Spreading of Covid-19 on Human Populace

Dr. Subrata Roy
Associate Professor
Department of Commerce
Mahatma Gandhi Central University
Motihari, East Champaran, Bihar

Avneesh Kumar
Assistant Professor
Department of Commerce
Mahatma Gandhi Central University
Motihari, East Champaran, Bihar

Abstract

The present study tries to examine the impact COVID-19 pandemic on world population and thus, daily data on COVID-19 cases, time, death, recovery and active cases are considered and obtained from the official websites of UN and WHO over a period from 22nd January 2020 to 24th May 2020. The study employs three non-linear regression equations and the results are varied according to the model. It is observed that log-log regression equation is the appropriate model to capture the time series data based on R2. The slope coefficients of the double model are positive and statistically significant. All the slope coefficients positively influence the spread of COVID-19 in world population. But it is also found that if recovery rate is increased by 20% then COVID-19 spreads is only 1.44% and it is possibly only when proper medical facility is provided.

Keywords: COVID-19, Non-Linear, Death, Recover, World Population, Pandemic

JEL Classification: C13, D8, D84

Introduction

Entire world is facing the dangerous effect of COVID-19. The world population is combating against the corona virus for protection and trying to guard the human civilization from its evil effects. A large number of people is infected and in isolation with treatment. The spreads of COVID-19 into the world populace is increasing at an exponential rate with the increase of time. The scientists all over the world are trying to develop vaccine by which the pandemic can be controlled at any cost. The anxiety is obvious to everyone and spending lives with worry. The origin of the epidemic of the new SARSCoV-2 corona virus causing COVID-19 pandemic is at Wuhan in China and spreads across the world with more than 0.55 million infected and over 0.35 million deaths (till May 24, 2020). According to Baud et al., 2020, opines that mortality rate varies between 5.5% and 5.9% but it may be reached to 20% in Wuhan where the epicenter of the pandemic takes place. In the mean time, the World Health Organization (WHO) declares various guidelines to combat with this pandemic and circulates this guideline to all the health authorities across the world as per protocols and informs the countrymen to take measures like constant washing of hands, hygiene habits, social distancing to detection tests, stay at home, using of masks, patient care inside the home, epidemiological supervision and many more precautions in socio-economic context (www.who.int/es/emergencies/diseases/novel-coronavirus-2019). But all the population groups around the world are at risk of astringent COVID-19 and the situation is more vulnerable for those group who are above 60 years of old with chronic diseases such as cardiovascular disease, diabetes, unrelieved respiratory disease and suffering from kidney problem (Caramelo et al., 2020; Cheng et al., 2020; Fu et al., 2020; Jordan et al., 2020; Lippi & Henry, 2020). It's true that COVID-19 pandemic creates severe socio-economic effects on happiness, quality of life, livelihoods, health, food and security of all populace around the globe. The judgment of human health risk must be understood as the susceptibility of a population and its ability to react to new conditions in order to alleviate possible effects. The vulnerability means the degree to which human being is exposed to deal with the adverse effect. Here, the vulnerability of a population depends on its local environment, the level of material resources, the success of governance and institutions, the quality of public health infrastructure and access to local information (Cutter, 1996). But the above aspects are not homogeneous and may differ according to geography, demographics and socio-economic reasons. So, to protect health from COVID-19, the factors which are related to the origin of the disease and those that affect the well-being of the population must be dealt with.

Although, it is true that outbreak of COVID-19 and worldwide lockdown has negative impact on economy but the environment and everything attached with it (except human) get rid off from the huge anthropogenic force like massive emission of pollutants of diverse kinds (Ray et al., 2020; Beine et al., 2020; Huang et al., 2020; Wu et al., 2020; Mahato et al., 2020) and this lockdown brings a immense opportunity to judge the anthropogenic intervention on qualitative degradation of environmental elements at very local to global scales (Anjum, 2020; Becchetti, 2020; Cadotte, 2020; Das et al., 2020; Layard et al., 2020; Saadat et al., 2020).

It is also well known that complete lockdown is not the only way out to save ourselves from the deadly disease COVID-19. The combine effect of COVID-19 and lockdown makes the population at health jeopardy as well as economic downturn around the globe. All the sectors of the economy are affected sternly. The governments, health organizations and other authorities are constantly focusing on identifying the cases affected by COVID-19 and trying to develop vaccine for preventing the populace from infection. It is recognized that health is the most expensive asset in our life. There are many factors like social, cultural, economic, psychological and environmental that influence health and wellbeing. So, to protect the population from serious health hazards, help the people live longer, offer healthier lives and improving the health of the poorest are the substantial challenges to us during this pandemic situation. The COVID-19 pandemic strains the healthcare systems and causes economic recession unparallel in the recent history and force the countries to take proper decisions on how to best meet the needs of their people.

The present study tries to examine the impact of COVID-19 on population when it spreads at exponential rate. More extensively, the study scrutinizes the influence of death, recovery, active cases and time on the expansion of COVID-19 pandemic in human civilization in the world populace. The introduction section provides a detail about the nature of the study. Section two deals with literature review and research gap. Objectives of the study are given in section three. Section four highlights on data and study period. Methodology is described in section five. Section six explains the result and section seven deals with conclusion and recommendation.

Literature Review

Corona virus is not flu, because it is not due to an influenza virus but it is very similar to those types. But, there are two epidemics of corona virus that has created severe respiratory illness in the recent past. The first one is Severe Acute Respiratory Syndrome (SARS) that is caused by SARS-COV virus and spreads among 30 countries across the world in 2003-04 which infected more than 8500 people and killed 813 people among them. The second epidemic is Middle East Respiratory Disease Syndrome (MERS) in Arabia due to corona virus that affected 2500 people and killed 858 people which is examined by Sullivan in 2018. Epidemics and sometimes called pandemics bring misery to the human beings. Their evil effects spread out into the human body rapidly and kill large number of population. If we remember about bubonic plague that started in 1347 and spread in Eurasia that killed approx 50% population. In the early 1500s a new epidemic popularly known as smallpox in America killed many Americans and the mortality rate was more than 50%. Similarly, cholera (1881), Spanish flu influenza (1918), Asian flu influenza (1957), Hong Kong flu influenza (1968) and HIV (1981), all these pandemics came after a certain period of time and killed a lot of people around the world. Likewise, SARS (2003) and MERS (2012) extended their roots almost 37 countries and many people were died. Correspondingly, Swine flu influenza (2009) pandemic spread globally and a huge death was occurred approx 0.68 million due to this dangerous virus. Then, West

Africa Ebola virus epidemic (2013) extended almost 10 countries and due to its severe effect lots of people lost their valuable lives. Similarly, Zika virus pandemic (2015) in the recent past extended its roots in a rapid way among 76 countries and badly affected many people. Finally, the entire world is now combating against COVID-19 (2019).

