedAg	Median Age	1.380 (0.780)**	-
EldPop	Elderly Population Share (70+), %	-	0.272 (0.146)***
SMU	Share of Mobile Users, %	-0.450 (0.5336)	-0.090 (0.398)
UPS	Urban Population Share, %	0.227 (0.4975)	0.236 (0.343)
PopDen	Population Density	0.088 (0.1035)	0.130 (0.061)**
PiEPov	Population in Extreme Poverty, %	-0.248 (0.117)**	-
Constant		2.806(4.630)	-6.232 (2.438)**
Number of Observations		80	126
F Value		28.03F(12, 67)	53.51 F(9,116)
Prob > F		0.0000	0.0000
R^2		0.8339	0.8059
Adjusted R^2		0.8041	0.7908
Root MSE		0.9915	0.9963

Note: *p < 0.1; **p < 0.05; ***p < 0.0

A positive relation is also observed between government stringency measures and the infections, but it is not significant. In fact, the stringency measures in various countries are not observed very strictly and due to a variety of factors, the infections continued to rise over time. Similar has been the case with the share of international visitors in population. But, the model reveals a negative and significant relation between extensive testing and infections.

Results from Model 2 indicate that there is a positive and significant relation between infections and gross domestic product per capita. Regarding extensive testing, it also finds negative relation. In contrast to Model 1, it finds a significant relation between population density and infections. Elderly population (70+) is found to be a significant factor influencing infections, but its effect has remained relatively weak than the median age.

b. COVID-19 Death Outcomes

Model 3 finds a significant and negative relation between COVID-19 deaths and the share of internet users in population. It reflects the importance of information in preventing mortality. But, it finds a positive relation of deaths with universal health care and the magnitude of COVID-19 infections which implies that when the masses are having access to universal health care, they also become less scared of pandemic which worsens the situation. Similarly, the magnitude of COVID-19 infections is also found to be positively related to the death outcomes.

Table 9: Regression Coefficients Explaining COVID-19 Death Outcomes

Indicator	Variable	Coefficient(S.E.)	
		Model 3	Model 4
SSiP	Smokers Share in Population, %)	0.107 (0.189)	-
PSIU	Population Share of Internet Users	-1.307 (0.315)*	-1.068 (0.363)**
PoDem	Prevalence of Democracy	-0.211 (0.355)	-0.259 (0.397)*
PiEPov	Population in Extreme Poverty, %	0.143 (0.086)	0.091 (0.081)
EldPop	Elderly Population Share (70+), %	0.210 (0.287)	0.228 (0.272)
UHC	Universal Health Coverage	2.039 (0.953)**	1.889 (1.037)
OoPEpc	Out of Pocket Expenditure per capita	-0.035 (0.168)	0.159 (0.181)
GHEpc	Govt. Health Expenditure per capita	0.187 (0.136)	0.435 (0.214)
MCinf	Magnitude of COVID-19 Infections	1.090 (0.051)*	1.011 (0.058)*
ETest	Extensive Testing		-0.259 (0.101)*
Hbeds	Hospital Beds per 1000 Population	-	0.009 (0.175)
GDPpc	GDP Per Capita		-0.491 (0.318)*
DALY	Disability Adjusted Life Years		0.595 (0.622)***
Constant		-8.826 (3.520)**	-11.336 (9.143)
Number of Observations		79	78
F Value		81.87 (9, 69)	65.63 (12, 65)
Prob > F		0.0000	0.0000
R^2		0.9144	0.9238
Adjusted R^2		0.9032	0.9097
Root MSE		0.7592	0.7189

Note: *p < 0.1; **p < 0.05; ***p < 0.0

Model 4 also confirms significance of internet usage in curbing mortality. It also highlights significance of prevalence of democracy in containing mortality. Similarly, it upholds the significance of extensive testing and per capita gross domestic product. It also confirms a positive relation between death outcomes and the incidence of morbidity (captured by DALYs) in society which indicates the co-morbidity-led death outcomes. It does not find any significant relation between the availability of hospital beds and the magnitude of expenditure.

7. Conclusions

Mankind has remained continuously exposed to a variety of infectious diseases caused by deadly pathogens – COVID-19 being the recent one. The economic devastation caused is significant. Still a study on the determining factors has been missing. This study is an attempt to fill this gap. Focusing on the first 3-million COVID-19 cases across 209 countries, it has studied the pattern of regional spread along with identifying worst and best countries as per their performance in getting exposed to COVID-19 virus and experiencing fatality. Following which, it has examined various determining factors of COVID-19 infections and deaths by fitting four econometric regression models estimated through the 'Ordinary Least Squares' (OLS)method.

