ARIMA modeling and forecasting of COVID-19 in three South Asian countries - Bangladesh, India, and Pakistan

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Abstract:

The outbreak of novel coronavirus (COVID-19) attracted worldwide attention. The worldwide economy has faced serious challenges as a result, particularly the healthcare industry. Even in countries with strong healthcare systems, COVID-19's effects could not be anticipated. This work analyzes the COVID-19 spread from a unique perspective for the entire world, through 3 South Asian countries - Bangladesh, India, and Pakistan. The objective of this research is to analyze the time series data of number of new cases of COVID-19 for 3 South Asian countries (Bangladesh, India, and Pakistan). The ARIMA model has been chosen to fit in order to fulfill the objectives of this study. For Bangladesh, the selected model is ARIMA (7,1,5), for India, is ARIMA (9,1,6) and for Pakistan, is ARIMA (3,1,3). Forecasting has been done using these models. As a result of our forecasting, it has been investigated that within the next six months, the COVID-19 will be under control for three countries. But, there will initially be a minor increase in the number of instances in Bangladesh and Pakistan. In India, the situation is more or less stable.

1. Introduction:

In December 2019, the corona pandemic originated in Wuhan, China from which the virus made its journey to the whole world. Within four months, on 11th March 2020, it was declared a pandemic by the World Health Organization[1]. This highly contagious virus has affected 582 million people worldwide and claimed 6.41 million lives in almost three years[2]. The earlier instances of coronavirus which have caused serious and fatal diseases in people and have been around the world for two decades are Severe Acute Respiratory Syndrome (SARS-CoV), Middle East Respiratory Syndrome (MERS-CoV)[3]. Although SARS-CoV and MERS-CoV have higher fatality rates than SARS_CoV-2 or COVID-19, SARS-CoV-2 spreads more easily among people causing a way higher number of cases and a very alarming number of overall deaths[4]. The confusion about how to deal with this new variant of coronavirus and the lack of proper measures in the initial stages of the outbreak worsened the situation tenfold and all the countries have been suffering from the consequences. Although several vaccines have been developed 12.3 billion shots of vaccine have been given all around the world[2], new variants of COVID-19 such as Alpha, Beta, Gamma, Delta, Omicron, etc. keep wreaking havoc with new surges or waves[5]. The COVID-19 virus is very contagious and results in respiratory collapse, which results in death. Due to the difference in epidemiological conditions and testing facilities, the spread of the virus varies from country to country[6].

In Bangladesh, the first case of COVID-19 was reported on 8th March 2020 and the spread in Bangladesh was quite rapid. As the spread of the virus increased and the cases became severe, the Government of Bangladesh imposed a complete lockdown to contain the spread of the virus. The first lockdown was announced on 26 March 2020 which was extended for 66 days till the end of May (31 May 2020). Observing the miseries of the daily wage earners and the collapse of the industries and overall economy, all kinds of restrictions were withdrawn from public movements and activities on September 1[7]. In India, the first case of COVID-19 was observed on 30th January 2020 although the spread in India was extremely slow. The timeline of the lockdown imposed by the Government of India (24 March 2020- 31 May 2020) was quite similar to the timeline of the lockdown in Bangladesh[8]. Meanwhile, in Pakistan, the first reported case of COVID-19 was on 5th February 2020. The timeline of the nationwide lockdown in Pakistan was from 1st April 2020 to 9th May 2020[9].

Governments of different countries claim to be increasing their medical and testing facilities and they are in fact doing massive vaccination programs to fight against COVID-19 pandemic. But the new variants of this virus and new waves every now and then are hard to keep up. To know the estimated number of infections, the estimated number of deaths, the estimated effect of this on the economy etc., estimating the COVID-19 outbreak's spread is crucial. It helps the Government, the medical personnel and the mass people in general to stay alert and prepared to deal with the change of the pandemic situation.

In this project, we have used Integrated Auto Regressive Moving Average (ARIMA) model to investigate the trends of COVID-19 and predict the incidence and spread of COVID-19 in these three South Asian countries- Bangladesh, India, and Pakistan.

1.1. Objective of the study:

1. To fit the ARIMA model by using the data of number of new cases of COVID-19.

2. To make a comparison and analysis of time series data for 3 South Asian countries (Bangladesh, India, Pakistan) affected by COVID-19, based on the ARIMA model.

3. To predict the COVID-19 dynamics by using fitted ARIMA models for next six months.

1.2. Literature Review:

In the past few decades, there has been numerous research focused on statistical issues pertaining to a prospective detection of outbreaks of infectious diseases. The challenges arise in early detection and possible evolution of the epidemic for taking the appropriate preventive measures. In past two years, an increasing body of literature has tried to forecast the incidence and prevalence of COVID-19 pandemic by using different approaches, such as the ARIMA (Benvenuto et al., 2020; Chakraborty and Ghosh, 2020;1 Ribeiro et al., 20202, Singh et al., 2020), the exposed-identified-recovered (EIR) model (Xiong and Yan, 2020), the susceptible exposed-infected-recovered (SEIR) model (Wu et al., 2020), the segmented Poisson model (Zhang et al., 2020), the SIDARTHE3 model (Giordano et al., 2020), the susceptible-infected-recovered (SIR) model (Nesteruk, 2020), the SIR/death model (Anastassopoulou et al., 2020; Fanelli and Piazza, 2020), and mathematical methods based on travel volume (Tuite et al., 2020).

In this study, we want to make a comparison and analyze the time series data of number new cases of COVID-19 of 3 South Asian countries (Bangladesh, India and Pakistan) which are in the same geographical area.

There have been many studies on the forecasting and disease modeling using ARIMA framework, such as-

Chen S. et al. (2022) predicted the incidence of pulmonary tuberculosis by establishing the ARIMA model and providing support for pulmonary tuberculosis prevention and control during COVID-19 pandemic. In this study, they analyzed the characteristics of time, region and population distribution, epidemic trend and incidence prediction of tuberculosis in Anhui province. The ARIMA model can be a useful tool for predicting future TB cases[10].

Cihan (2021) used the ARIMA time series method to estimate how many people will be fully vaccinated against COVID-19 during the course of the next ten days in the US, Asia, Europe, Africa, South America, and the rest of the world. The most effective ARIMA models were chosen. They stated that their future goal of study is to forecast the number of fully vaccinated people in the future with deep learning time series models[11].

Ceylan (2020) estimated the prevalence of COVID-19 in Italy, Spain, and France, where the virus spreads fastest and causes tragic results. They presented the situation of the COVID-19 pandemic and they estimated by the ARIMA model. The results of their analysis can shed light on understanding the trends of the outbreak and give an idea of the prediction of COVID-19 prevalence trends of those countries which can help take precautions and policy formulation for this epidemic in other countries[12].

Wang et al. (2019) aimed to investigate the specific epidemiological characteristics and epidemic situation of brucellosis in Jinzhou City of China. The ARIMA models have been successfully established here which is suitable for predicting and practicable for forecasting the incidence of brucellosis in Jinzhou[13].

He and Tao (2018) explores the epidemiology of several influenza viruses among youngsters in Wuhan, China. Their research reveals that the ARIMA model can be used to predict the likelihood that certain influenza virus strains will provide a positive test result. Young children are more likely to develop influenza and test positive for it, which places a significant strain on families and society[14].

Michael J Kane et al. (2014) applied ARIMA and Random Forest time series models to incidence data of outbreaks of highly pathogenic avian influenza (H5N1) in Egypt. Together with demonstrating the similarity between bird and human epidemics (Rabinowitz et al. 2012), offers a fresh strategy for forecasting these potentially lethal outbreaks in bird populations using current, publicly available data[15].

Ren et al. (2013) did a time series analysis which demonstrated a seasonal pattern of hepatitis E infection in Shanghai, China. An ARIMA-BPNN combined model was used to describe the linear and nonlinear patterns of the time series data. This model effectively forecasts hepatitis E infection[16].

Liu et al. (2011) found that ARIMA models applied to historical HFRS incidence data are an important tool for HFRS surveillance. Their modeling approach can be used to monitor and predict HFRS incidence in China. This ARIMA model could also be used to optimize HFRS prevention by providing estimates on HFRS incidence trends in China[17].

Earnest et al. (2005) developed ARIMA model by using the number of beds occupied during the SARS outbreak. They found that three-day forecasts provided a reasonable prediction of the number of beds required during the outbreak ARIMA models. They also concluded that the model could be used in planning for bed-capacity during outbreaks of other infectious diseases, as well as predicting requirements for other critical resources[18].

The above discussion revealed that no prior research has been conducted regarding three South Asian countries (Bangladesh, India and Pakistan) by using fitting the ARIMA model and forecasting. So, to fill up this literature gap, the present study has been conducted. Despite being an academic study, the current research provides information on these three countries' COVID-19 policies.

1.3.Data:

Data on daily new COVID-19 cases in Bangladesh, India, and Pakistan from each country's initial COVID-19 case up to June 29, 2022 was taken from the website “Our World in Data (https://ourworldindata.org/)”. This data was used to plot daily new cases against time points. This also used for fitting the ARIMA model and also for forecasting next 6 months (184 days) of daily new cases of COVID-19 for respective countries.

1.4.Methodology:

1.4.1. Introduction:

The study's methodological section is presented in this section. Here, we have talked about the theories used to build models and formulate predictions.

1.4.2. Autoregressive Integrated Moving Average (ARIMA) Model:

A suitable degree of differencing can be used to convert a homogeneous nonstationary time series into a stationary time series. Because the autoregressive moving average models are helpful for describing stationary time series, in this section we talked about how to use differentiation to create a broad class of time series models called autoregressive integrated moving average models, which are helpful for describing a variety of homogeneous nonstationary time series. **[Time Series Analysis, Second Edition, William W.S.Weil]**

1.4.2.1. An Autoregressive Process

Let Y_t represent total case at time t. If we model Y_t as

$$(Y_t - \delta) = \alpha_1(Y_{t-1} - \delta) + u_t$$

where δ is the mean of Y and where u_t is an uncorrelated random error term with zero mean and constant variance σ_2 (i.e., it is white noise), then we say that Y_t follows a first order autoregressive, or AR(1), stochastic process. Here the value of Y at time t depends on its value in the previous time period and a random term; the Y values are expressed as deviations from their mean value. In other words, this model says that the forecast value of Y at time t is simply some proportion (=α_1) of its value at time (t-1) plus a random shock or disturbance at time t, again the Y values are expressed around their mean values. But if we consider this model,

$$(Y_t - \delta) = \alpha_1(Y_{t-1} - \delta) + \alpha_2(Y_{t-2} - \delta) + u_t$$

then we say that $Y_t$follows a second-order autoregressive, or AR(2), process. That is, the value of Y at time t depends on its value in the previous two time periods, the Y values being expressed around their mean value δ. In general, we can have

$$(Y_t - \delta) = \alpha_1(Y_{t-1} - \delta) + \alpha_2(Y_{t-2} - \delta) + \cdots + \alpha_p\left(Y_{t-p} - \delta\right) + u_t$$

in which case Y_t, is a pth-order autoregressive, or AR(p), process.

[Gujarati D.N.,Basic Econometrics, 3rdedition]

1.4.2.2. A Moving Average Process

The AR process just discussed is not the only mechanism that may have generated Y. Suppose we model Y as follows:

$$Y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1}$$

Where μ is a constant and μ, is the white noise stochastic error term. Here Y at time t is equal to a constant plus a moving average of the current and past error terms. Thus, in the present case, we say that Y follows a first-order moving average, or an MA(1), process.

But if Y follows the expression

$$Y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2}$$

Then it is an MA(2) process. More generally,

$$Y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \cdots + \beta_q u_{t-q}$$

Is an MA(q) process. In short, a moving average process is simply a linear combination of white noise error terms. **[Gujarati D.N., Basic Econometrics, 3rd edition]**

1.4.2.3.Autoregressive Moving Average Process

It is quite likely that Y has characteristics of both AR and MA and is therefore ARMA. Thus, Y_t follows an ARMA (1, 1) process if it can be written as

$$Y_t = \theta + \alpha_1 Y_{t-1} + \beta_0 u_t + \beta_1 u_{t-1}$$

Because there is one autoregressive and one moving average term. Where,θ represents a constant term.In general, in an ARMA (p,q) process, there will be p autoregressive and q moving average terms. **[Gujarati D.N.,Basic Econometrics, 3rd edition]**

1.4.2.4.Autoregressive Integrated Moving Average (ARIMA) Process

The time series models are based on the assumption that the time series involved are (weakly) stationary. Briefly, the mean and variance for a weakly stationary time series are constant and its covariance is time-invariant. But we know that many economic time series are nonstationary, that is, they are integrated. But if a time series is integrated of order 1 [i.e., it is I(1)], its first differences are I(0), that is, stationary. Similarly, if a time series is I(2), its second difference is I(0). In general, if a time series is I(d), after differencing it d times we obtain an I(0) series. Therefore, if we have to difference a time series d times to make it stationary and then apply the ARMA (p, q) model to it, we say that the original time series is ARIMA (p, d, q), that is, it is an autoregressive integrated moving average time series, where p denotes the number of autoregressive terms, d the number of times the series has to be differenced before it becomes stationary, and q the number of moving average terms. Thus, an ARIMA(2,1,2) time series has to be differenced once (d=1) before it becomes stationary and the (first-differenced) stationary time series can be modeled as an ARMA (2, 2) process, that is, it has two AR and two MA terms. Of course, if d = 0 (i.e., a series is stationary to begin with), ARIMA (p, d=0, q). Note that an ARIMA (p, 0, 0) process means a purely AR (p) stationary process; an ARIMA (0,0, q) means a purely MA(q) stationary process.