COVID-19 outbreak expands significantly into a global pandemic. It is the epidemic of a respiratory illness caused by a virus identified and popularly known as COVID-19 (Corona virus). The virus is officially designated as "Severe Acute Respiratory Syndrome Corona virus 2 (SARS-COV-2)" that is assigned by the International Committee on Taxonomy of Viruses. It is related genetically but unlike from acute respiratory syndrome corona viruses (SARS-CoV) (WHO, 2020). The Pattern of symptoms is the same in the majority of patients with mild or levels of symptoms (JSA & AIPSN, 2020).

Although, the literature on COVID-19 is very scanty but research is carrying on around the world on it. A study by Tomes (2010) observes that Spanish influenza arrived in the United States at a time when new forms of mass transportation, mass media, mass consumption and mass warfare had vastly expanded the public places in which communicable diseases could spread. So, public health authorities tried to implement social distancing measure to control over the situation of deadly crowd disease. The study reports that social distancing is an important measure that significantly can reduce the mortality rates affected by H1N1 influenza pandemic during 1918-1919. In 2012, Lewandowsky et al., says that widespread prevalence and persistence of misinformation in contemporary societies, such as the false belief that there is a link between childhood vaccinations and autism, is a matter of public concern. They speak about myths surrounding vaccinations which prompted some parents to refuse to give immunization from their children have led to a marked increase in vaccine preventable disease as well as unnecessary public expenditure on research and public information campaigns aimed at rectifying the situation. They examine how this misinformation is disseminated in society both unintentionally and purposely. Misinformation can originate from rumors but also from works of fiction, governments and politicians and vested interests. Moreover, changes in the media landscape including the arrival of internet have fundamentally influenced the ways in which information is communicated and spread and they also examine the misinformation at the level of the individual and review the cognitive factors that often render misinformation resistant to correction. Recently, we have seen misinformation spreading over the social media about COVID-19 pandemic and it is very difficult to assess which is wrong and which right. This misinformation is spreading by the individual, political leaders, religious saints and their followers for their vested interest. So, it is dangerous for a country to control over the situation of COVID-19 and thus, to control over the debunking of misinformation they provide specific recommendations pertain to the ways in which corrections should be designed, structured and applied in order to maximize their impact. Kim et al., (2016) once again memorizes the Ebola scare in 2014 where many people evinced strong fear and xenophobla and their study informed by the pathogen-prevalence hypothesis, tested the influence of individualism and collectivism on xenophobic response to the threat of Ebola. Benjamin Hurlbut (2017) examines the relationship between political norms associated with governance of pandemic risk and argues that scientific regimes are laying claim to a kind of sovereignty by positioning the norms of scientific practice including a commitment to unfettered access to scientific information and to the authority of science to declare what needs to be known as essential to global governance. He reports that scientific authority occupies a constitutional position insofar as it figures centrally in the repertoire of imaginaries that shape how a global community is imagined. Another study by Lancet (2018) concludes that influenza virus causes death to children but fortunately the corona virus has not led to death in children but infected (CIA et al., 2020). Similarly, a study by Li et al., 2019 depicts that 71000 influenza associated excess respiratory deaths occurred in individuals aged 60 years or older. In 2019, Yang et al., says that COVID-19 outbreaks in Wuhan, Hubei province and began spreading rapidly with more than 80000 cases confirmed and 3000 deaths in China. Many countries like Italy, Iran, Korea, Japan, USA and others have reported nearly 60000 cases and most of the COVID-19 patients initially suffered from fever, cough, fatigue and breathing problem along with muscle pain, headache, chest pain and diarrhea similar to the symptoms observed after chemotherapy, targeted and immune therapy.

A study by Guan et al., in 2020 claims that around 14% per 1000 were died. In India, currently, 7000 persons have been tested since the epidemic began (Scroll, 2020). A joint mission on COVID-19 conducted by WHO and China (2020) reports that COVID-19 is transmitted via droplets and fomites during close unprotected contact between an infector and infectee, in China, human to human transmission of the COVID-19 is largely occurring in families and China has a policy of meticulous case and contact identification for COVID-19. Similarly, Ceukelaire et al., (2020) says that corona virus (COVID-19) outbreak has already spread from China to the entire world in less than two months. Now, the time is to take stock and to assess the responses of different countries to the outbreak so far. In 2020, Suleman et al., describes the challenges of COVID-19 in Pakistan and thus, they develop a transparent user friendly method to stimulate the outbreak data. They use GIS tools to identify and define the field of investigation that helps to the authorities to locate the highly effected area and can take proper measures to those areas. They also suggest that GIS technique can be used for more effective investigation in the vulnerable geographical areas in Pakistan. Another study by Hao Xu et al., (2020) examines the possible environmental effects caused by COVID-19 in China and therefore, they have considered daily data of COVID-19 confirmed cases, air quality and meteorological variables of 33 locations in China over a period from 29th January 2020 to 15th February 2020 by applying Poisson regression equation. They find that the effect air quality index (AQI) on confirmed cases associated with an increase in each unit of AQI is statistically significant in many cities. They also suggest that an enhanced impact of AQI on the COVID-19 spread under low relative humidity (RH). Similarly, in 2020 Lorena et al., critically examines the risk of social, environmental and health factors in Mexican indigenous population in the context of COVID-19 pandemic and proposes strategies to mitigate the impacts on these on communities. They suggest community based approach to address these social, environmental and health gaps in the communities. They also opine that health is the preeminent factor of cohesion for inserting development and progress proposals in indigenous communities during this COVID-19 pandemic. Likewise, Mondal and Pal (2020), examines the impact of forced lockdown on environmental components in pre and during lockdown by identifying stone quarrying and crushing areas during COVID-19 pandemic in middle catchment of Dwarka river basin of Eastern India. They observe that maximum Particulate matter 10 is 189 to 278 ug/m3 in pre lockdown period reduced to 50 to 60 ug/m3 after 18 days of lockdown. Similarly, land surface temperature dominated by the crusher areas reduced to below 65dBA after lockdown and the adjacent river water is qualitatively improved after declaration of lockdown. So, they opine that emergency lockdown shows a way out to restore environment and ecosystem in a rapid rate.