From the analysis, it is observed that the prevalence of democracy in a country has been positively related to the spread of COVID-19 infections. At the same time, democracy has also been a deterrent to death outcomes especially in situations when countries experience high per capita income. In other words, it is observed that in democratic countries, the COVID-19 infections have been high, but the death outcomes have been lower. In line with Singh (2020b), the study also finds a significant role of extensive testing in containing not only COVID-19 infections but also the death outcomes. In countries where an extensive testing has been done, there has been not only less infections, but the death outcome has also been low. It has also found a negative impact of internet usage on death outcomes. It has found co-morbidity and not the elderly population share as significant determinant of death outcomes. Similarly, it has not found any significant impact of per capita government and out of pocket expenditure, hospital beds availability on death outcomes.

An important contribution of the study is to develop criterion that enables the identification of 'Best' and 'Worst' performing nations. Across various sub-regions, it is important to highlight that highly developed countries have been among the worst and the best performers. So, it is reasonable to conclude that good governance has played a key role in reduction of spread besides containing fatality rates across the board.

The study has relied on available secondary information. It needs to be mentioned that information of all the required variables was not available across all the nations which resulted into a relatively a smaller number of observations in regression analysis vis-à-vis the number of nations examined while conducting global spread analysis. As the onslaught of COVID-19 pandemics is still going on, there is the possibility that with increasing intensity of the infections across nations, there may take place a change in the nature and coefficients of these determining factors. But, they inform about the dynamics of pandemics in the initial phase and thus, by taking care of these determining factors, there emerges a high possibility to contain the pandemics in its initial phase itself.

Appendix

Table A1: Results of Diagnostic Tests Related to Ordinary Least Squares Regression

Test Type	Test Name		Infections		Deaths	
			Model 1	Model 2	Model 3	Model 4
Residual Normality Test	Shapiro-Wilk W Test for Normality	Prob>z	0.6506	0.6423	0.5220	0.5160
Multicollinearity Test	Variance Inflation Factor	Mean	3.14	2.37	5.26	6.10
Model Specification Test	Link Test	_hat	0.003	0.000	0.000	0.000
		_hatsq	0.073	0.629	0.189	0.192
	Regression Specification Error Test (RESET)	Prob > F	0.1992	0.129	0.059	0.068
N			80	126	79	78

Table A2: Summary Statistics of Model 1

Variable Type	Variable Name	N	Mean	S.D.	Minimum	Maximum
Dependent	Ln(Infections/Million)	176	4.79	2.21	-0.69	9.17
Independent	Ln(Democracy Index)	163	1.61	0.48	0.12	2.29
	Ln(Stringency Index)	159	3.49	0.29	1.77	4.04
	Ln(International Visitors,%)	148	3.01	2.74	-10.27	8.13
	Ln(Tests/Infection)	155	3.03	1.24	-0.57	7.25
	Ln(CO_2 Emissions per capita)	204	0.77	1.49	-3.09	3.78
	Ln(Non-Agricultural Workforce,%)	182	4.27	0.36	2.82	4.61
	Ln(Work Participation Rate, 15+)	180	4.01	0.23	3.2	4.48
	Ln(Median Age)	175	3.38	0.31	2.71	3.88
	Ln(Mobile Phone Users, %)	202	4.61	0.44	2.72	5.84
	Ln(Urban Population, %)	204	4.00	0.47	2.58	4.61
	Ln(Population Density)	202	4.42	1.55	-1.99	9.94
	Ln(Extremely Poor Population, %)	111	1.04	2.04	-2.3	4.35

Note: SD – Standard Deviation

Table A3: Summary Statistics for Model 2

Variable Type	Variable Name	N	Mean	S.D.	Minimum	Maximum
Dependent	Ln(Infections/Million)	174	4.79	2.22	-0.69	9.17
Independent	Ln(GDP per capita)	195	8.81	1.45	5.75	12.01
	Ln(Elderly(70+)%)	172	1.44	0.79	-0.64	2.92
	Ln(Tests/Infection)	153	3.04	1.24	-0.57	7.25
	Ln(International Visitors,%)	146	3.19	2.28	-3.11	8.13
	Ln(Non-Agricultural Workforce,%)	180	4.28	0.36	2.82	4.61
	Ln(GDPpercapita)	195	8.81	1.45	5.75	12.01
	Ln(Work Participation Rate, 15+)	178	4.00	0.23	3.20	4.48
	Ln(Urban Population, %)	202	4.00	0.47	2.58	4.61
	Ln(Population Density)	200	4.43	1.55	-1.99	9.94

Note: SD – Standard Deviation

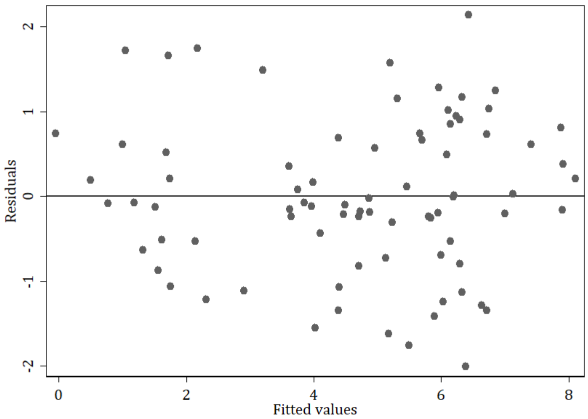
Table A4: Summary Statistics for Model 3 and Model 4