1.4.2.5. Steps in ARIMA modeling

1. Verify that the times series is stationary as the first step. To do this, plot the series graphically or use the Augmented Dicky Fuller Test (ADF).
2. Model identification is step two. From the plots of the partial autocorrelation function (PACF) and autocorrelation function (ACF), the AR and MA terms can be derived graphically.
3. Using the least squares method, ARIMA parameters are calculated. AIC values are used to determine which model is the best.
4. The residual analysis has been completed.
5. Based on data an out-of-sample forecast is made. A 6 months (184 days) projection is made out from June 30, 2022 to December 30, 2022.
6. The process is repeated for the Bangladesh, India, Pakistan to verify the model's specifications and forecasting precision for the 3 South Asian countries. [6]

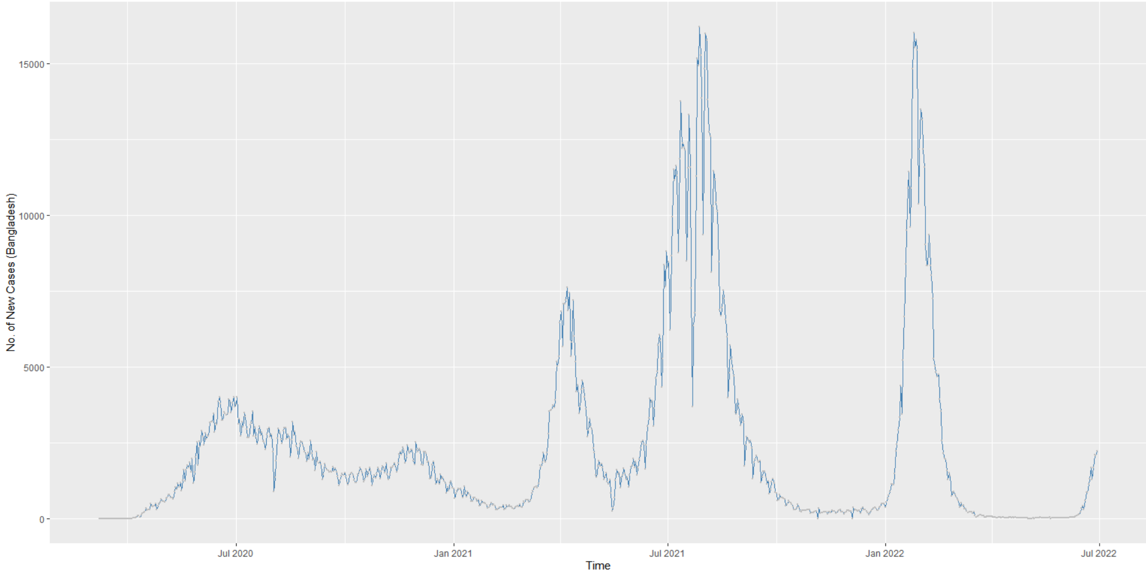
1.5.Analysis:

Analyses were done with the help of two statistical softwares - R & STATA. The stationary check was conducted using STATA and ARIMA model was fitted using ‘tseries’ and ‘forecast’ package. Plots drawn for trend analysis were done with ‘ggplot2’ package. A *p*-value of less than 0.05 was considered statistically significant.

2. Trend Analysis of new cases of COVID-19 in Bangladesh, India and Pakistan:

2.1. Analysis of COVID-19 trend of daily new cases in Bangladesh

Figure 2.1.a. Plot of daily new cases of COVID-19 in Bangladesh



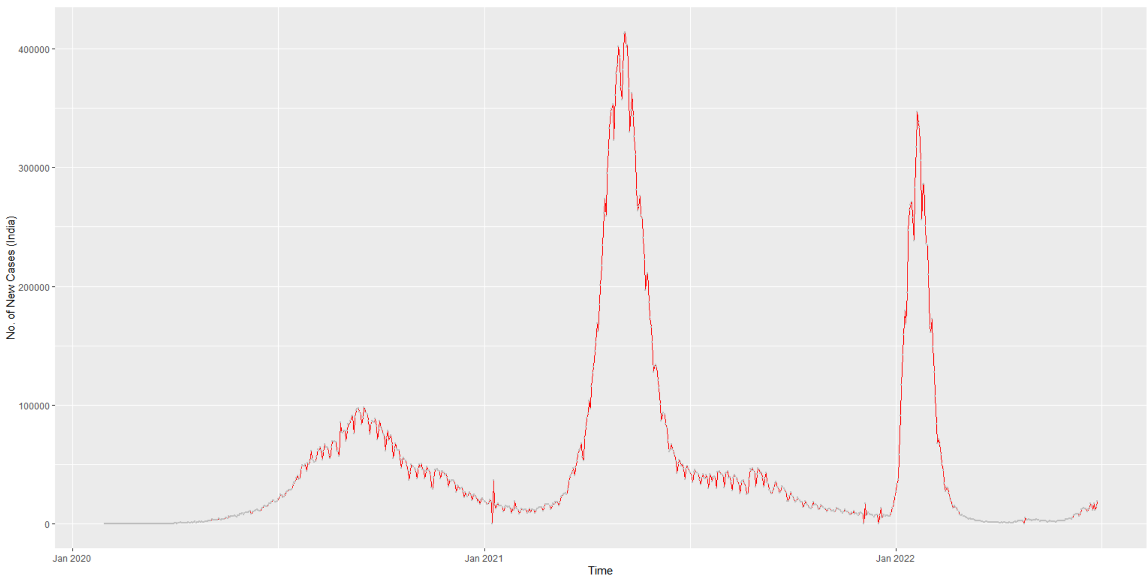
From figure 2.1.a, we see that on March 8, Bangladesh confirmed its first three initial instances of coronavirus infection (COVID-19). It is anticipated that the virus would continue to spread for an extended period of time, after which the total number of confirmed cases rose dramatically. In reaction to the COVID-19 epidemic, the Government of Bangladesh issued extraordinary "general leave" from 26 March to 30 May 2020, under the term "lockdown," and extended it seven times[19]. However, the shutdown did not significantly reduce the spread of disease. This figure (2.1.a) shows that after the first high in July 2020, the number of cases decreased, with a little increase in December 2020 followed by a decline. But unfortunately, beginning in early March 2021, the number of reported cases increased dramatically. Also, we can see that around the time of July, 2021 Bangladesh's maximum daily new case, 16230, was registered. After reaching the highest peak point, the number of active cases had declined. Following that, the figure (2.1.a) of daily numbers of new cases showed a positive downward trend until January 2022, when they began climbing again and reached their second peak with 16032 daily new instances. However, this trend of escalation did not continue after that. This figure(2.1.a) shows that the number of new cases per day plummeted and rapidly settled into a stable rhythm that will persist until

June 6, 2022 and the number of new cases per day has been slightly increasing since then[20].

Several measures have been taken by the government to combat the COVID-19 pandemic in Bangladesh, including screenings, rescues, and lockdowns, restrictions on local and international air travels, and online learning instead of on campus learning which can be seen in the figure. Despite this, COVID-19 was hard to predict since it was a new experience for all of us. As a result, a developing country like Bangladesh, a humanitarian crisis is likely to arise during a pandemic, and they performed well at preventing it.

2.2. Analysis of COVID-19 trend of daily new cases in India

Figure 2.2.a. Plot of daily new cases of COVID- 19 in India



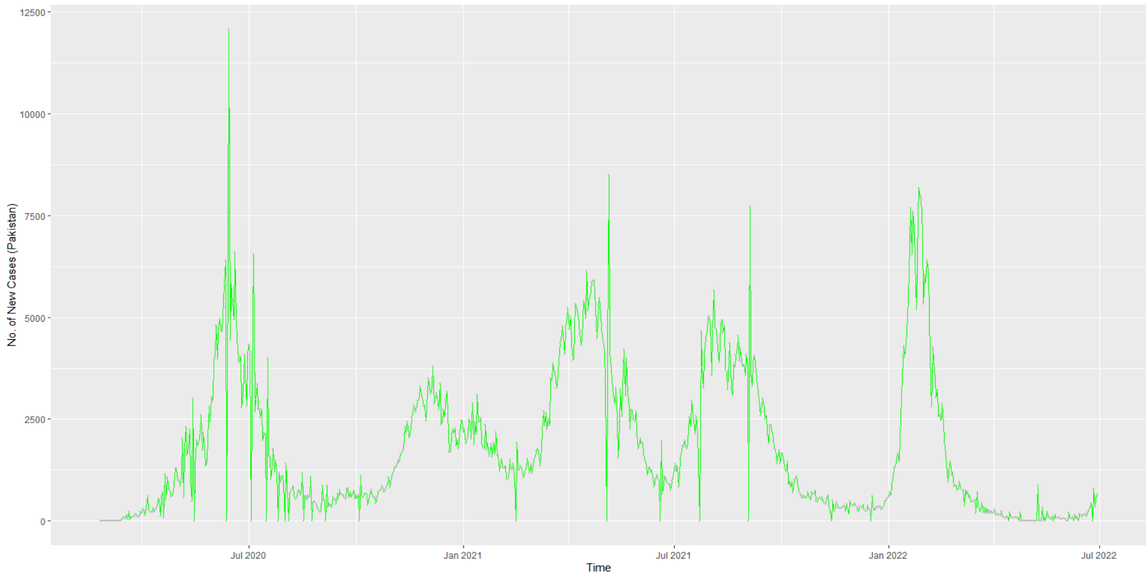
From figure 2.2.a, we see that COVID-19 hit India pretty early on 2020. The first case was reported at the end of January. Keeping a low profile for quite a few days, COVID-19 surged forward fast. Indian government employed almost 2 month wide national lockdown starting from March 24, 2020 in attempt of controlling the rapid spread of this virus[8]. Which perhaps helped slowing down the spread but daily new cases kept rising everyday nonetheless. Almost after a year, at the beginning of 2021, new COVID-19 cases started to go down as seen in the figure (2.2.a). But unfortunately, within a few months COVID-19 cases reached a new peak. India's record daily new case, 414188 was recorded around that time. After that the figure

(2.2.a) of daily new cases started showing a hopeful decreasing pattern until 2022. At January cases started rising again and increased very fast and reached almost 350000 daily new cases. Fortunately, this increasing pattern didn't last after that. Daily new cases dived downwards and reached a stable pattern soon which was noticeable until June 29, 2022 from this figure (2.2.a).

The figure (2.2.a) shows that the Indian government did struggle with the unpredictable rise and fall of this virus. However, COVID-19 being a new virus, it was hard to predict its patterns. On the basis of on-going researches, new measures were taken to prevent it every now and then. So, a country as populated as India did a pretty good job despite the occasional high rises of new cases.

2.3.Analysis of COVID-19 trend of daily new cases in Pakistan

Figure 2.3.a. Plot of daily new cases of COVID-19 in Pakistan



From figure 2.3.a, we see that on February 26, 2020, Pakistan revealed its first two confirmed instances. This was connected to Iran's travel history[21]. Out of the 471 suspected cases, there were a total of 20 confirmed cases (COVID-19 Positive) within fifteen days, with the province of Sindh having the greatest number of cases, followed by Gilgit Baltistan. And then the number of these cases is rising quickly, making matters worse[22].