A 55 year old individual from Hubei province in China may have been the first person to have infected COVID-19 in 17th November 2019 (South Morning China Post). At that time, authorities suspected that the virus came from something sold at a wet market in the city. However, it is now confirmed that early in what is now a pandemic, some infected people had no connection to that seafood market that is reported by the researchers in 20th January 2020 in a journal (The Lancet). Scientists now suspect that corona virus has been originated in a bat and somehow hopped to another animal, possibly the pangolin which then passed it into the human body. So, here there is a lot of anomaly about origin of COVID-19. Someone claims it is artificially invented by the scientists and the other groups claim it has been passed from the animal body. Now, the disease is spreading among the people without any animal intermediary and the scientists are trying to trace the virus back to where it has been originated to learn more about its spread.

From the above studies it is clear that the researchers have tried to find out the impact of COVID-19 on environment, health, economy and other related areas. Keeping in view of the above, the present study tries to examine the growth/expansion rate of COVID-19 caused by death, recovery, time and active cases in the world population. The study is new one and there is scanty of literatures and surely adds value to the existing literature.

Objective of the study

The present study tries to examine the following objectives:

1. To examine the impact of time on COVID-19 spreading

2. To examine the impact of death on COVID-19 spreading

3. To scrutinize the influence of recovery on COVID-19

4. To observe the impact of active cases on COVID-19 pandemic

Data & Study period

The study uses five variables which are exclusively related to COVID-19 pandemic. The variables are COVID-19 cases (affected by corona virus), time, death caused by COVID-19, recovery from COVID-19 and active cases in the whole population. Here, COVID-19 is considered as the dependent variable and the remaining are the independent variables. Here, daily data are considered i.e. from 22nd January to 24th May 2020 and collected from the official websites of United Nation and World Health Organization and also crossed checked with the data provided by various secondary sources.

Methodology

The methodology is the technique by which various problems can be solved systematically. In economics it is assumed that population relationships are linear and that's why regression analysis takes the right form. But in reality linearity assumption is not follow always and therefore, we experience various problems like inflation accelerates as unemployment rates fall; elasticity of demand and supply usually change as price change; diminishing marginal utility; diminishing marginal returns; diminishing trend of stock return due to financial recession etc.

Therefore, critical errors may take place if a non-linear situation is studied by considering a linear model.

Suppose, COVID-19 (denoted by Y is a dependent variable) spreads exponentially when 't' (times an independent variable) increases and this situation can be shown as under:

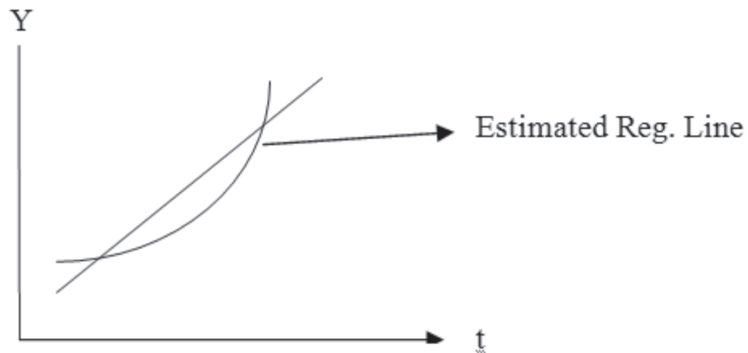

Figure 1 COVID spreads

It is observed from figure 1 that the estimated regression line only correctly represents the population line at two points. The estimated regression line moves towards right over time with large forecast errors. So, it is important to choose an appropriate functional form to study this situation. The above situation can be addressed by considering an exponential-logarithmic function.

The properties of exponential-logarithmic functions are as under:

(i). generally, exponential function looks like $y = a^x$, $a > 0$, where 'a' represents the base (constant), x represents exponent and 'y' is growing exponentially as long as $x > 0$.

(ii). Log is the inverse of exponential function that takes the form $x = \log_a^y$ (a logarithm of y to a given base say 'a' is the power to which 'a' must be raised in order to arrive at 'y'.

(iii). The most common base for exponential function is the constant 'e', where $e = \lim_{n \to \alpha}(1 + \frac{1}{n})^n \approx 2.7183$

So, the most common logarithms are logs to the base 'e' (natural logs) looks like $x = \log_e y$ to $x = \ln y$ that can be shown as under:

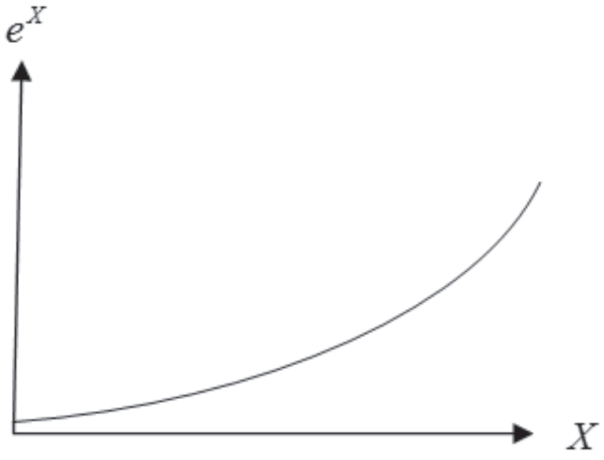

Figure 2: Exponential Curve

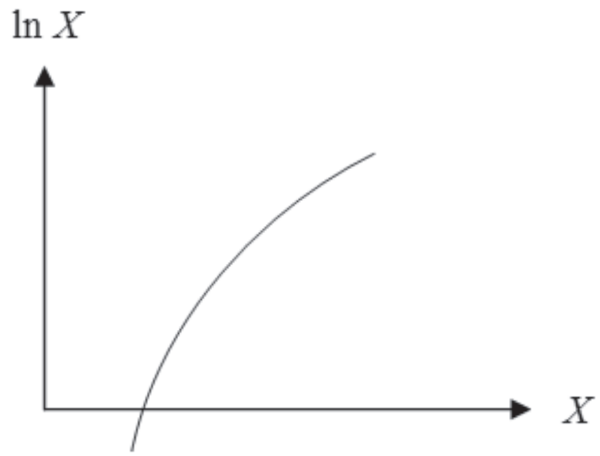

Figure 3: Logarithmic Curve

(iv). both exponential and logarithmic functions are monotonic increasing transformations. Suppose ' m ' and ' n ' are two numbers where $m \geq n$, then $e^m > e^n and$ $\ln(m) < \ln(n)$

(v). log operations for any two positive numbers ' p ' and ' q ' as below:

$\ln(p.q) = \ln p + \ln q$

$\ln(\frac{p}{q}) = \ln(p) - \ln(q)$ that imlies $\ln(\frac{1}{q}) = -\ln(q)$

$\ln(p^q) = q.\ln(p)$

(vi). exponential function operations for any two positive numbers ' p ' and ' q ' as under:

$p^q = e^{q.\ln(p)}$

$a^p.a^q = a^{p+q}$

$(a^p)^q = a^{(p.q)}$

The study applies appropriate functions when necessary to allow non-linear relationship among the variables. Similarly, derivative of ' Y ' may also be introduced with respect to ' X ' to not be a constant but rather to vary as ' X ' changes. The properties of the derivatives of logarithmic-exponential functions are as under:

(a). If $Y = \ln(X)$, then $\frac{dY}{dX} = \frac{1}{X}$

(b). If $Y = e^X$, then $\frac{dY}{dX} = e^X$

©. If $Y = e^{a.X}$, then $\frac{dY}{dX} = a.e^{a.X}$

(d). If $Y = a^X$, then $\frac{dY}{dX} = a^X \ln(a)$

From the above, it is expected that equilibrium in economics must be maintained and thus, it may be identified the elasticity of 'Y' with respect to 'X' for exponential-logarithmic function as below:

Let, $\eta = \frac{\%\Delta Y}{\%\Delta X} = \frac{dY}{dX}.\frac{X}{Y}$ then the properties may be expressed as below:

(a). If $Y = a.\ln(X)$, then $\eta = \frac{a}{Y}$

(b). If $Y = e^X$, then $\eta = e^X \frac{X}{Y} = e^X \frac{X}{e^X} = X$

After details reviewing the properties of logarithmic-exponential functions, appropriate models may be developed those look like linear after transformation where ordinary least square (OLS) estimation is possible. With this view, the present study considers three logarithmic-exponential functions.

(I). Let's start with the linear-log function as under:

$$Y = \alpha_0 + \beta_1 \ln(X) + e \quad \textbf{(1)}$$

Where, 'Y' is the response variable, 'X' is the predictor variable, 'e' is the disturbance term with zero mean and constant variance, 'α_0' and 'β_1' are the coefficients to be estimated.

Equation 1 is appropriate when it is assumed that the underlying relationship between 'Y' and 'X' looks like as below:

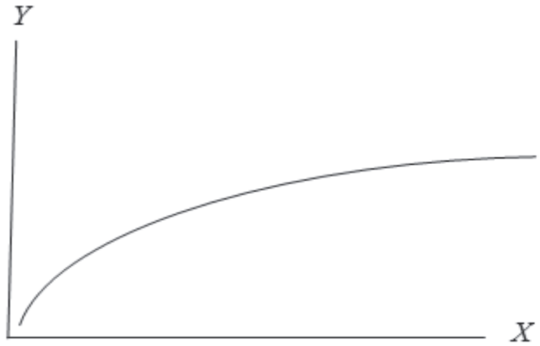

Figure 4: Diminishing marginal return

The above figure tells that 'Y' follows diminishing marginal returns when 'X' increases in the short run. But, if 'X' variable is transformed into log then the above figure looks like as below:

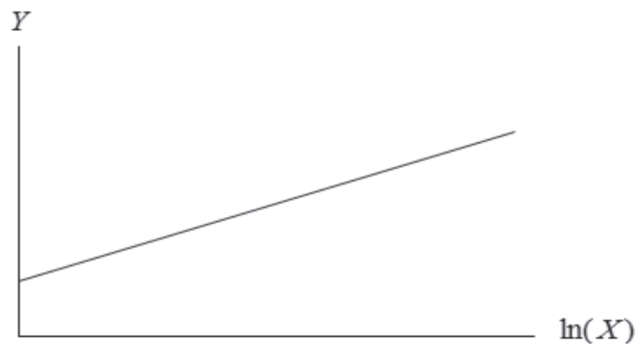

Figure 5: Increasing marginal return

Thus, by transforming one of the variables into log form we can follow the OLS technique to measure linear relationship and only then the OLS estimators is recognised as BLUE. Here, the '$\hat{\beta}$' estimator is no longer report the marginal effect of 'X' upon 'Y' rather it reports the marginal effect of $\ln(X)$ upon 'Y'. So, first of all un-transform the estimators generated by the regression equation and then interpret.