Variable Type			Variable Name	N	Mean	S.D.	Minimum	Maximum
Dependent			Ln(Number of Deaths)	135	4.18	2.40	0.69	10.95
Independent	Model 3	Model 4	Ln(Smokers Share in Population, %)	143	2.95	0.55	0.69	3.85
			Ln(Population Share of Internet Users)	198	3.80	0.79	0.27	4.61
			Ln(Prevalence of Democracy)	161	1.60	0.48	0.12	2.29
			Ln(Population in Extreme Poverty, %)	110	1.04	2.05	-2.30	4.35
			Ln(Elderly Population Share (70+), %)	172	1.44	0.79	-0.64	2.92
			Ln(Universal Health Coverage)	179	4.13	0.27	3.22	4.49
			Ln(Out of Pocket Expenditure per capita)	182	4.45	1.58	-1.65	7.97
			Ln(Govt. Health Expenditure per capita)	183	5.05	1.98	0.66	8.82
			Ln(Magnitude of COVID-19 Infections)	175	6.73	2.68	1.79	13.83
			Ln(Extensive Testing)	153	3.04	1.24	-0.57	7.25
			Ln(Hospital Beds per 1000 Population)	159	0.82	0.85	-1.61	2.60
			Ln(GDP Per Capita)	195	8.81	1.45	5.75	12.01
			Ln(Disability Adjusted Life Years)	184	10.33	0.39	9.61	11.48

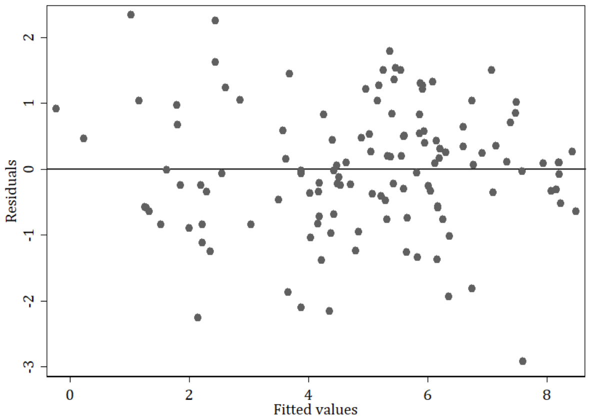
Note: SD – Standard Deviation

Figure A1a: Detection of unusual & influential data: Residual-versus-Fitted Plot (rvfplot)