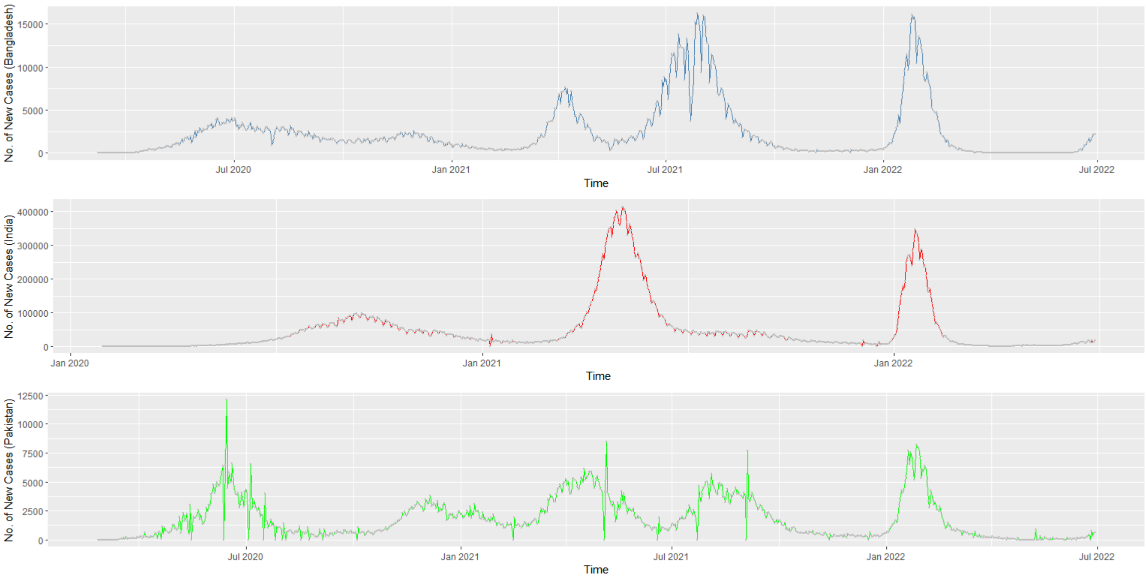
A nationwide lockdown was imposed on the nation beginning on April 1 and continued twice more until May 9. After it was over, the lockdown was gradually lifted[6].

From figure 2.3.a, we fail to identify distinct wave patterns. However, experts divided the pattern in three COVID-19 waves in Pakistan thus far for ease of analysis. According to figure 2.3.a, the first COVID-19 wave in the country started in late May 2020 and peaked in mid-June when daily new confirmed case numbers reached high point with the number of 12073, then ended in mid-July[23].The COVID-19 situation in Pakistan improved after the initial wave, and the country's testing positivity rates stabilized at low levels. However, the figure 2.3.a shows that in early November 2020, cases started to increase once more, reaching a peak with the second wave in the nation. To the extent of figure 2.3.a in February 2022, figure 2.3.a gives us again a higher number of new confirmed cases and since then it is diminished to get reduced.

Six months after reporting the first case, the Pakistani government's efforts have resulted in a steady decline in new cases[24]. International organizations, including the WHO, have praised Pakistan's government for taking the necessary precautions and measures against the COVID-19 pandemic to ensure not only the containment of disease spread but also that the government's duty to its citizens and their safety has been fulfilled[25].

2.4. Comparison of COVID-19 trends of daily new cases in Bangladesh, India and Pakistan

Figure 2.4.a. Plots of daily new cases of COVID-19 in Bangladesh, India and Pakistan (Top to bottom)



The figure 2.4.a shows that although COVID-19 is still prevailing in all three countries, the first attack of this virus happened at different times in different countries. In Bangladesh first case of COVID-19 was reported on March 8, 2020. In India and Pakistan, first cases of COVID-19 were reported on January 30, 2020 and February 25, 2020 respectively. If we compare the daily new cases of COVID-19 in these three countries, from the figure (2.4.a) we can see three approximate COVID-19 waves in Bangladesh and India. But in Pakistan there are a lot of wave-like patterns so we cannot determine any distinct number of COVID-19 waves. This indicates that, comparing to Bangladesh and India, Pakistan government is somehow struggling to keep the COVID-19 situation under control.

3. Analysis of the new cases of COVID-19 in Bangladesh, India and Pakistan using ARIMA model with interpretation:

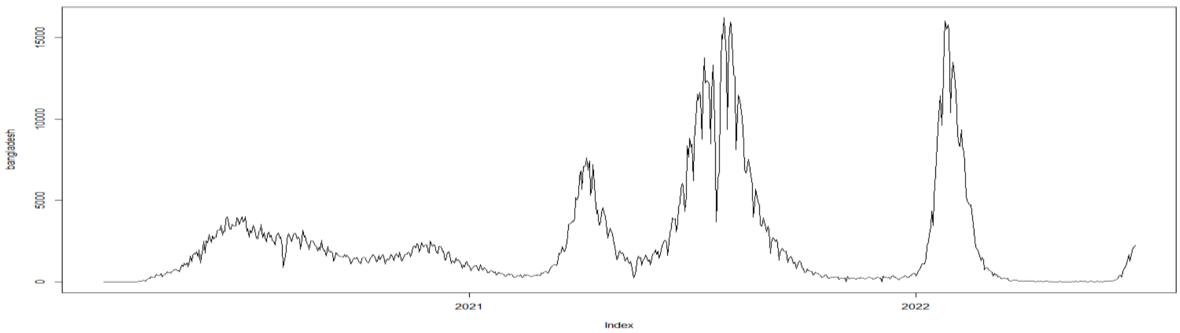
For analyzing the data, which consists of new cases of COVID-19 in Bangladesh from March 8, 2020 to June 29, 2022, in India from January 30, 2020 to June 29, 2022 and in Pakistan from February 25, 2020 to June 29, 2022, we have selected the best fitted models for three countries.

3.1. Bangladesh:

3.1.1. Analyzing the plot of the series:

At first we plot our data, where the variable new cases is plotted against time period. It is represented in figure (3.1.1.a).

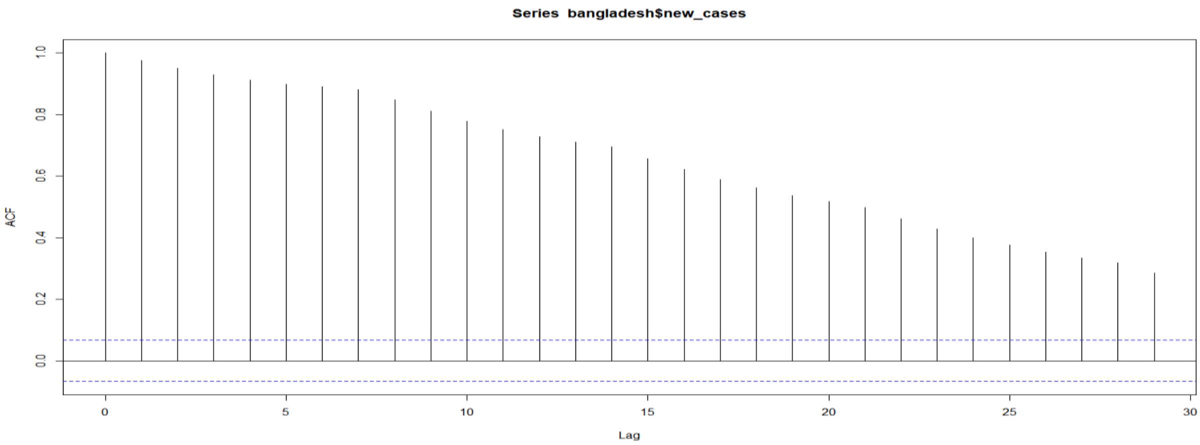
Figure 3.1.1.a. Plot of daily new cases of COVID-19 in Bangladesh against time period from March 8, 2020 to June 29, 2022



From figure 3.1.1.a, we see that there is no obvious increasing or decreasing trend in the plot of new cases of COVID-19 in Bangladesh. Also, we can conclude that, the data is not stationary.

We can also check the ACF plot for the data to see our observation was correct or not (shown in figure 3.1.1.b).

Figure 3.1.1.b. ACF Plot of the time series data (daily new cases of COVID-19 in Bangladesh)



In the ACF plot given in the figure 3.1.1.b, we can see that all the lags are outside the confidence band, that is, indicates non-stationarity.

3.1.2. Checking Stationarity:

After detection of non-stationarity of the data from the plot in the section above, we do a diagnosis of stationarity. This diagnosis can be accomplished with the help of Dickey-Fuller or Augmented Dickey-Fuller (ADF) tests. So, we perform Unit-root (ADF) test to check the stationarity of new cases of COVID-19 data in Bangladesh.

Table 3.1.2.A. Unit-root (Augmented Dickey-Fuller) Test Results

Dickey-Fuller test for unit root			Number of obs = 843	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.254	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.0741				

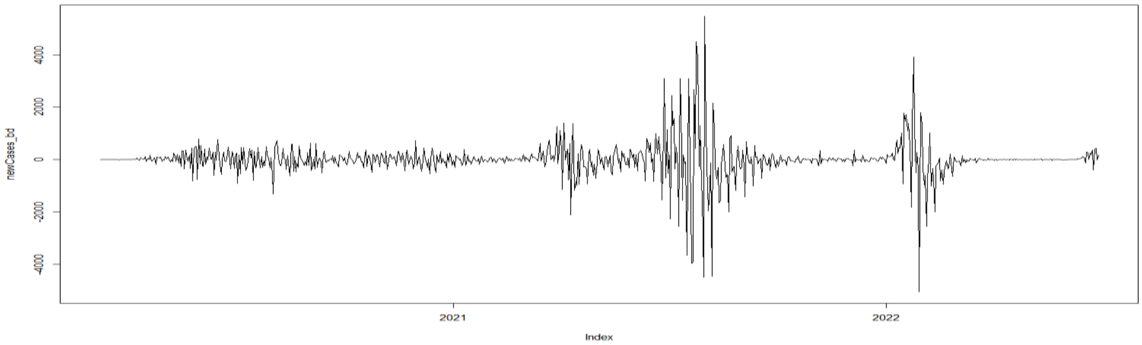
The Dickey-Fuller test results appeared as shown in table 3.1.2.A. To test stationarity, we focus on only two values of the result; Z(t) and Mackinnon p-value for Z(t). For a time series data to be stationary, the Z(t) should have a large negative number, p-value should be significant at least on 5% level of significance. Neither of these conditions is met in this test. Therefore, null hypothesis i.e. time series data is non-stationary, cannot be rejected.

As this time series is non-stationary, further analysis cannot be performed on it.

3.1.3. Making data Stationary:

From the diagnosis of stationarity, we see that the data is non-stationary. So we take first difference to see if this has any impact on the stationarity of the data or not. After taking first difference the plot of the data indicates stationarity (given in the figure 3.1.3.a).

Figure 3.1.3.a. Time series plot (daily new cases of COVID-19 in Bangladesh against time period) after taking first difference



To confirm stationarity further, we do the Unit-root (Augmented Dickey-Fuller) test like before.

Table 3.1.3.A. Unit-root (Augmented Dickey-Fuller) Test Results after taking first difference

Dickey-Fuller test for unit root			Number of obs = 842	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-28.228	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.0000				

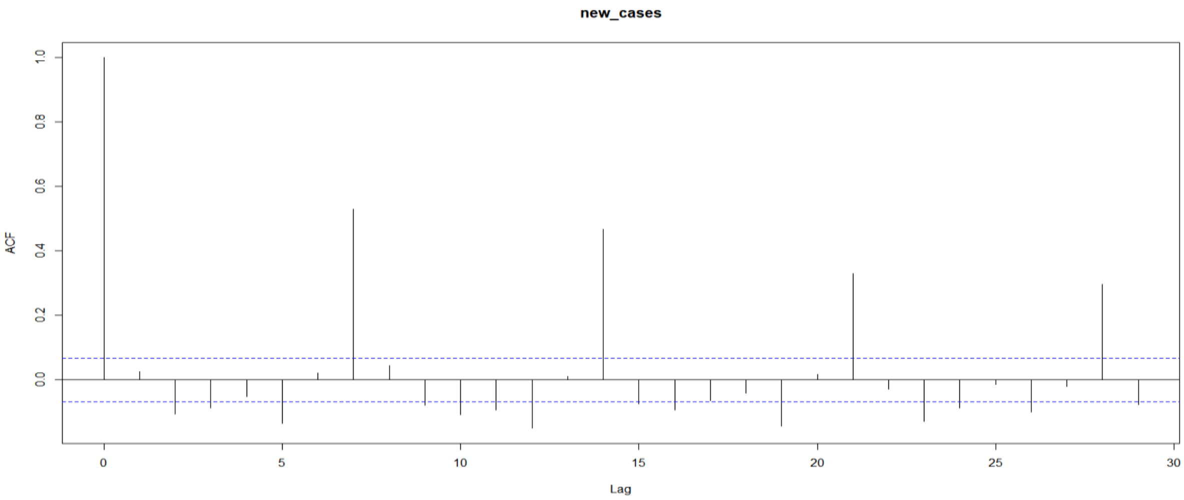
The Dickey-Fuller test results appeared as shown in table 3.1.3.A. For a time series data to be stationary, the Z(t) should have a large negative number, p-value should be significant at least on 5% level of significance. Here both of these conditions is met in this test. Therefore, null hypothesis i.e. time series data is non-stationary, is rejected. And since the time series new cases is stationary, further analysis can be performed on it.

3.1.4. Determining appropriate ARIMA model for Bangladesh:

We have found in the previous section 3.1.3 that the data of new cases of COVID-19 in Bangladesh become stationary at first difference. Hence our integration parameter is d = 1 for this type.