So, the marginal effect of 'X' upon 'Y' may be shown as under:

$$\frac{dY}{dX} = \frac{\beta_1}{X} \qquad \textbf{(2)}$$

It follows a diminishing marginal effect when 'X' increases and the elasticity of 'Y' with respect to 'X' may be written as below:

$$\eta = \frac{\beta_1}{Y} \qquad \textbf{(3)}$$

But, here the equilibrium changes as 'Y' changes which indicates average levez`l of 'Y'.

(II). The study also considers a log-linear (semi-log) model that can be presented as below:

$$\ln(Y) = \alpha_0 + \beta_1 X + \varepsilon \qquad \textbf{(4)}$$

Consider equation 1 again (linear-log model), where log is used to transform a variable in the right hand side (independent variable) to allow unbend a concave line to straight line. In the same way, if log transformation is used in the left hand side (dependent variable) of a variable then it is possible to allow unbend a convex and exponential curve into a straight line.

Suppose, COVID-19 (represented by 'Y') grows exponentially at a rate 'h' at any point of time 't' and this relationship may be expressed as under:

$$Y_t = Y_0(1+h)^t \qquad \textbf{(5)}$$

Where, zero (0) represents any subjective starting time point. The spreading rate or growth rate ('h') of COVID-19 can be estimated only when the natural log of both sides is taken possible in equation 5 as under:

$$\ln(Y_t) = \ln(Y_0) + t.\ln(1+h) \qquad \textbf{(6)}$$

The above notation can be simplified as below:

$COVID-19 = \ln(Y_t); \quad \alpha_0 = \ln(Y_0) = \ln(COVID-19_0); \mathrm{X} = \mathrm{t}$ and $\beta_1 = \ln(1+h)$

Now, inserting an error term in equation 6 to each time period to allow disturbances then equation 6 looks like:

$$\ln(Y_t) = \alpha_0 + \beta_1 X + \varepsilon_t \qquad \textbf{(7)}$$

Now, if exponential rule is followed in equation 7 then it looks like as below:

$$Y_t = e^{\alpha_0 + \beta_1 X + \varepsilon_t} \qquad \textbf{(8)}$$

So, it is possible to estimate the unknown spreading rate or growth rate of COVID-19 (represented by 'Y') by regressing the natural log of 'Y' against time (X) and then un-transform the coefficients for their interpretation. Here, the regression slope coefficient $\hat{\beta}_1$ measures the natural log of $(1+h)$ which is equal to the percentage change in 'Y' per one unit change in 't'. The underlying spreading rate denoted by 'h' may be estimated as below:

$$\hat{h} = e^{\hat{\beta}_1} - 1 \qquad \textbf{(9)}$$

On the other hand, the marginal effect of 'X' (time) upon 'Y' rather than the spreading rate or growth rate can be estimated by applying the properties of the derivatives of logarithmic and exponential functions which is explained above:

$$\frac{dY}{dX} = \beta_1 Y \qquad \textbf{(10)}$$

and the equilibrium between 'Y' and 'X' can be shown as under:

$$\eta = \frac{dY}{dX}.\frac{X}{Y} = \beta_1 X \qquad \textbf{(11)}$$

So, to forecast '$\hat{Y}$' after putting some expected value of 'X' into the regression equation 8 it looks like as under:

$$E(Y_t) = E(e^{\beta_1 t + \alpha_0 + \varepsilon_t}) = e^{\alpha_0 + \beta_1 t}.E(e^{\varepsilon_t}) \qquad \textbf{(12)}$$

If $E(e^{\varepsilon_t}) = 1$, then the forecast is unbiased, consistent and efficient but if

$$E(e^{\varepsilon_t}) = e^{\sigma^2/2} \neq 1 \qquad \textbf{(13)}$$

then the forecast is biased, inconsistent and inefficient. This problem may be corrected to forecast 'Y' by using the following log-linear regression model as under:

$$\hat{Y}_t = e^{\hat{\alpha}_0 + \hat{\beta}_1 X_t + (\hat{\sigma}^2/2)} \qquad \textbf{(14)}$$

Where, $\hat{\sigma}^2$ represents the sample variance of the disturbances.

(III). Finally, the study considers a log-log (double log) model to analyse the effect of COVID-19 into the human life. Therefore, COVID-19 spreading, death by COVID-19, COVID-19's active cases and recover from COVID-19 are taken into consideration.

Generally, a log-log model can be written as under:

$$\ln(Y) = \alpha_0 + \beta_1 \ln(X) + \varepsilon \qquad \textbf{(15)}$$

The above equation can be linked with the Cobb-Douglas production function in a judicious way. According to C-D production function, a firm produces 'Q' by using two inputs 'L' (labour) and 'K' (capital) and also subject to changes the technology measured by the parameter 's' and that can be presented in the following form:

$$Q = K^{\beta_1} L^{\beta_2}.s \qquad \textbf{(16)}$$

After taking log on both sides and adding an error term in the equation it looks like as below:

$$\ln(Q) = \alpha_0 + \beta_1 \ln(K) + \beta_2 \ln(L) + \varepsilon \quad \textbf{(17)}$$

Where, $\alpha_0 = \ln(s)$, 'β_1' and 'β_2'are the coefficients to be estimated. But the expected coefficients $\hat{\beta}_k$ are the unbiased estimators of the equilibrium of 'Q' with respect to the exogenous variables 'K' and 'L'. However, the sum of the $\hat{\beta}_k$ estimates gives a measure of returns to scale. If the sum is greater than one meaning that increasing returns to scale and vice-versa and also if the sum is equal to one then indicates constant returns to scale.

Here, the marginal effect of 'X' upon 'Y'can be derived by applying the derivatives of logarithmic-exponential functions as under:

$$\frac{dy}{dx} = \beta_k . \frac{y}{x_k} \quad \textbf{(18)}$$

So, based on the C-D production function the COVID-19 issue can be formulated as under:

$$COVID-19 = Death^{\beta_1} Active^{\beta_2} \mathrm{Re}\,cover^{\beta_3} Day^{\beta_4} .m \quad \textbf{(19)}$$

Here, it is assumed that COVID-19 affects human life in various ways. Due to COVID pandamic, a lot of people has already been died, many people is suffering till now and many of them have recovered subject to changes the medical treatment measured by the parameter 'm'.