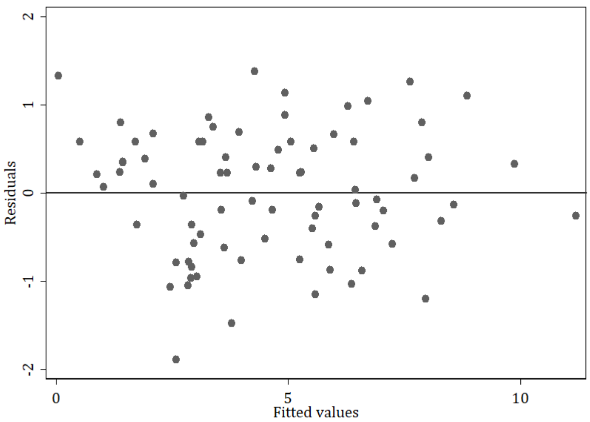
Model 1



Model 2



Model 3



Model 4

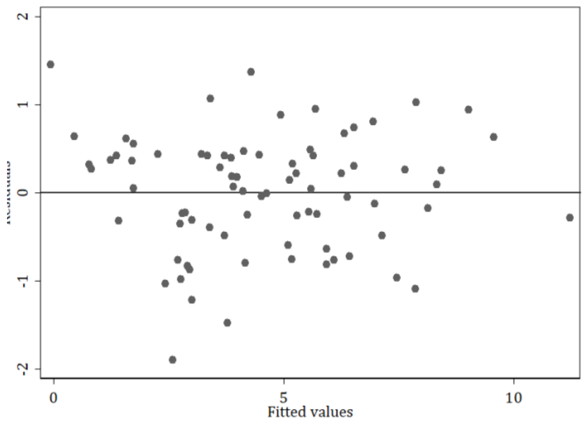
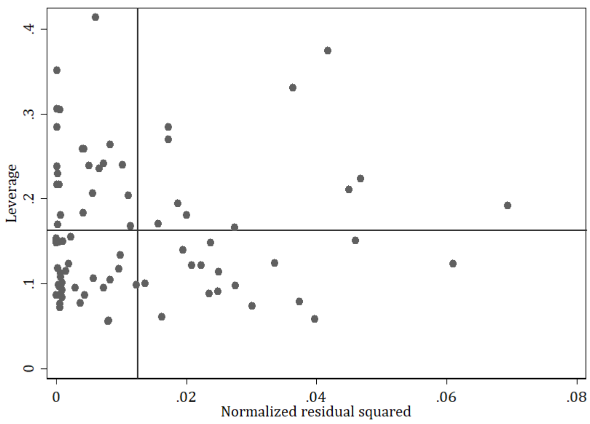
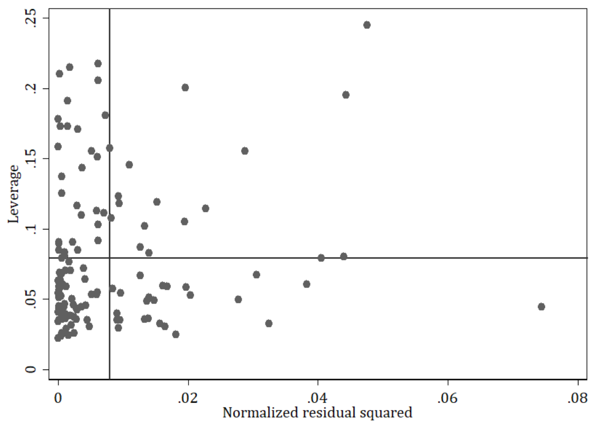


Figure A1b: Detection of unusual & influential data: Leverage-versus-Squared-Residual Plot (lvr2plot)