Now from the ACF plot of the differenced values of new cases shown in the figure 3.1.4.a, we consider lags 2, 5, and 7 for the MA model. We are ignoring higher-ordered lags (10+) to avoid complications in the model.

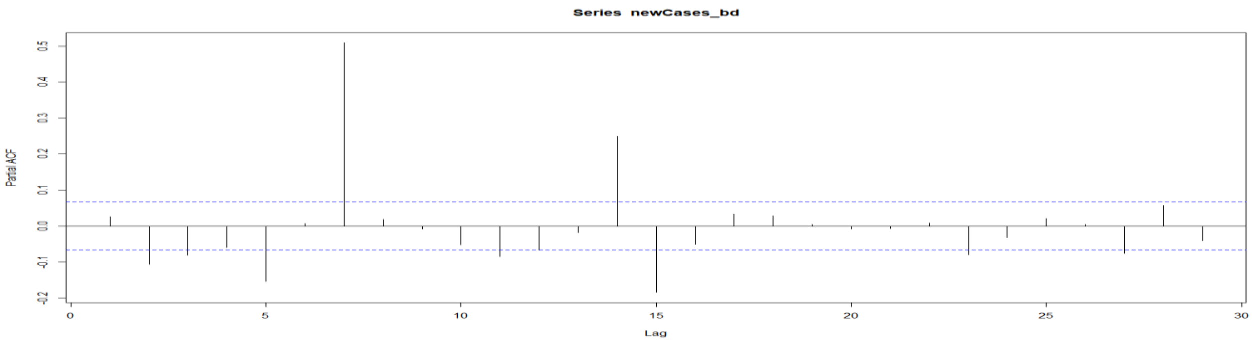
Figure 3.1.4.a. ACF plot of the time series data (daily new cases of COVID-19 in Bangladesh) after taking first difference



So we have considered MA (2), MA(5) and MA(7).

Again, from the PACF plot of the differenced values of new cases shown in the figure 3.1.4.b, we consider lags 2, 5, and 7 for the AR model. We are ignoring higher-ordered lags (10+) to avoid complications in the model.

Figure 3.1.4.b. PACF plot of the time series data (daily new cases of COVID-19 in Bangladesh) after taking first difference



So, we have considered AR(2), AR(5) and AR(7) models.

To select the best model amongst the plausible models, we can use the Alkaike's Information Criterion (AIC), proposed by Akaike(1974). The AIC is given by,

$$AIC = -2\log L + 2m$$

Where, L is the maximum likelihood and m is the number of terms estimated in the model. We choose the best model that has the minimum AIC values as well as the highest log likelihood values.

Table 3.1.4.A: The AIC values for ARIMA(p,1q) for new cases of COVID-19 in Bangladesh

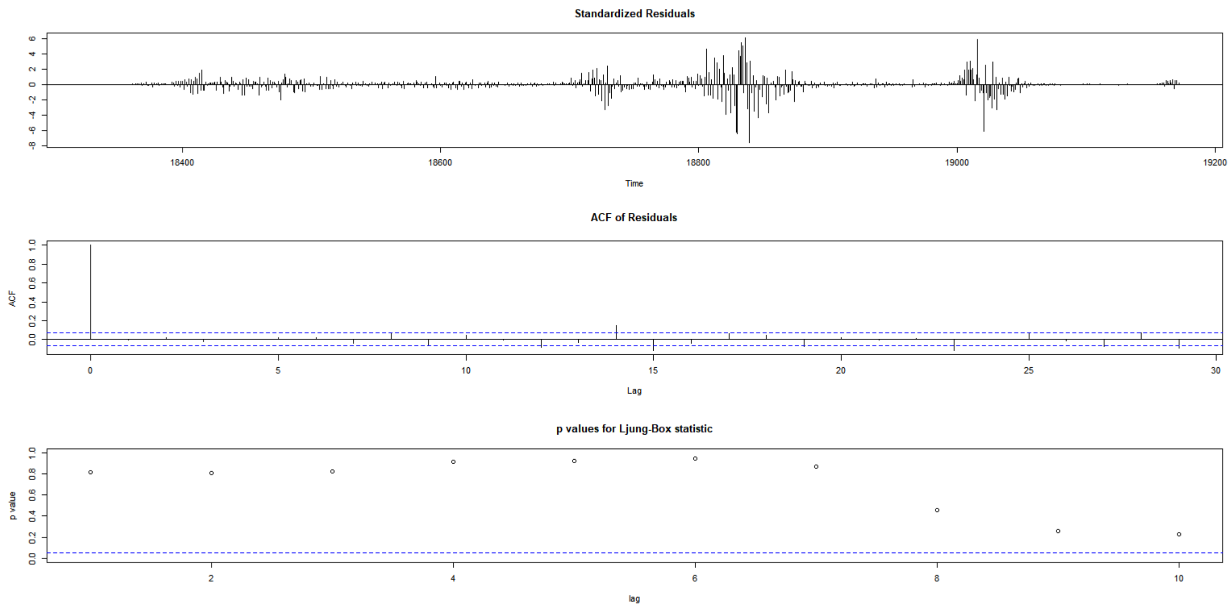
Model	Log-Likelihood	AIC
ARIMA(2,1,2)	-6662.090	13334.18
ARIMA(5,1,2)	-6636.219	13288.44
ARIMA(7,1,2)	-6566.821	13153.64
ARIMA(2,1,5)	-6665.743	13347.49
ARIMA(5,1,5)	-6582.015	13186.03
ARIMA(7,1,5)	-6556.733	13139.47
ARIMA(2,1,7)	-6617.749	13255.50
ARIMA(5,1,7)	-6579.584	13185.17
ARIMA(7,1,7)	-6535.257	13100.51

From table 3.1.4.A, we can see that ARIMA (7,1,7) has the lowest AIC and log-likelihood value. But this model has too many parameters. So we select the model with the second lowest AIC value and log-likelihood value, which is ARIMA (7,1,5) model. This model also has a much higher number of parameters, but for the lack of a better model with lower parameters, we select this model to proceed further.

3.1.5. Diagnosis of the residuals:

To see if our fitted model is good or not, we do the diagnostic test which gives the result given in the figure 3.1.5.a.

Figure 3.1.5.a. Residual analysis of ARIMA (7,1,5) model

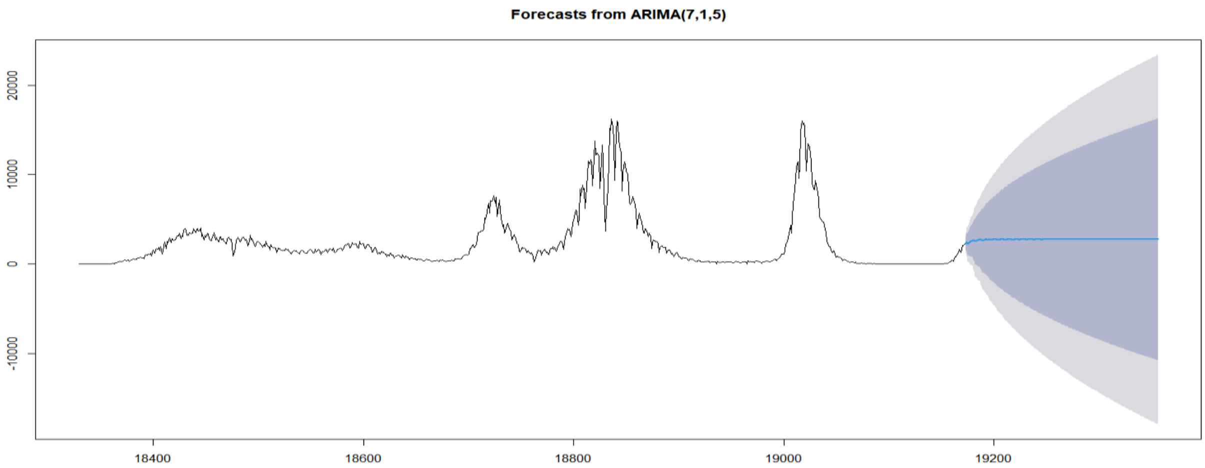


The first part (Standardized Residuals) of figure 3.1.5.a shows that our residuals look like they are white noise so the series should be stationary and modeled correctly.
The ACF plots of residuals are within the confidence band shown in the second part (ACF of Residuals) of the figure 3.1.5.a, suggesting no autocorrelation, that is, independence in the observations.
The null hypothesis of the Ljung-Box test is that there is no autocorrelation in the errors. In the third part (p values for Ljung-Box statistic) of the figure 3.1.5.a, the p-value of the Ljung-Box test is above chosen confidence level (higher p-value) indicates that we have no evidence against the null hypothesis of no autocorrelation. That means, we accept our null hypothesis at 5% level of significance. So, our fitted model, ARIMA (7, 1, 5) is valid for the dataset.

3.1.6. Forecasting:

The following figure shows the forecasted values of new cases of COVID-19 in Bangladesh using ARIMA (7,1,5). 6 months (184 days) ahead of the series has been considered for forecasting and both 80% and 95% confidence interval has been employed in forecasting.

Figure 3.1.6.a. Forecast from ARIMA (7,1,5)



Forecasting points estimates by making necessary adjustments based on the information on new cases is given in Appendix, table 3.1.6.A

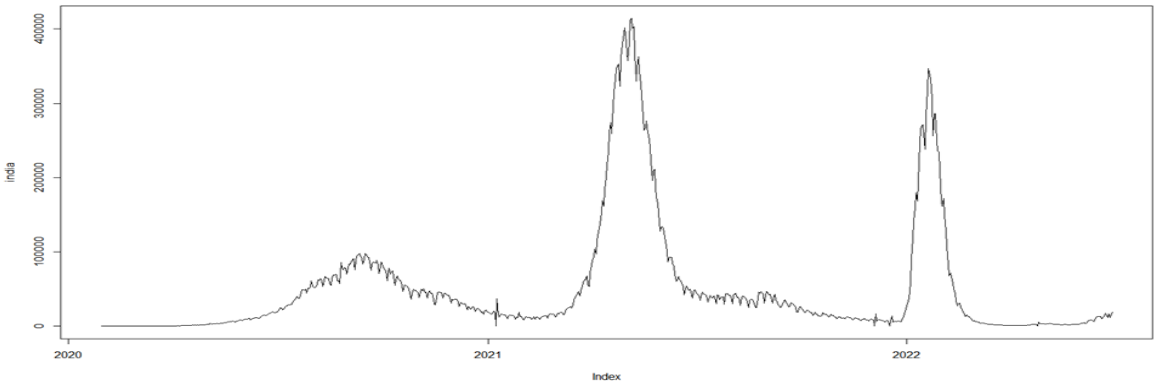
Both figure 3.1.6.a and the table 3.1.6.A we see that, the number of daily new cases there will be slight rise and fluctuation in the number of cases for almost 3 months and then stops increasing and reaches a stable condition. So we can say that, after six months, daily new cases of COVID-19 in Bangladesh will be under control. This can be said on the basis of our data analysis.

3.2. India:

3.2.1. Analyze the plot of the series:

Our data is first shown, with the variable new cases plotted against time. This is represented in figure 3.2.1.a.

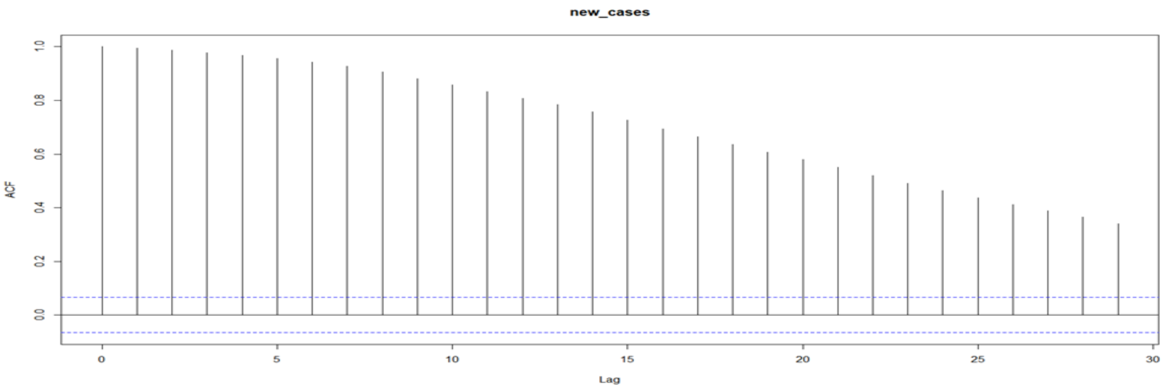
Figure 3.2.1.a. Plot of daily new cases of COVID-19 in India against time period from January 1, 2020 to June 29, 2022



We can draw the conclusion that the data are not stationary.

To determine whether our observation was accurate or not, we may also look at the ACF plot of the data.