Now, after taking log on both the sides and putting an error tem in equation 19 the converted equation looks like:

$$\ln(COVID-19) = \alpha_0 + \beta_1 \ln(Death) + \beta_2 \ln(Active) + \beta_3 \ln(\mathrm{Re}\,cover) + \beta_4 (Day) + \varepsilon \quad \textbf{(20)}$$

Where, $\alpha_0 = \ln(m)$; $\ln(COVID-19)$ represents the growth or transmission of COVID-19 among the people; $\ln(Death)$ indicates the patients died in COVID-19; $\ln(Active)$ tells about patients are suffering from COVID-19 till now; $\ln(\mathrm{Re}\,cover)$ signifies that how many patients are recovered from COVID-19 after treatment; 'β_1', 'β_2' and 'β_3'are the coefficients to be estimated by OLS technique and 'ε' is the disturbances term with its usual assumptions.

Results & Analysis

The world scenario of COVID-19 from 22nd January to 24th May, 2020 is given in figure 1. It is observed that the transmission of COVID-19 to the human body during this short period of time is increasing sharply (exponential rate) only a little relief on 16th May, 2020 and then again as before. But, the recovery rate after medical treatment is also increasing which is a good sign to us. Although the recovery rate is lower as compared to the transmission rate. It is also found that the graph of the active cases who are under medical treatment in between the graphs of transmission case (COVID-19) and recovery case. Here, it is found that the direction of the active graph will follow a diminishing trend if recovery rate is higher and will cross the active graph very soon if medical treatment is improved. The death rate is also in increasing trend but the rate of growth is very low as compared to recovery and the death rate will be under control if proper medical treatment could be provided.

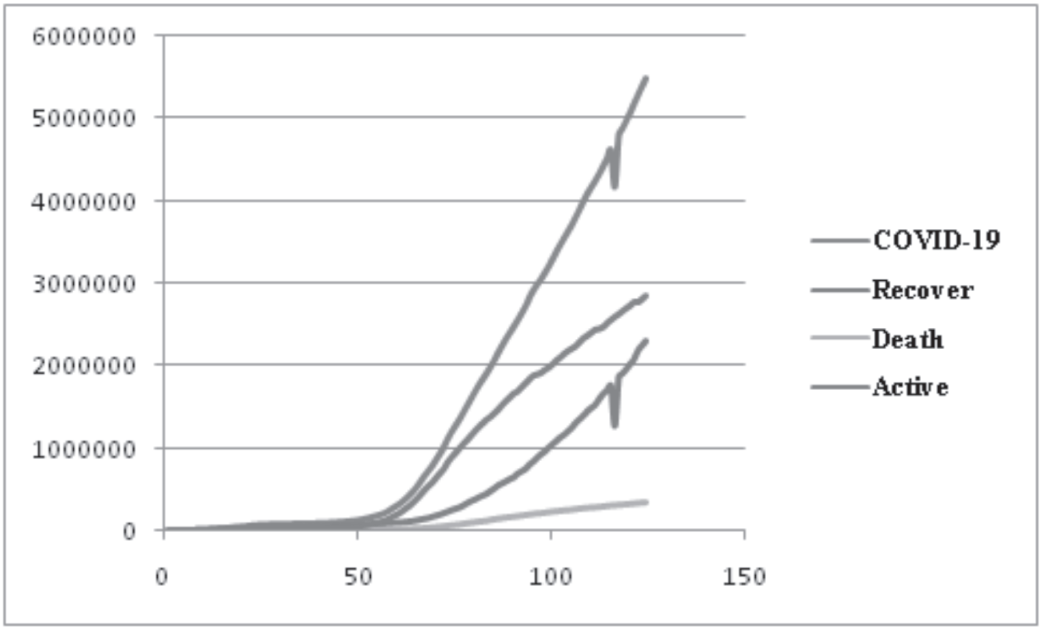

Figure 6: World Scenario of COVID (22nd January to 24th May, 2020)

The coefficient of the estimated regression models are presented in table 1. It is found that the estimated coefficient of the linear-log model is positive and statistically significant. In this model time (independent variable) is denoted as X and transformed into log form. So, to interpret the coefficient, it has to be divided by hundred (1243010.00/100) and the value is 12430.00 that means when time (independent) is increased by 1% then the dependent variable increases by about 12430.00 or in other words, for every 10% increase in time (X), transmission of COVID-19 to the human life increases by about [1243010.00*log(1.10)] 51451.52. So, it may be opined that human transmission by COVID-19 is increased sharply according to the time.

Similarly, it is observed that the estimated coefficient of the log-linear model is also positive and statistically significant. In case of level-level regression model, it is very easy to interpret the slope coefficient. But, in this case slope coefficient cannot be interpreted simply. So, to interpret the slope coefficient, first exponentiates and then subtracts one from this coefficient and then multiply by 100 and then the resultant value indicates the percent increase (or decrease) in the dependent variable for every one-unit increase in the independent variable. Here, the slope coefficient is 0.0600 that can be interpreted after converting the slope coefficient in this form [exp(0.0600) – 1)* 100 = 6.19]. So, it may be interpreted that for every one day increase in time (independent variable), the COVID-19 spreading to the world population increases by about 6.19%.

Finally, the outcome of log-log model (double log) is presented in table 1. It is found that all the slope coefficients are positive and statistically significant. Before interpreting the death coefficients of the log-log model, first the coefficient is to be converted into this from $(1.01^{0.3053}-1)*100$ that means for 1% increase (decrease) in the independent variable then what percent changes is occurred in the dependent variable. After converting the coefficient of death it is found 8.47% that means 1% increase in death by COVID-19 in world population the spreading rate of COVID-19 into human population is 8.47%. Similarly, the coefficient of active case is found 0.4815 and after converting it becomes 20.84% that means 1% increase in active case (till suffering from COVID-19) or who are in treatment, the spread of COVID-19 into the world population is 20.84%. In the same way, the slope coefficient of recovery rate is observed 0.0787 and after conversion it is found 0.60% that indicates that 1% increase in recovery rate the spreads of COVID-19 into the population is 0.60%. If it is extended in this way that if 20% increase in recovery rate the spreads of COVID-19 into the world population is found to be 1.44%. So, it may be said that if recovery rate is increased in a rapid way with proper treatment then spreading of COVID-19 in the world populace may be controlled. Finally, the slope coefficient of time is 0.2016 and after converting, it is found 3.77% that means that 1% increase in time, the spreading of COVID-19 to the population is 3.77% or almost four times that means with the enhancement of time, the spreading of COVID-19 into the human life has increased harshly.