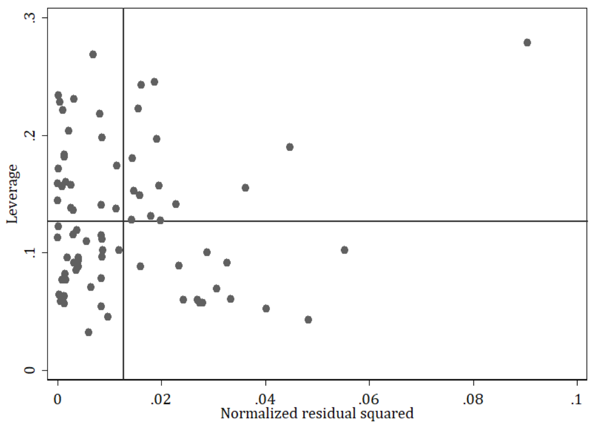
Model 1



Model 2



Model 3



Model 4

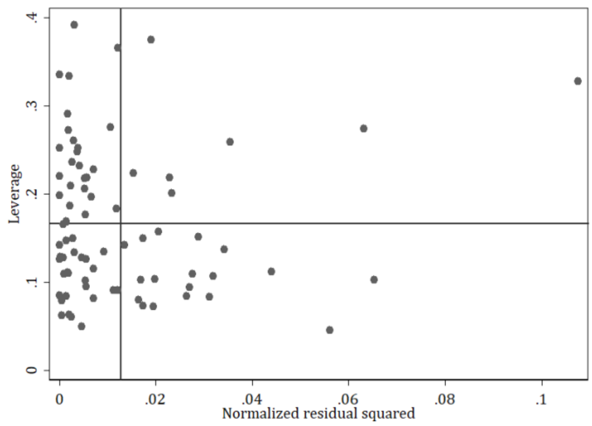


Figure A2a: Added-Variable Plot (avplot) for Model 1

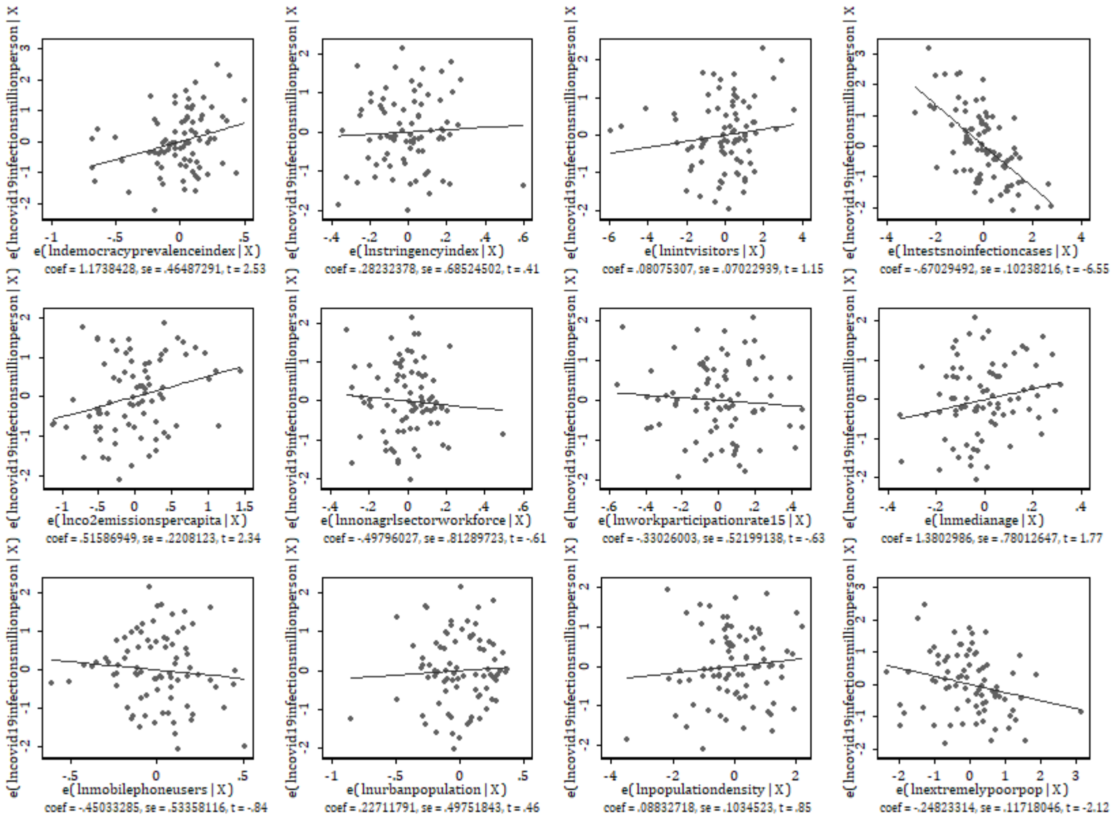


Figure A2b: Added-Variable Plot (avplot) for Model 2