Figure 3.2.1.b. ACF Plot of the time series data (daily new cases of COVID-19 in India)



Here, all the lags are outside the confidence band indicates non-stationarity.

3.2.2. Checking Stationarity:

Here, we use Unit-root (ADF) test to check the stationarity of new cases of COVID-19 data in India. The ADF test results appeared as shown in table 3.2.2.A.

Table 3.2.2.A. Unit-root (Augmented Dickey-Fuller) Test Results

Dickey-Fuller test for unit root			Number of obs = 843	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.521	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.8219				

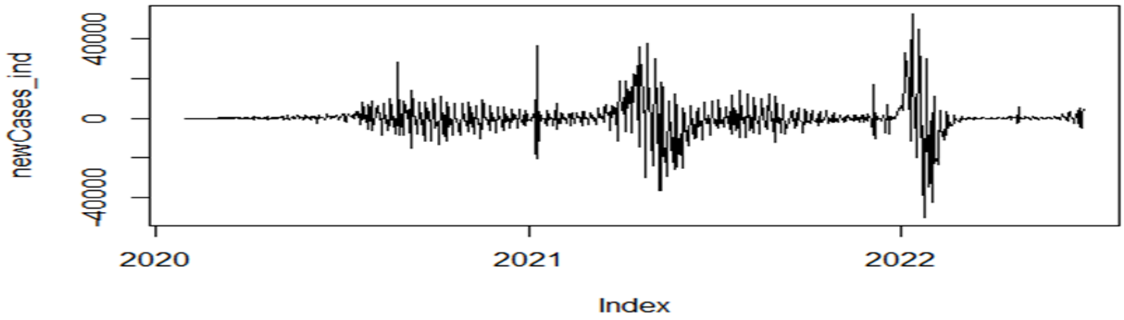
This test shown in Table 3.2.2.A fails to satisfy necessary requirements (large negative z(t) and significant p value) for stationarity. Therefore, null hypothesis i.e. time series data is non-stationary, cannot be rejected at 5% level of significance. So, further analysis on the time series new cases cannot be done.

3.2.3. Making data Stationary:

To determine whether this has any effect on the data's stationarity, we take the first difference.

The data plot after the first difference shows stationarity is given in figure 3.2.3.a.

Figure 3.2.3.a. Time series plot (daily new cases of COVID-19 in India against time period) after taking first difference



We repeat the ADF test to further verify stationarity. The ADF test results appeared as shown in figure 3.2.3.b.

Table 3.2.3.A. Unit-root (Augmented Dickey-Fuller) Test Results after taking first difference

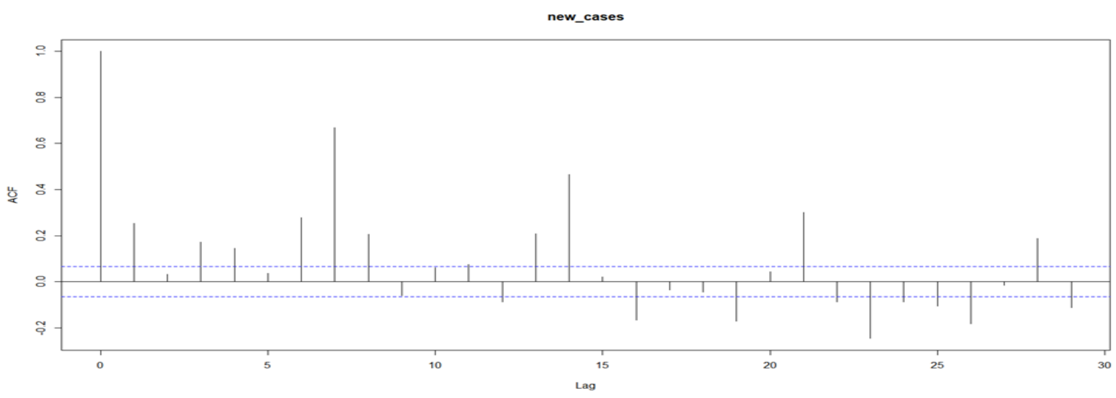
Dickey-Fuller test for unit root			Number of obs = 842	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-22.878	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.0000				

Both of the requirements (mentioned earlier) are satisfied in this test in table 3.2.3.A.. Therefore null hypothesis i.e. time series data is non-stationary, is rejected at 5% level of significance. So, further analysis can be done on the time series new cases.

3.2.4. Determining appropriate ARIMA model for India:

The data of new COVID-19 cases in India became stationary at the first difference. Hence our integration parameter is d = 1 for this type. Now from the ACF plot of the differenced values of new cases shown in the figure 3.2.4.a, we consider lags 1, 3, 6, 7 and 8 for the MA model. We are ignoring higher-ordered lags (10+) to avoid complications in the model.

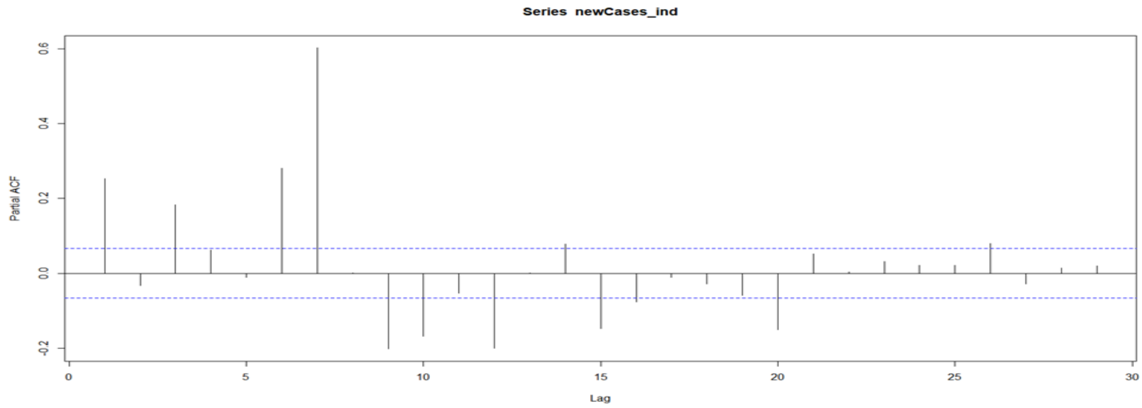
Figure 3.2.4.a. ACF plot of the time series data (daily new cases of COVID-19 in India) after taking first difference



We have considered MA(1), MA(3), MA(6), MA(7) and MA(8).

Again, from the PACF plot of the differenced values of new cases shown in the figure 3.2.4.b, we consider lags 1, 3, 6, 7 and 9 for the AR model. Ignoring higher-ordered lags(10+) same as before.

Figure 3.2.4.b. PACF plot of the time series data (daily new cases of COVID-19 in India) after taking first difference



Considering AR(1), AR (3), AR (6), AR (7) and AR (9) models.

To select the best model amongst the plausible models, we can use the Alkaike's Information Criterion (AIC). (AIC theory was discussed in the Bangladesh section). We choose the best model that has the minimum AIC values as well as the lowest log likelihood values.

Table 3.2.4.A: The AIC values for ARIMA(p,1q) for new cases of COVID-19 in India

Model	Log Likelihood	AIC
ARIMA(1,1,1)	-9141.753	18289.51
ARIMA(3,1,1)	-9102.555	18215.11
ARIMA(6,1,1)	-9021.994	18059.99
ARIMA(7,1,1)	-8894.578	17807.16
ARIMA(9,1,1)	-8851.570	17725.14
ARIMA(1,1,3)	-9134.950	18279.90
ARIMA(3,1,3)	-9044.350	18102.70
ARIMA(6,1,3)	-8917.294	17854.59
ARIMA(7,1,3)	-8874.376	17770.75
ARIMA(9,1,3)	-8853.025	17732.05
ARIMA(1,1,6)	-9023.368	18062.74
ARIMA(3,1,6)	-8991.042	18002.08
ARIMA(6,1,6)	-8893.048	17812.10
ARIMA(7,1,6)	-8849.797	17727.59
ARIMA(9,1,6)	-8841.623	17715.25
ARIMA(1,1,7)	-8969.606	17957.21

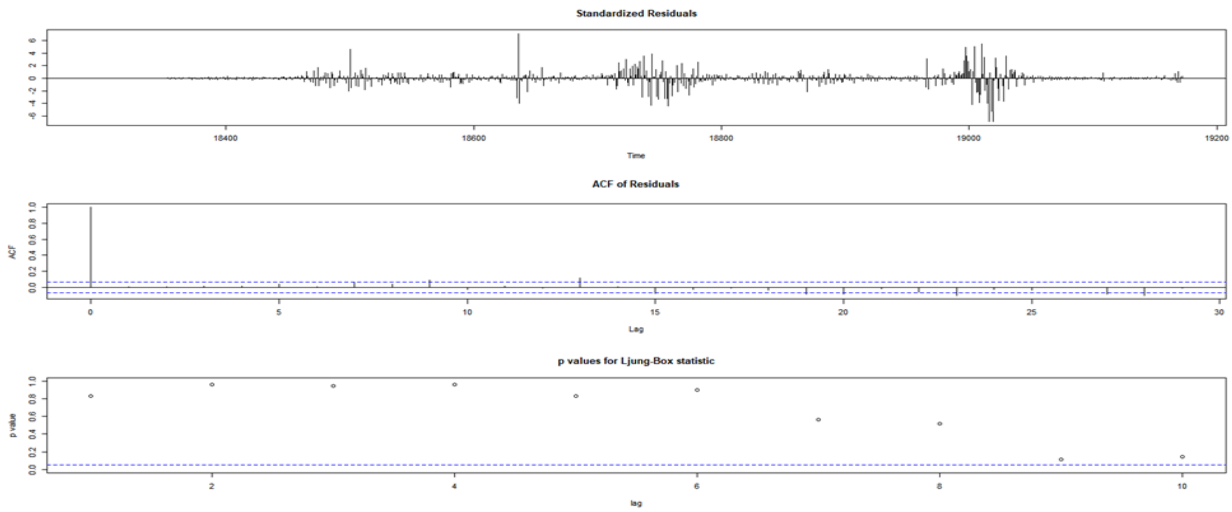
ARIMA(3,1,7)	-8936.539	17895.08
ARIMA(6,1,7)	-8855.705	17739.41
ARIMA(7,1,7)	-8848.481	17726.96
ARIMA(9,1,7)	-8841.041	17716.08
ARIMA(1,1,9)	-8964.997	17949.99
ARIMA(3,1,9)	-8936.154	17896.31
ARIMA(6,1,9)	-8852.704	17735.41
ARIMA(7,1,9)	-8845.810	17723.62
ARIMA(9,1,9)	-8832.743	17701.49

Here from table, ARIMA (9,1,9) has lowest AIC values. But it contains too many parameters, so we seek second lowest which is ARIMA (9,1,6). This model also has a lot more parameters, but we choose to move on with it because there isn't a better model with fewer parameters.

3.2.5. Diagnosis of the residuals:

To see if our fitted model is good or not, we do the diagnostic test which gives the result given in figure 3.2.5.a.

Figure 3.2.5.a. Residual analysis of ARIMA(9,1,6) model



The first part (Standardized Residuals) of figure 3.2.5.a shows that our residuals appear to be white noise, indicating that the series should be stationary and that the model is accurate.

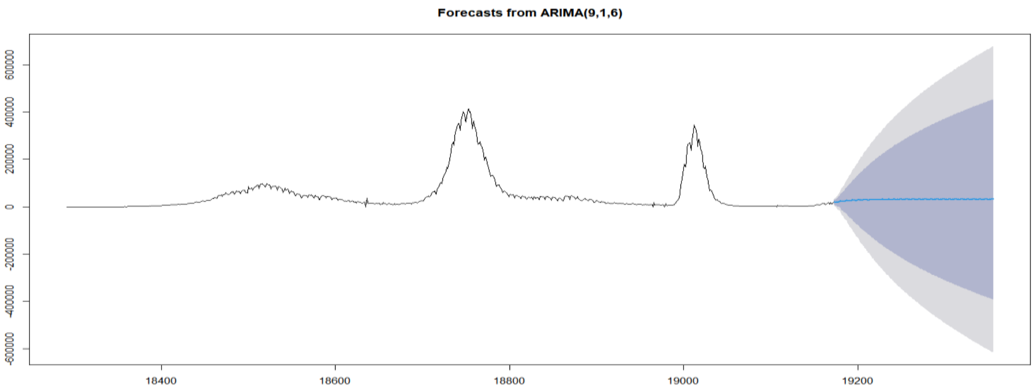
The residuals' ACF plots are inside the confidence interval, indicating that there is no autocorrelation and that the data are independent which shown in the second part (ACF of Residuals) of the figure 3.2.5.a.

The absence of autocorrelation in the errors is the Ljung-Box null hypothesis. As the Ljung-Box p-value is higher than the selected confidence level (higher p-value) in the third part (p values for Ljung-Box statistic) of the figure 3.1.5.a, so there is no evidence to reject the null hypothesis that there is no autocorrelation. So, we accept the null hypothesis at 5% level of significance. Therefore, the dataset can be used with the fitted model.