From the above results it may be determined which model is appropriate in this perspective. So, coefficient of determination (R^2) is used to identify the best model. It is observed that each model has produced R^2 value (goodness of fit). It is assumed that model suitability depends on higher R^2 value. It is observed that the R^2 value of the log-log model (Double log) is higher as compared to the linear-log model as well as log-linear model and thus, it may be said that log-log model is an appropriate model to fit the time series historical data on COVID-19 of the world population.

Table 1: Regression estimates of the exponential-logarithmic models

Model	Beta Coefficients				R^2
	β_1	β_2	β_3	β_4	
Linear-Log Model: $Y = \alpha_0 + \beta_1 \ln(X) + e_t$	1243010.00* (10.1373) 0.0000				0.4572
Log-Linear Model: $\ln(Y_t) = \alpha_0 + \beta_1 X + \varepsilon_t$	0.0600* (40.6788) 0.0000				0.9313
Log-Log Model: $\ln(\text{COVID-19}) = \alpha_0+\beta_1\ln(\text{Death})+\beta_2\ln(\text{Active})+\beta_3\ln(\text{Recover})+\beta_4\ln(\text{Day})+\varepsilon$	0.3053* (10.81311) 0.0000	0.4815* (18.5552) 0.0000	0.0787* (3.9988) 0.0001	0.2016* (4.1656) 0.0001	0.9993

*Significant at 5% level

Source: Authors' own calculation

Conclusion & Recommendation

The present study examines the impact of COVID-19 on human populace by considering three non-linear regression models. It is found from the figure that spreads of COVID-19 on population is increased at an exponential rate with respect of time. But the death curve is not hike so much like others. However, there are large differences on the results estimated by all the regression models but the coefficients are positive and statistically significant in all cases. It is also concluded that log-log model is an appropriate model to capture the entire situation. It is observed that all the independent variables are statistically significant and positively influence the spreading of COVID-19 on world population. The COVID-19 has spread over time almost four times but spreading of COVID-19 is not so increased sharply according to the recovery rate. It is also found that when active cases is increasing then positive cases are also increased in a rapid way. But when positive cases are compared with the death rate then it is found that spreading rate is almost 8.5% where death rate is 1%. So, it may be opined that if health services are improved then positive cases may be controlled. In this situation more testing is required, proper isolation must be arranged, good treatment is required to control over the situation until vaccine is not developed. It may be recommended that global corona virus pandemic teaches us lesson like strong public health systems have the flexibility to address massive health threats with the collective responses they require. Unnecessary privatization of health services and individualization of risks might further weaken our ability to address this and future global pandemics. So, the Government will give more attention on health services, social safety and security, foods and financial stability for sustaining human civilization. More research is needed to find out solution from COVID-19 spreading and how the whole human civilization will combat with it.

References

Anjum, N. A. (2020). "Good in the worst: Covid-19 restrictions and ease in global air pollution", https://doi.org/10.20944/preprints202004.0069.v1.

Baud, D., Qi, X., Nielsen-Saines, K., Musso, D., Pomar, L., Favre, G. (2020). "Real estimates of mortality following COVID-19 infection", Lancet Infect. Dis. In press.

Becchetti, l., Conzo, P., Salustri, F. (2020). "Understanding the heterogeneity of adverse COVID-19 outcomes: The role of poor quality of air and lockdown decisions", available at ssrn 3572548.

Beine, M., Bertoli, S., Chen, S., D'Ambrosio, C., Docquier, F., Dupuy, A., Fusco, A., Girardi, S., Haas, T., Islam, N., Koulovatianos, C. (2020). "Economic effects of COVID-19 in Luxembourg".

Cadotte, M. (2020). "Early evidence that COVID-19 Government policies reduce urban air pollution", Https://doi.org/10.31223/osf.io/nhgj3.

6. Cai, J., Xu, J., Lin, D., Yang, Z., Xu, L., Qu, Z., Zhang,

Y., Zhang, H., Jia, R., Liu, P., Wang, X., Ge, Y., Xia, A., Tian, H., Chang, H., Wang, C., Li, J., Wang, J., & Zeng, M. (2020). "A Case Series of children with 2019 novel corona virus infection: Clinical and epidemiological features", Clinical Infectious Diseases. https://doi.org/10.1093/cid/ciaa198

Ceukelaire, D. W., & Bodini, C. (2020). "We need strong public health care to contain the global corona pandemic", International Journal of Health Services, 0(0), 1-2.

Caramelo, F., Ferreira, N., Oliveiros, B. (2020). "Estimation of risk factors for CIVID-19 mortality – Preliminary results", medRxiv, 2020.02.24.20027268.

Cheng, Y., Luo, R., Wang, K., Zhang, M., Wang, Z., Dong, L. (2020). "Kidney disease is associated with in-hospital death of patients with COVID-19, Kidney International, 97(5), 829-838.

Dickey, A. D., & Fuller, A. W. (1979). "Distribution of the estimators for autoregressive time series with a unit root", Journal of the American Statistical Association, 74(366), 427-431.

Das, S., Ghosh, P., Sen, B., Mukho[adhyay, L. (2020). "Critical community size for COVID-19 – A model based approach to provide a rationale behind the lockdown", arXiv preprint ar Xiv:2004.03126.

Fu, L., Fei, J., Xiang, H. X., Xiang, Y., Tan, Z. X., Li, M. D., et al. (2020). "Analysis of death risk factors among 200 COVID-19 patients in Wuhan, China: A hospital based case cohort study", Analysis of death risk factors among, p. 200.