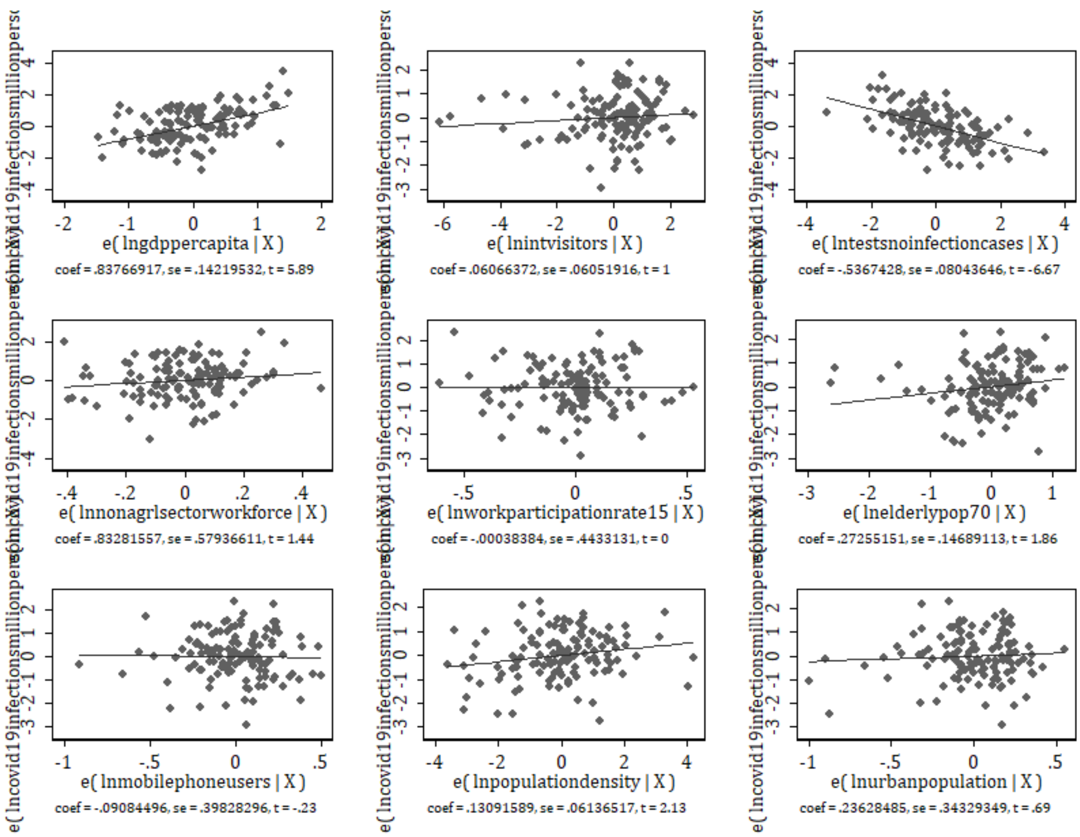


Figure A2c: Added-Variable Plot (avplot) for Model 3

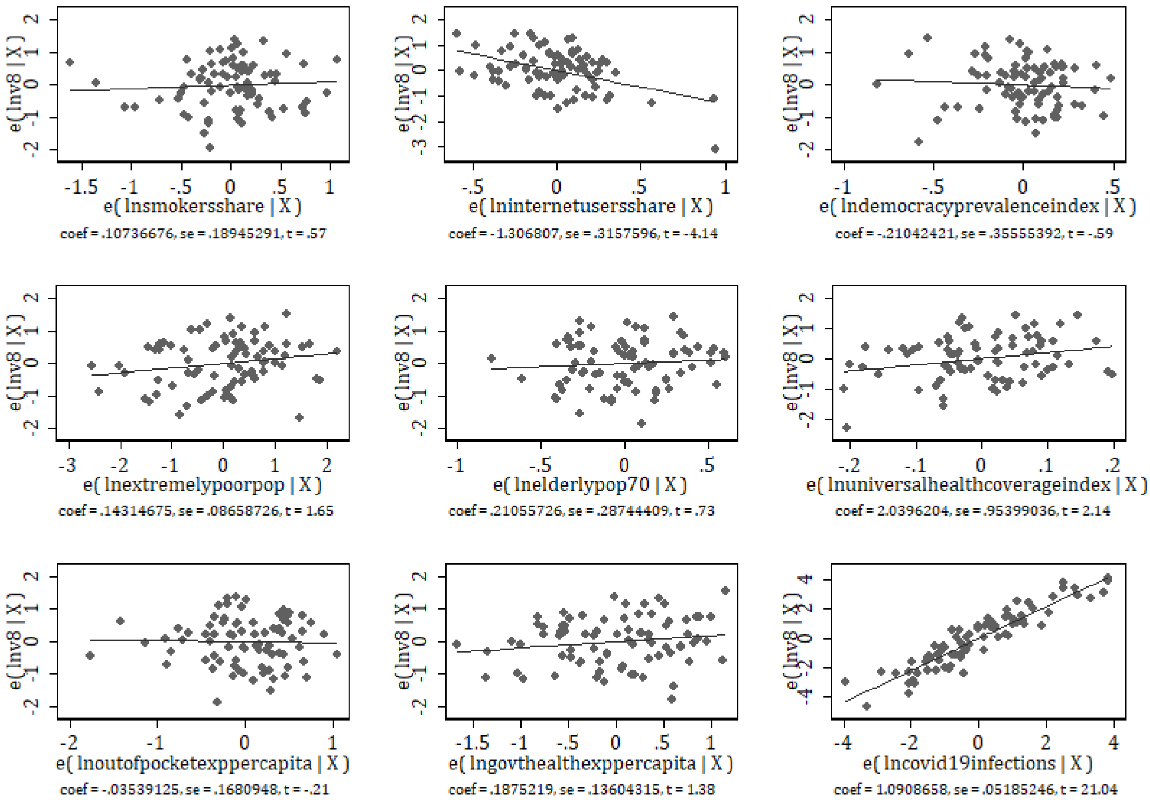


Figure A2d: Added-Variable Plot (avplot) for Model 4

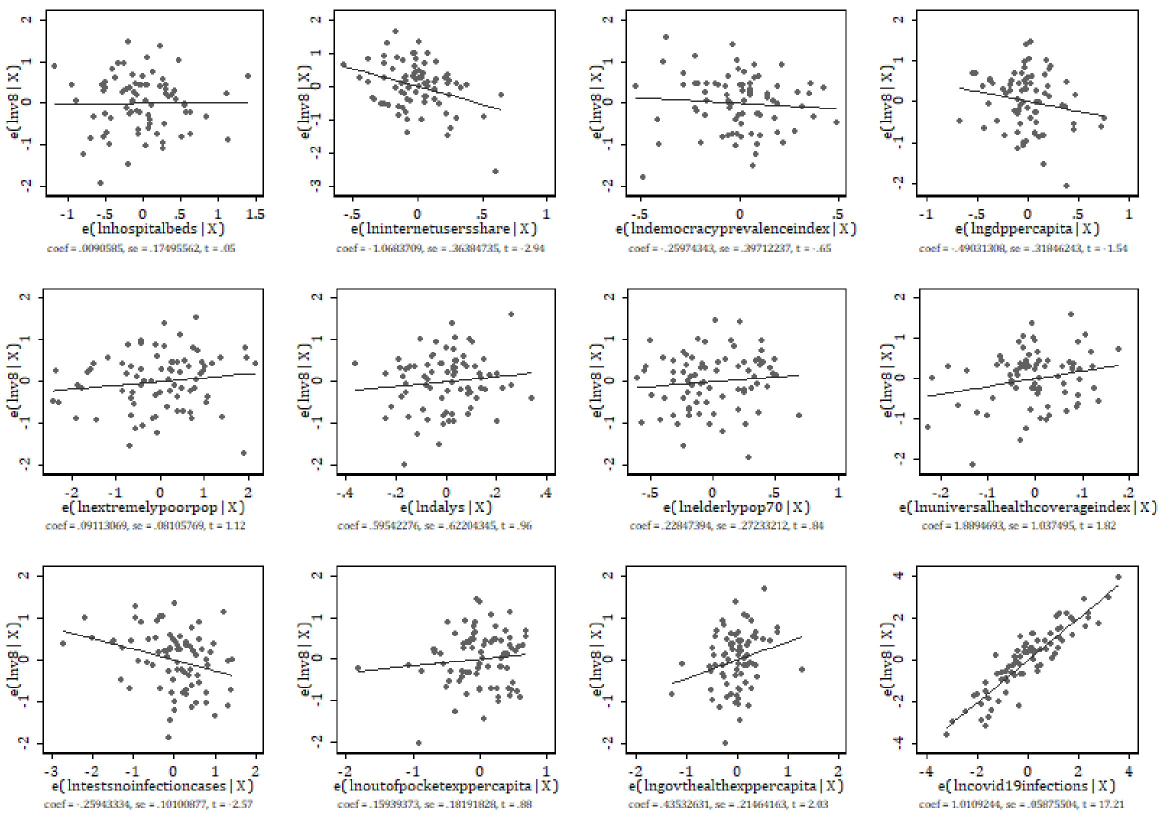
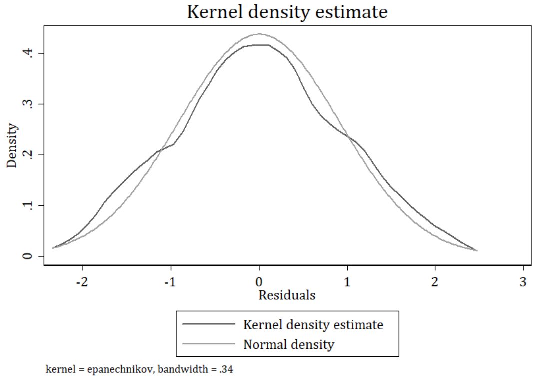
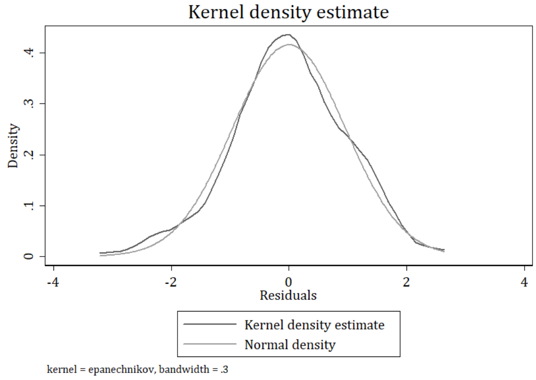