3.2.6. Forecasting:

The following figure shows the forecasted values of new cases of COVID-19 in India using ARIMA (9,1,6). 6 months (184 days) ahead of the series has been considered for forecasting and both 80% and 95% confidence interval has been employed in forecasting.

Figure 3.2.6.a. Forecast from ARIMA (7,1,5)



Forecasting points estimates by making necessary adjustments based on the information on new cases is given in Appendix, table 3.2.6.A

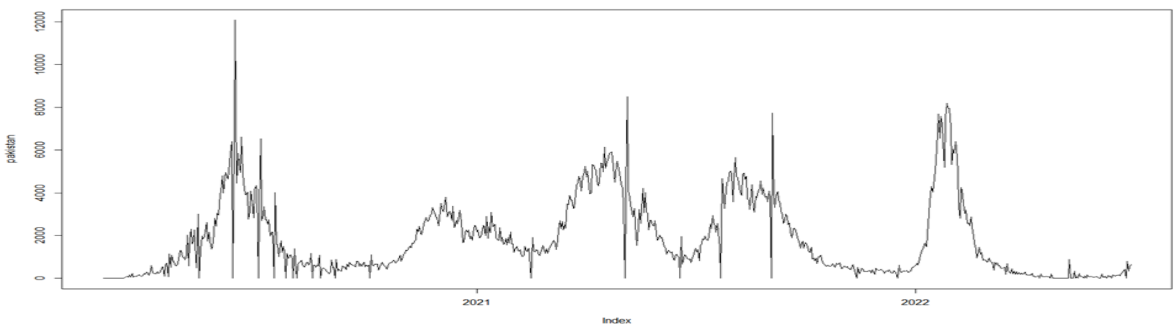
Both figure 3.2.6.a and table 3.2.6.A shows that the number of daily new cases would gradually increase and fluctuate for roughly three months before stopping to rise and reaching a steady condition. Therefore, we may predict that after six months, India's daily COVID-19 outbreaks will be under control and it can be said according to our data analysis.

3.3. Pakistan:

3.3.1. Analyze the plot of the series:

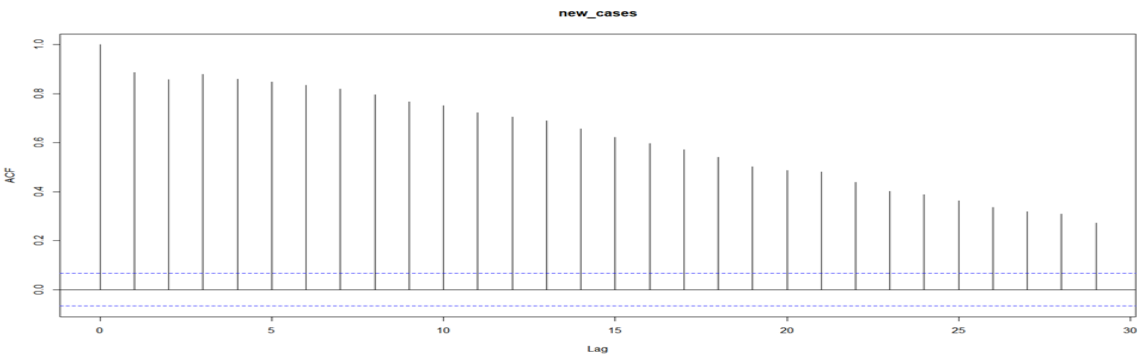
First, we plot our data, with the variable number of new cases versus time period. It is depicted in figure (3.3.1.a).

Figure: 3.3.1.a. Plot of daily new cases of COVID-19 in Pakistan against time period from February 25, 2020 to June 29, 2022



So, from graph we may demonstrates that the data is not stationary. To check the accuracy of our observation, we may also look at the ACF plot of the data.

Figure 3.3.1.b. ACF Plot of the time series data (daily new cases of COVID-19 in Pakistan)



Here, all lags are outside the confidence band, indicating that the data is nonstationary.

3.3.2. Checking Stationarity:

After detecting non-stationarity from the plot in the section 3.3.1, we do an analysis to make the data stationary. Therefore, we conduct the ADF test to determine the stationarity of new COVID-19 cases in Pakistan.

Table 3.3.2.A. Unit-root (Augmented Dickey-Fuller) Test Results

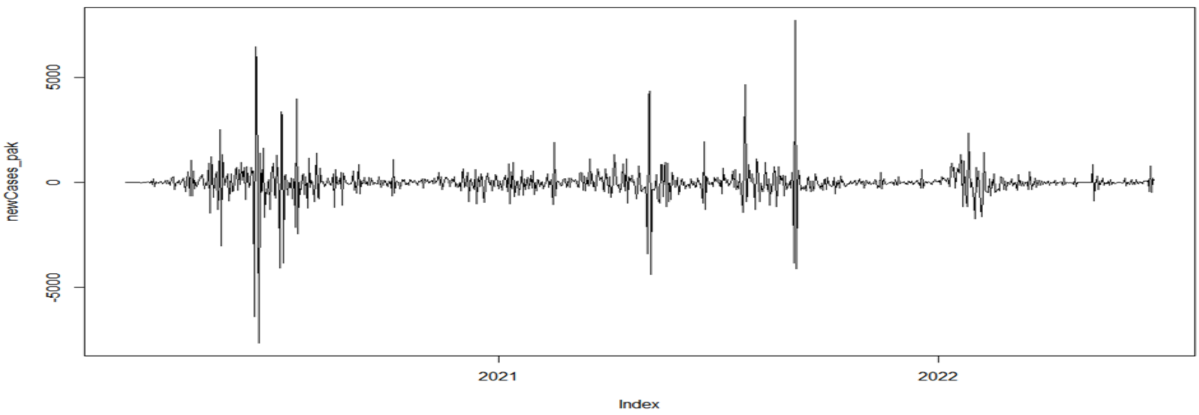
Dickey-Fuller test for unit root			Number of Obs = 855	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-7.204	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.0000				

From the table 3.3.2.A we see although the p value is significant, z(t) is not negatively large enough to be stationary. Therefore, null hypothesis i.e. time series data is non-stationary, cannot be rejected. So, further analysis on the time series new cases cannot be done.

3.3.3. Making data Stationary:

According to the stationarity analysis, the data is non-stationary. So, we calculate the first difference to determine if this has an effect on the stationarity of the data (given in the figure 3.3.3.a).

Figure 3.3.3.a. Time series plot (daily new cases of COVID-19 in Pakistan against time period) after taking first difference



As before, again we conduct the ADF test to confirm stationarity.

Table 3.3.3.A. Unit-root (Augmented Dickey-Fuller) Test Results after taking first difference

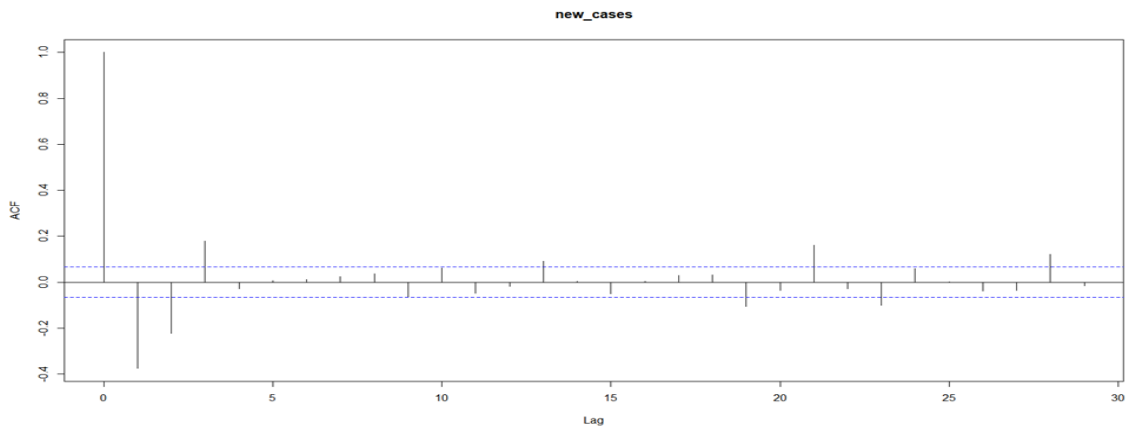
Dickey-Fuller test for unit root			Number of obs = 854	
	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-43.338	-3.960	-3.410	-3.120
MacKinnon approximate p-value for Z(t) = 0.0000				

Both of the requirements (mentioned earlier) are satisfied in this test (table 3.3.3.A). Therefore null hypothesis i.e. time series data is non-stationary, is rejected. So, further analysis can be done on the time series new cases.

3.3.4. Determining appropriate ARIMA model for Pakistan:

We investigated that the data of new cases of COVID-19 in Pakistan become stationary after the first difference. Therefore, our integration parameter for this type is d = 1. Now, based on the ACF plot of the different values of new instances depicted in the figure 3.3.4.a, we consider lags 1, 2, and 3 for the MA model.

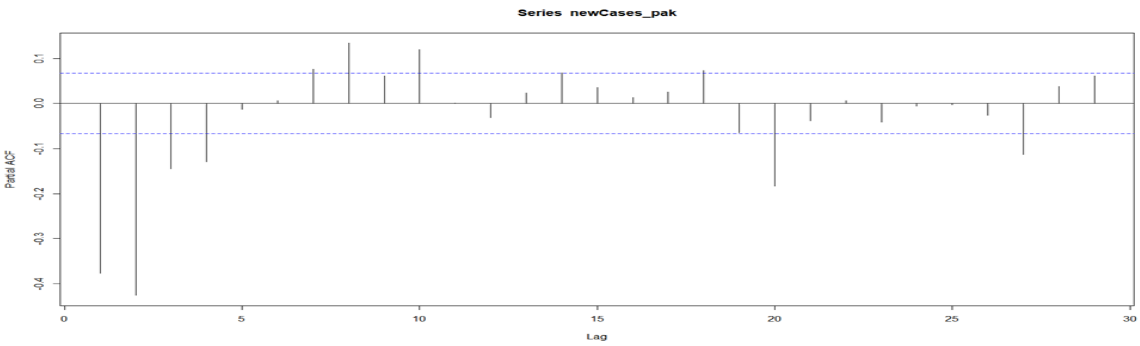
Figure 3.3.4.a. ACF plot of the time series data (daily new cases of COVID-19 in Pakistan) after taking first difference



It follows that we can think about MA (1), MA (2) and MA (3) models.

Again, based on the ACF plot of the different values of new instances depicted in the figure below, we evaluate lags 1, 2, 3, 4, and 8 for the MA model. To avoid model complexity, we are ignoring lags of orders of 10 and above.

Figure 3.3.4.b. PACF plot of the time series data (daily new cases of COVID-19 in Pakistan) after taking first difference



It follows that we can think about AR (1), AR (2), AR (3), AR (4) and AR (8) models. To select the best model amongst the plausible models, we can use the Alkaike's Information Criterion (AIC). (AIC theory was discussed in 3.1.4 section). We choose the best model that has the minimum AIC values as well as the lowest log likelihood values.