Guan, W., Ni, Z., Hu, Y., Liang, W., Ou, C., He, J., Liu, L., Shan, H., Lei, C., Hui, D. S. C., Du, B., Li, L., Zeng, G., Yuen, K.-Y., Chen, R., Tang, C., Wang, T., Chen, P., Xiang, J., … Zhong, N. (2020). Clinical Characteristics of Coronavirus Disease 2019 in 23, China. New England Journal of Medicine, 0(0), null. https://doi.org/10.1056/NEJMoa2002032

Hurlbut, B. J., (2017). "A science that knows no country: Pandemic preparedness, global risk, sovereign science", Big Data & Society, July-December (2017), 1-14.

Huang, X., Ding, A., Gao, J., Zheng, B., Zhou, D., Qi, X., Tang, R., Ren, C., Nie, W., Chi, X., Wang, J. (2020). "Enhanced secondary pollution offset reduction of primary emissions during COVID-19 lockdown in China", https://doi.org/10.31223/osf.io/hvuzy.

Jordan, R. E., Adab, P., Cheng, K. K. 92020). "COVID-19: risk factors for severe disease and death". BMJ 368, m1198.

Kim, S. H., Sherman, K. David., & Updegraff, A. J. (2016). "Fear of Ebola: The influence of collectivism on Xenophobic threat responses", Psychological Science, 27(7), 935-944.

Li, L., Liu, Y., Wu, P., Peng, Z., Wang, X., Chen, T., Wong, J. Y. T., Yang, J., Bond, H. S., Wang, L., Lau, Y. C., Zheng, J., Feng, S., Qin, Y., Fang, V. J., Jiang, H., Lau, E. H. Y., Liu, S., Qi, J., … Yu, H. (2019). Influenza-associated excess respiratory mortality in China, 2010–15: A population-based study. The Lancet Public Health, 4(9), e473–e481. https://doi.org/10.1016/S2468-2667(19)30163-X

Lippi, G., Henry, B. M. (2020). "Chronic obstructive pulmonary disease is associated with severe coronavirus disease 2019 (COVID-19)", Respiratory Medical, in press.

Lewandowsky, S., Ecker, H. K. U., Seifert, M. C., Schwarz, N., & Cook, J. (2012). "Misinformation and its correction: continued influence and successful de biasing", Psychological Science in the Public Interest, 13(3), 106-131.

Layard, R., Clark, A., De Neve, J. E., Krekel, C., Fancourt, D., Hey, N., O'Donnell, G. (2020). "When to release the lockdown? A wellbeing framework for analysing costs and benefits".

Mahato, S., Pal, S., Ghosh, K. G. (2020). "Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India", Science Total Environment, 730, https://doi.org/10.1016/j.scitotenv.2020.139086.

Martinez, L., Vega, L., Ramirez, A., Aguilar, M., Ramirez, R. (2020). "Critical review of social, environmental and health risk factors in the Mexican indigenous population and their capacity to respond to the COVID-19", Science of the Total Environment, 733, 139357.

Mondal, I., Pal, S. (2020). "COVID-19 pandemic persuaded lockdown effects on environment over stone quarrying crushing areas", Science of the Total Environment, 732, 139281.

Reuters. (2020). 2019 corona virus: The Korean clusters. Reuters. https://graphics.reuters.com/CHINA-HEALTH-SOUTHKOREA-CLUSTERS/0100B5G33SB/index.html

Report of the WHO-China Joint Mission on Corona virus Disease 2019 (COVID-19)

Ray, D., Salvatore, M., Bhattacharyya, R., Wang, L., Mohammed, S., Purkayastha, S., Halder, A., Rix, A., Barker, D., Kleinsasser, M., Zhou, Y. (2020). “Predictions, role of interventions and effects of a historic national lockdown in India's response to the COVID-19 pandemic: Data science call to arms”, medRxiv, https://doi.org/10.1101/2020.04.15.20067256.

Scroll. (2020, March 14). Is India testing enough for corona virus cases? [Text]. Scroll. In. https://scroll.in/pulse/956110/is-india-testing-enough-for-coronavirus-cases

Sullivan, S. (2018). Challenges in reducing influenza-associated mortality. The Lancet, 391(10127), 1242–1244. https://doi.org/10.1016/S0140-6736(17)33292-0.

Saadat, S., Rawtani, D., Hussain, C. M. (2020). “Environmental perspective of COVID-19”, Science Total Environment, 138870, https://doi.org/10.1016/j-scitotenv.2020.138870.

Sarwar, S., Waheed, R., Sarwar, S., Khan, A. (2020). “COVID-19 challenges to Pakistan: Is GIS analysis useful to draw solutions?, Science of the Total Environment, 730, 139089.

Tomes, N. (2010). “Destroyer and Teacher”: Managing the masses during the 1918-1919 influenza pandemic”, Public Health Reports, 2010 Supplement 3, 125, 48-62.

The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. (2020). The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19)—China, 2020. http://weekly.chinacdc.cn/en/article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51

“Understanding the COVID-19 epidemic and the demands of the peoples science movements and people's health movements”, Jan Swasthya Abhiyan & All India People's Science Network, 16th February, 2020.

Xu, H., Yan, C., Fu, Q., Xiao, K., Yu, Y., Han, D., Wang, W., Cheng, J. (2020). “Possible environment effects on the spread of COVID-19 in China”, Science of the Total Environment, 731, 139211.

Yang, G., & Zhang, H. (2020). “Challenges and countermeasure of integrative cancer therapy in the epidemic of COVID-19”, Integrative Cancer Therapies, 19(1—2), 1-14.

WHO. (2020). Q & A on corona viruses (COVID-19). https://www.who.int/news-room/q-a-detail/q-a-coronaviruses.

Wu, X., Nethery, R. C., Sabath, B. M., Braun, D., Dominici, F. (2020). “Exposure to air pollution and COVID-19 mortality in the United States”, medRxiv, https://doi.org/10.1101/2020.04.05.20054502.