Figure A3: Residual Normality Test - Kernel Density Plot

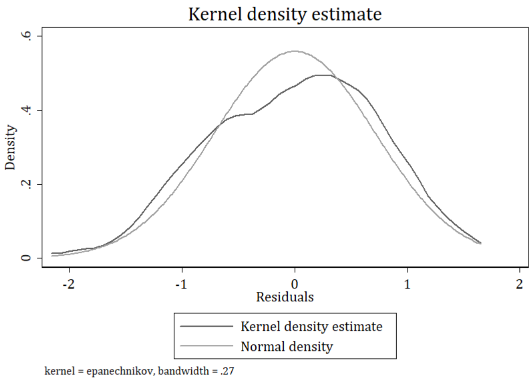
Model 1



Model 2



Model 3



Model 4

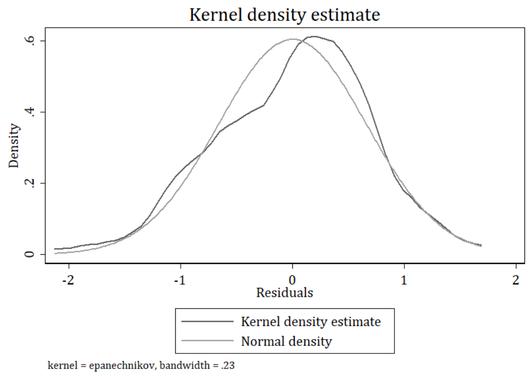
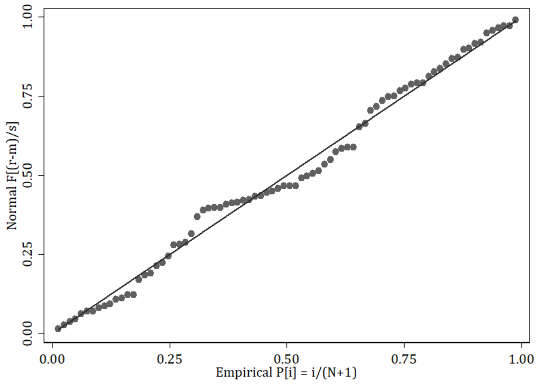
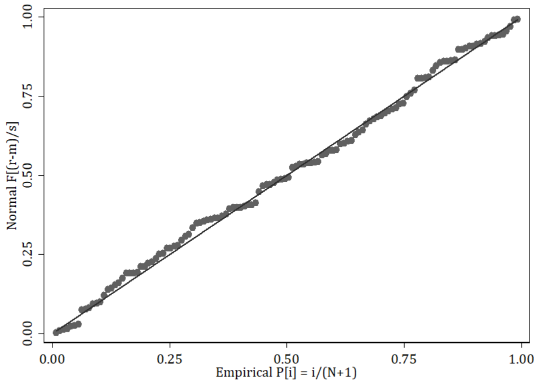