Table 3.3.4.A: The AIC values for ARIMA(p,1q) for new cases of COVID-19 in Pakistan

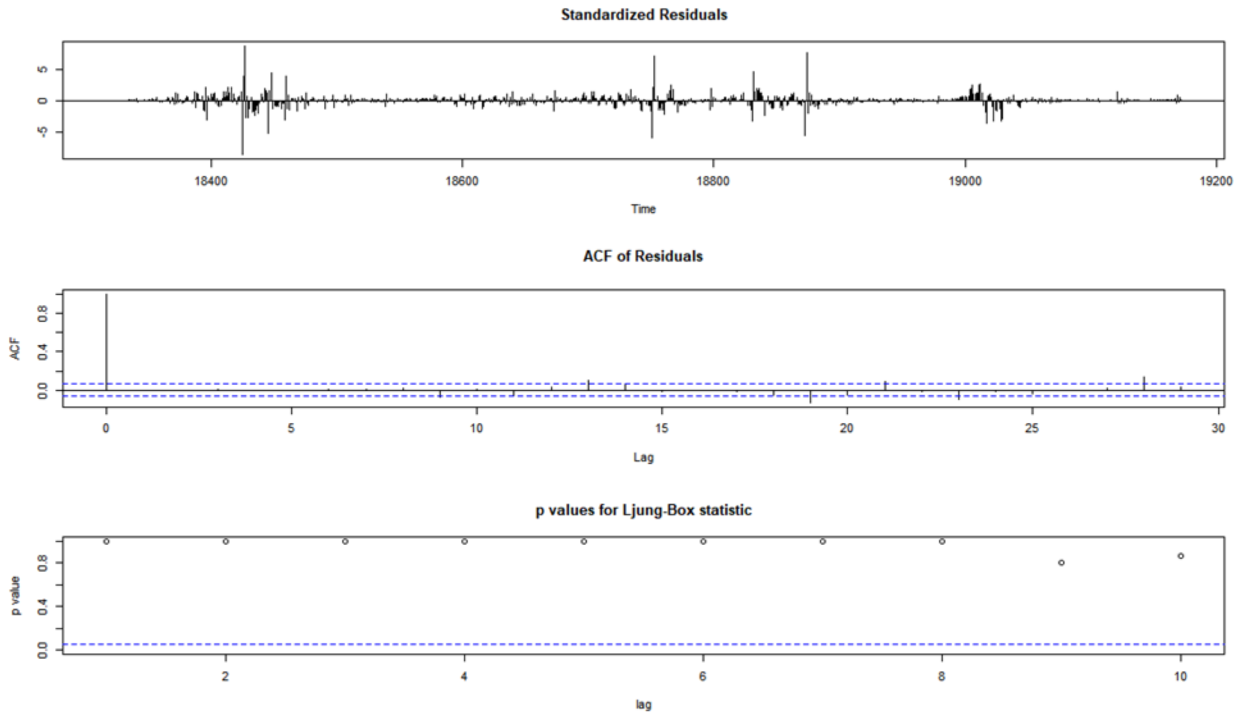
Model	Log-likelihood	AIC
ARIMA (1, 1, 1)	-6830.709	13667.42
ARIMA (2, 1, 1)	-6807.437	13622.87
ARIMA (3, 1, 1)	-6807.435	13624.87
ARIMA (4, 1, 1)	-6804.819	13621.64
ARIMA (8, 1, 1)	-6789.386	13598.77
ARIMA (1, 1, 2)	-6822.029	13652.06
ARIMA (2, 1, 2)	-6807.426	13624.85
ARIMA (3, 1, 2)	-6806.703	13625.41
ARIMA (4, 1, 2)	-6793.325	13600.65
ARIMA (8, 1, 2)	-6788.611	13599.22
ARIMA (1, 1, 3)	-6796.859	13603.72
ARIMA (2, 1, 3)	-6791.656	13595.31
ARIMA (3, 1, 3)	-6789.990	13593.98
ARIMA (4, 1, 3)	-6789.814	13595.63
ARIMA (8, 1, 3)	-6788.372	13600.74

According to the table 3.3.4.A, the lowest AIC and log-likelihood value seen ARIMA (3, 1, 3) comes out on top and is considered to be the best model.

3.3.5. Diagnosis of the residuals:

To determine if our fitted model is satisfactory or not, we conduct the diagnostic test depicted in Figure 3.3.5.a.

Figure 3.3.5.a. Residual analysis of ARIMA (3,1,3) model



The first portion of figure 3.3.5.a (Standardized Residuals) demonstrates that our residuals resemble white noise, indicating that the series should be stationary and accurately represented.

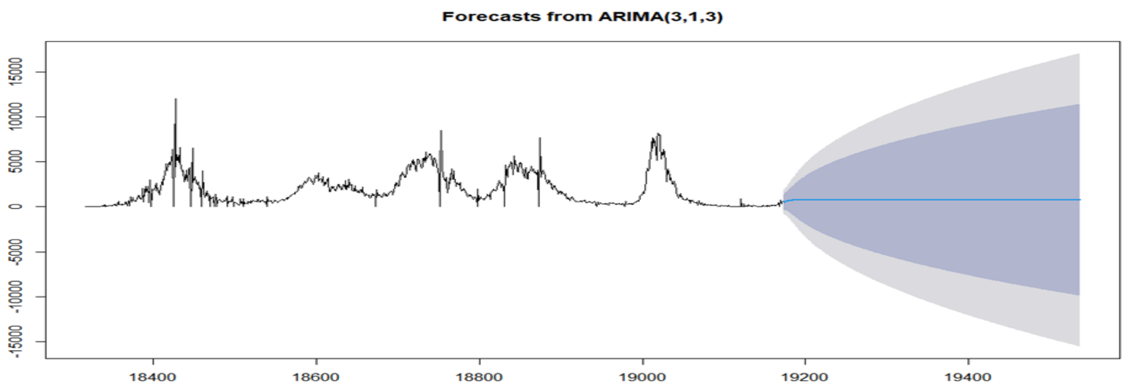
There appears to be no autocorrelation, or independence, in the data because the ACF plots of residuals fall within the confidence band indicated in the second part (ACF of Residuals) of figure 3.3.5.a.

The null hypothesis of the Ljung-Box test states that the errors have no autocorrelation. In the third section (p-values for the Ljung-Box statistic) of Figure 3.3.5.a, the Ljung –Box test p-value is greater than the selected confidence level (higher p-value) implies that there is no evidence to reject the null hypothesis of no autocorrelation. So, we reject the null hypothesis at 5% level of significance. As a result, our fitted model ARIMA (3,1,3) is correct for the dataset.

3.3.6. Forecasting:

The figure 3.3.6.a depicts the predicted values of new COVID-19 cases in Pakistan using ARIMA (3,1,1). Forecasting has been done for 6 months (184 days) ahead of the series, and both the 80% and 95% confidence intervals have been used.

Figure 3.3.6.a. Forecast from ARIMA (3,1,3)



Forecasting points estimates by making necessary adjustments based on the information on new cases is given in Appendix, table 3.3.6.A.

From figure 3.3.6.a and table 3.3.6.A, we see that there will be a modest increase and fluctuation in the number of daily new cases for almost three months, until the trend levels out and becomes steady. Six months from now, we can confidently predict that the number of new cases of COVID-19 in Pakistan will steady. This can be concluded on the basis of our data analysis.

4. Summary and conclusion:

The first step was to test for unit root in all the three time series. A visual examination of the data plot suggested that the series were non stationary. All series had to be differenced once to establish stationarity. Augmented Dickey Fuller test was conducted to diagnose stationarity problem. The best fitted model for Bangladesh is ARIMA (7, 1, 5), for India is ARIMA (9, 1, 6) and for Pakistan is ARIMA (3, 1, 3). The residuals of the ARIMA series have been plotted and found to be stationary. The ARIMA models were then used to forecast the new cases of COVID-19 for 184 days up to December 30, 2022. Forecasted values for each model are presented in tables (3.1.6.A, 3.2.6.A, 3.3.6.A) with 80 percent and 95 percent confidence intervals. Plots with forecasted values and confidence intervals are presented in figures (3.1.6.a, 3.2.6.a, 3.3.6.a). The forecasted number of new cases have not increased significantly in next few months but there have been ups and downs in the number. After this period, the forecasted number of daily new cases reaches a stable value. So we can conclude that for all three countries, COVID-19 situation seem to be coming under control. However, in case of Bangladesh and Pakistan, it might take a little longer according to the forecasted values. Because comparing to India, the forecasted daily new cases of COVID-19 increases at the beginning in Bangladesh and Pakistan according to both figures and tables.

Though this is an academic exercise, but the present study gives us the picture of the present situation as well as future situation (in the next six months) of COVID-19 as a whole regarding three Asian countries. On the other hand, we have used ARIMA models to fit by using the data of number of daily new cases of COVID-19 for three countries. This study will enrich the present literature. Because there are so many studies regarding COVID-19 and fitting of ARIMA model but the present research tried to fill up the literature gap. We can also say something about further scope of this study. That means, by using other models (VAR model, VECM, Neural Network model), forecasting of number of new cases of COVID-19 can be calculated in future. In that case, this study will help to a great extent as a supporting literature.

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7. Appendix:

Table 3.1.6.A. Forecasting points estimates from June 30, 2022 to December 30, 2022 with Confidence Intervals

dates	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2022-06-30	2348.258	1609.18	3087.336	1217.935	3478.581
2022-07-01	2482.179	1436.79	3527.567	883.3951	4080.963
2022-07-02	2229.618	982.832	3476.405	322.8232	4136.413
2022-07-03	2411.955	980.8537	3843.056	223.2746	4600.635
2022-07-04	2519.418	906.5732	4132.263	52.78466	4986.052
2022-07-05	2569.874	836.3039	4303.444	-81.3927	5221.141
2022-07-06	2661.058	817.8021	4504.314	-157.959	5480.075
2022-07-07	2626.761	548.9269	4704.595	-551.012	5804.534
2022-07-08	2691.702	397.3003	4986.103	-817.282	6200.686
2022-07-09	2535.905	35.05203	5036.757	-1288.82	6360.629
2022-07-10	2628.364	-33.5387	5290.267	-1442.67	6699.394
2022-07-11	2662.664	-138.964	5464.291	-1622.06	6947.383
2022-07-12	2716.037	-208.31	5640.385	-1756.37	7188.441
2022-07-13	2773.575	-269.329	5816.479	-1880.14	7427.295
2022-07-14	2717.392	-494.323	5929.106	-2194.5	7629.285
2022-07-15	2748.194	-626.819	6123.208	-2413.44	7909.832
2022-07-16	2642.778	-896.82	6182.375	-2770.57	8056.125

2022-07-17	2701.273	-970.271	6372.817	-2913.87	8316.415
2022-07-18	2714.306	-1072.3	6500.915	-3076.81	8505.424
2022-07-19	2759.256	-1135.41	6653.925	-3197.13	8715.638
2022-07-20	2795.848	-1206.64	6798.331	-3325.42	8917.118
2022-07-21	2746.196	-1390.24	6882.636	-3579.94	9072.335
2022-07-22	2759.977	-1507.63	7027.588	-3766.77	9286.725
2022-07-23	2686.085	-1714.02	7086.193	-4043.3	9415.47
2022-07-24	2727.713	-1783.16	7238.582	-4171.07	9626.492
2022-07-25	2734.777	-1875.29	7344.843	-4315.71	9785.265
2022-07-26	2770.661	-1934.87	7476.193	-4425.83	9967.151
2022-07-27	2793.597	-2008.64	7595.836	-4550.79	10137.99
2022-07-28	2754.828	-2159.62	7669.28	-4761.18	10270.83
2022-07-29	2759.882	-2265.04	7784.8	-4925.07	10444.83
2022-07-30	2707.591	-2428.07	7843.251	-5146.72	10561.91
2022-07-31	2738.705	-2493.04	7970.449	-5262.56	10739.97
2022-08-01	2744.086	-2575.97	8064.143	-5392.24	10880.41
2022-08-02	2772.197	-2633.93	8178.321	-5495.76	11040.15
2022-08-03	2786.175	-2707.66	8280.014	-5615.93	11188.28
2022-08-04	2756.973	-2834.37	8348.318	-5794.25	11308.2
2022-08-05	2757.51	-2930.1	8445.121	-5940.94	11455.96
2022-08-06	2720.522	-3062.89	8503.935	-6124.44	11565.49
2022-08-07	2744.218	-3124.87	8613.306	-6231.78	11720.21
2022-08-08	2748.985	-3200.51	8698.479	-6349.98	11847.95
2022-08-09	2770.764	-3257.71	8799.237	-6448.99	11990.52
2022-08-10	2778.91	-3330.16	8887.977	-6564.1	12121.92
2022-08-11	2757.111	-3438.91	8953.135	-6718.89	12233.11
2022-08-12	2755.395	-3526.62	9037.411	-6852.12	12362.91
2022-08-13	2729.343	-3637.82	9096.502	-7008.39	12467.07
2022-08-14	2747.522	-3697.63	9192.674	-7109.49	12604.53
2022-08-15	2751.866	-3767.65	9271.378	-7218.87	12722.6
2022-08-16	2768.579	-3824.37	9361.526	-7314.46	12851.62
2022-08-17	2772.983	-3894.81	9440.774	-7424.52	12970.49
2022-08-18	2756.706	-3990.11	9503.526	-7561.66	13075.08
2022-08-19	2753.999	-4071.05	9579.048	-7684.01	13192.01
2022-08-20	2735.761	-4166.51	9638.036	-7820.36	13291.88
2022-08-21	2749.753	-4224.61	9724.117	-7916.62	13416.12
2022-08-22	2753.662	-4290.25	9797.569	-8019.06	13526.39
2022-08-23	2766.372	-4346.47	9879.211	-8111.78	13644.52
2022-08-24	2768.424	-4414.5	9951.35	-8216.91	13753.76
2022-08-25	2756.228	-4499.54	10012	-8340.52	13852.97
2022-08-26	2753.237	-4574.69	10081.16	-8453.85	13960.33
2022-08-27	2740.561	-4658.5	10139.62	-8575.32	14056.44
2022-08-28	2751.35	-4715.1	10217.8	-8667.59	14170.29
2022-08-29	2754.795	-4777.23	10286.81	-8764.44	14274.03
2022-08-30	2764.376	-4832.81	10361.56	-8854.51	14383.26
2022-08-31	2764.993	-4898.26	10428.25	-8954.94	14484.93