Figure A4: Standardized Normal Probability (P-P) Plot

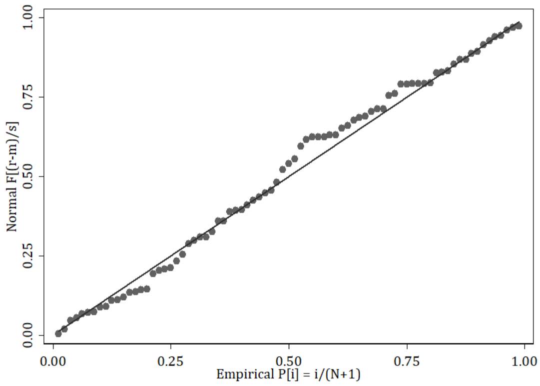
Model 1



Model 2



Model 3



Model 4

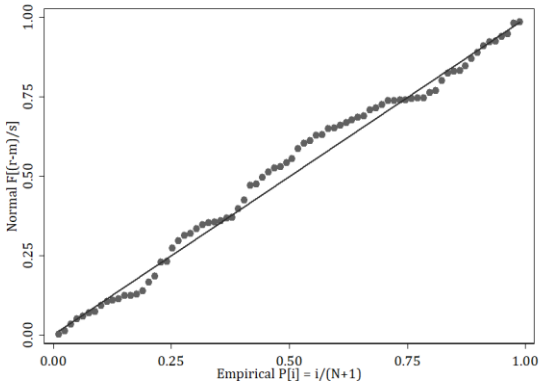
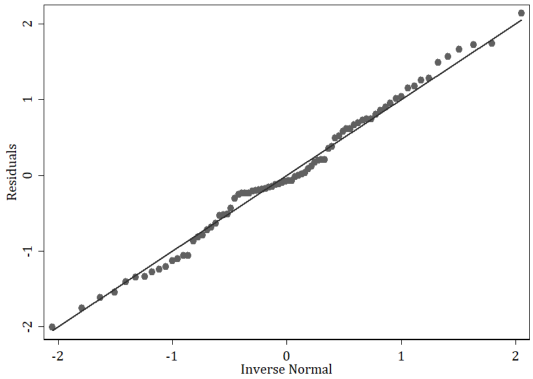
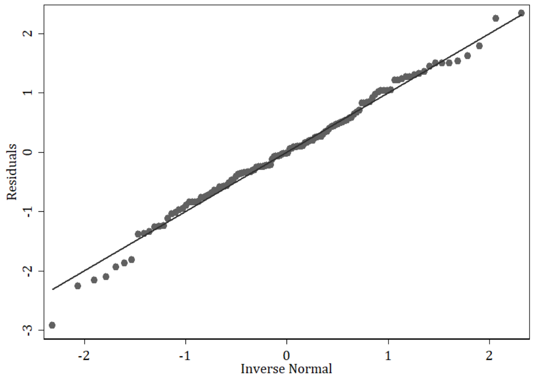


Figure A5: Q-Q Plot

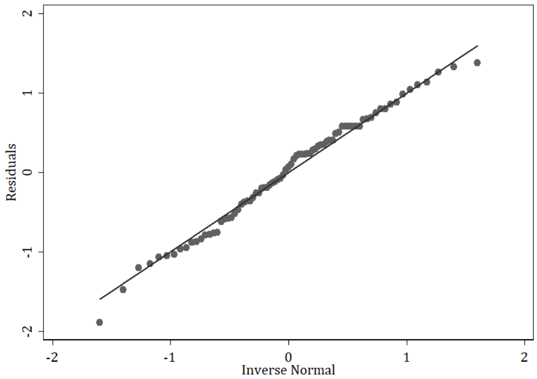
Model 1



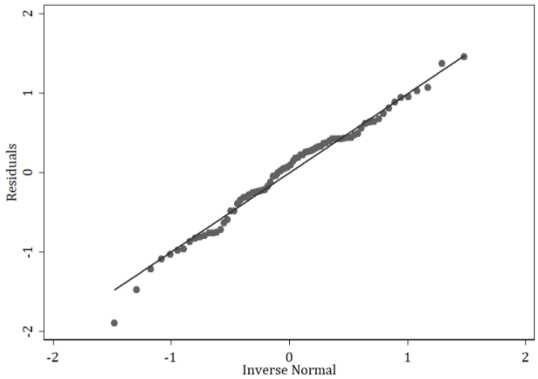
Model 2



Model 3



Model 4



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