2022-09-01	2755.816	-4975.31	10486.94	-9067.92	14579.55
2022-09-02	2752.925	-5045.46	10551.31	-9173.68	14679.53
2022-09-03	2744.192	-5120.49	10608.88	-9283.8	14772.19
2022-09-04	2752.521	-5175.7	10680.74	-9372.64	14877.69
2022-09-05	2755.495	-5234.94	10745.93	-9464.83	14975.82
2022-09-06	2762.655	-5289.71	10815.03	-9552.38	15077.69
2022-09-07	2762.437	-5352.55	10877.43	-9648.37	15173.24
2022-09-08	2755.503	-5423.27	10934.28	-9752.85	15263.86
2022-09-09	2752.901	-5489.1	10994.91	-9852.16	15357.96
2022-09-10	2746.946	-5557.41	11051.31	-9953.48	15447.37
2022-09-11	2753.384	-5611.27	11118.04	-10039.3	15546.02
2022-09-12	2755.904	-5668.08	11179.89	-10127.5	15639.28
2022-09-13	2761.21	-5721.89	11244.31	-10212.6	15734.99
2022-09-14	2760.541	-5782.18	11303.26	-10304.4	15825.5
2022-09-15	2755.282	-5847.78	11358.35	-10402	15912.54
2022-09-16	2753.045	-5909.87	11415.96	-10495.7	16001.84
2022-09-17	2749.037	-5972.96	11471.03	-10590.1	16088.17
2022-09-18	2754.016	-6025.5	11533.53	-10673.1	16181.13
2022-09-19	2756.119	-6080.19	11592.43	-10757.8	16270.09
2022-09-20	2760.016	-6132.92	11652.95	-10840.6	16360.59
2022-09-21	2759.139	-6190.78	11709.06	-10928.6	16446.86
2022-09-22	2755.139	-6252.19	11762.47	-11020.4	16530.67
2022-09-23	2753.277	-6311.03	11817.58	-11109.4	16615.93
2022-09-24	2750.622	-6369.97	11871.21	-11198.1	16699.36
2022-09-25	2754.475	-6421.22	11930.17	-11278.5	16787.49
2022-09-26	2756.206	-6474.04	11986.45	-11360.2	16872.65
2022-09-27	2759.042	-6525.61	12043.7	-11440.6	16958.7
2022-09-28	2758.105	-6581.19	12097.4	-11525.1	17041.33
2022-09-29	2755.055	-6639.12	12149.23	-11612.1	17122.21
2022-09-30	2753.544	-6695.11	12202.2	-11696.9	17204.01
2022-10-01	2751.822	-6750.72	12254.36	-11781.1	17284.7
2022-10-02	2754.805	-6800.71	12310.32	-11859.1	17368.7
2022-10-03	2756.212	-6851.84	12364.27	-11938	17450.46
2022-10-04	2758.256	-6902.21	12418.72	-12016.2	17532.67
2022-10-05	2757.345	-6955.68	12470.37	-12097.4	17612.13
2022-10-06	2755.016	-7010.66	12520.7	-12180.3	17690.33
2022-10-07	2753.813	-7064.16	12571.79	-12261.5	17769.11
2022-10-08	2752.729	-7117.03	12622.49	-12341.8	17847.22
2022-10-09	2755.038	-7165.8	12675.87	-12417.6	17927.65
2022-10-10	2756.169	-7215.39	12727.73	-12494	18006.36
2022-10-11	2757.627	-7264.54	12779.8	-12570	18085.21
2022-10-12	2756.788	-7316.06	12829.64	-12648.3	18161.88
2022-10-13	2755.008	-7368.53	12878.55	-12727.6	18237.62
2022-10-14	2754.067	-7419.84	12927.97	-12805.6	18313.71
2022-10-15	2753.412	-7470.42	12977.24	-12882.6	18389.41
2022-10-16	2755.2	-7518	13028.4	-12956.3	18466.7

2022-10-17	2756.1	-7566.18	13078.38	-13030.5	18542.66
2022-10-18	2757.126	-7614.12	13128.37	-13104.3	18618.57
2022-10-19	2756.382	-7663.84	13176.61	-13180	18692.74
2022-10-20	2755.02	-7714.14	13224.18	-13256.2	18766.22
2022-10-21	2754.296	-7763.51	13272.1	-13331.3	18839.89
2022-10-22	2753.925	-7812.14	13319.99	-13405.5	18913.33
2022-10-23	2755.309	-7858.58	13369.2	-13477.2	18987.85
2022-10-24	2756.018	-7905.44	13417.48	-13549.3	19061.32
2022-10-25	2756.732	-7952.19	13465.66	-13621.2	19134.62
2022-10-26	2756.087	-8000.28	13512.45	-13694.4	19206.53
2022-10-27	2755.046	-8048.68	13558.77	-13767.8	19277.91
2022-10-28	2754.496	-8096.32	13605.31	-13840.4	19349.39
2022-10-29	2754.31	-8143.27	13651.89	-13912.1	19420.73
2022-10-30	2755.38	-8188.61	13699.37	-13982	19492.76
2022-10-31	2755.935	-8234.25	13746.12	-14052.1	19563.97
2022-11-01	2756.422	-8279.84	13792.69	-14122.1	19634.93
2022-11-02	2755.873	-8326.42	13838.17	-14193	19704.79
2022-11-03	2755.078	-8373.15	13883.3	-14264.1	19774.23
2022-11-04	2754.666	-8419.25	13928.58	-14334.4	19843.7
2022-11-05	2754.598	-8464.72	13973.92	-14403.9	19913.07
2022-11-06	2755.425	-8509	14019.85	-14472	19982.88
2022-11-07	2755.854	-8553.5	14065.2	-14540.3	20052.01
2022-11-08	2756.18	-8597.98	14110.34	-14608.5	20120.87
2022-11-09	2755.721	-8643.18	14154.62	-14677.4	20188.84
2022-11-10	2755.114	-8688.41	14198.64	-14746.3	20256.48
2022-11-11	2754.81	-8733.13	14242.75	-14814.5	20324.09
2022-11-12	2754.812	-8777.29	14286.91	-14882	20391.64
2022-11-13	2755.451	-8820.56	14331.46	-14948.5	20459.43
2022-11-14	2755.78	-8863.97	14375.53	-15015.1	20526.66
2022-11-15	2755.992	-8907.4	14419.38	-15081.6	20593.61
2022-11-16	2755.612	-8951.33	14462.55	-15148.6	20659.83
2022-11-17	2755.15	-8995.22	14505.52	-15215.5	20725.79
2022-11-18	2754.929	-9038.68	14548.53	-15281.8	20791.69
2022-11-19	2754.971	-9081.65	14591.59	-15347.6	20857.52
2022-11-20	2755.463	-9123.96	14634.89	-15412.5	20923.47
2022-11-21	2755.714	-9166.36	14677.79	-15477.5	20988.95
2022-11-22	2755.847	-9208.77	14720.47	-15542.5	21054.15
2022-11-23	2755.535	-9251.54	14762.61	-15607.7	21118.77
2022-11-24	2755.184	-9294.22	14804.58	-15672.8	21183.15
2022-11-25	2755.026	-9336.53	14846.58	-15737.4	21247.46
2022-11-26	2755.089	-9378.42	14888.6	-15801.5	21311.69
2022-11-27	2755.468	-9419.81	14930.75	-15865	21375.95
2022-11-28	2755.657	-9461.26	14972.57	-15928.5	21439.82
2022-11-29	2755.735	-9502.71	15014.18	-15991.9	21503.41
2022-11-30	2755.482	-9544.4	15055.36	-16055.6	21566.52
2022-12-01	2755.216	-9585.97	15096.4	-16119	21629.43

2022-12-02	2755.105	-9627.23	15137.44	-16182	21692.25
2022-12-03	2755.175	-9668.14	15178.49	-16244.6	21754.99
2022-12-04	2755.466	-9708.65	15219.59	-16306.8	21817.69
2022-12-05	2755.608	-9749.2	15260.41	-16368.8	21880.06
2022-12-06	2755.65	-9789.74	15301.04	-16430.9	21942.16
2022-12-07	2755.445	-9830.42	15341.31	-16493	22003.87
2022-12-08	2755.244	-9870.99	15381.48	-16554.9	22065.4
2022-12-09	2755.168	-9911.28	15421.61	-16616.5	22126.83
2022-12-10	2755.238	-9951.27	15461.74	-16677.7	22188.16
2022-12-11	2755.462	-9990.96	15501.88	-16738.5	22249.43
2022-12-12	2755.566	-10030.6	15541.78	-16799.3	22310.39
2022-12-13	2755.584	-10070.3	15581.49	-16859.9	22371.12
2022-12-14	2755.42	-10110.1	15620.92	-16920.7	22431.51
2022-12-15	2755.269	-10149.7	15660.25	-16981.2	22491.74
2022-12-16	2755.218	-10189.1	15699.54	-17041.4	22551.86
2022-12-17	2755.284	-10228.2	15738.81	-17101.3	22611.88
2022-12-18	2755.455	-10267.1	15778.05	-17160.9	22671.8
2022-12-19	2755.532	-10306	15817.09	-17220.4	22731.46
2022-12-20	2755.535	-10344.9	15855.96	-17279.8	22790.9
2022-12-21	2755.404	-10383.8	15894.59	-17339.2	22850.05
2022-12-22	2755.291	-10422.5	15933.13	-17398.5	22909.06
2022-12-23	2755.258	-10461.1	15971.62	-17457.4	22967.95
2022-12-24	2755.318	-10499.4	16010.08	-17516.1	23026.73
2022-12-25	2755.448	-10537.6	16048.49	-17574.5	23085.4
2022-12-26	2755.504	-10575.7	16086.72	-17632.8	23143.84
2022-12-27	2755.498	-10613.8	16124.8	-17691.1	23202.07
2022-12-28	2755.394	-10651.9	16162.67	-17749.3	23260.06
2022-12-29	2755.309	-10689.8	16200.47	-17807.3	23317.9
2022-12-30	2755.289	-10727.6	16238.21	-17865.1	23375.64

Table 3.2.6.A. Forecasting points estimates from June 30, 2022 to December 30, 2022 with Confidence Intervals

dates	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2022-06-30	20374.09	13316.78	27431.39	9580.873	31167.3
2022-07-01	19929.17	9608.554	30249.79	4145.15	35713.19
2022-07-02	18296.03	5231.504	31360.55	-1684.44	38276.49
2022-07-03	19918.97	4062.833	35775.1	-4330.9	44168.83
2022-07-04	18465.46	-90.876	37021.8	-9914.01	46844.93
2022-07-05	19615.94	-1537.22	40769.11	-12735	51966.93
2022-07-06	22915.9	-1202.07	47033.87	-13969.4	59801.16
2022-07-07	24740.63	-3785.11	53266.36	-18885.7	68366.98
2022-07-08	23384.79	-9619.45	56389.02	-27090.8	73860.4

2022-07-09	22353.82	-14423	59130.6	-33891.4	78599.05
2022-07-10	23626.64	-16774.9	64028.2	-38162.2	85415.49
2022-07-11	22038.63	-21956.1	66033.32	-45245.5	89322.71
2022-07-12	23351.41	-23927.9	70630.69	-48956	95658.82
2022-07-13	25910.53	-24905.1	76726.21	-51805.3	103626.4
2022-07-14	27228.59	-27950.1	82407.28	-57159.9	111617.1
2022-07-15	25975.37	-33522.5	85473.24	-65018.8	116969.5
2022-07-16	25011.43	-38370.3	88393.12	-71922.5	121945.4
2022-07-17	26124.86	-40998	93247.75	-76530.7	128780.5
2022-07-18	24580.34	-46218.2	95378.9	-83696.7	132857.4
2022-07-19	25867.56	-48367.1	100102.3	-87664.6	139399.7
2022-07-20	27936.13	-49893.4	105765.6	-91093.8	146966.1
2022-07-21	28828.71	-53134.1	110791.6	-96522.7	154180.1
2022-07-22	27705.21	-58302.3	113712.7	-103832	159242.4
2022-07-23	26841.55	-62899.4	116582.5	-110405	164088.4
2022-07-24	27810.53	-65551.8	121172.9	-114975	170595.9
2022-07-25	26353.12	-70555.2	123261.4	-121855	174561.6
2022-07-26	27612.65	-72658.2	127883.5	-125738	180963.8
2022-07-27	29268.54	-74478.4	133015.5	-129399	187935.8
2022-07-28	29850.41	-77739.5	137440.4	-134694	194395
2022-07-29	28866.56	-82460.9	140194	-141394	199127.2
2022-07-30	28095.88	-86738.7	142930.5	-147528	203720.2
2022-07-31	28956.45	-89296.5	147209.4	-151896	209808.7
2022-08-01	27595.72	-94002.4	149193.8	-158372	213563.9
2022-08-02	28825.82	-95977.4	153629	-162044	219695.8
2022-08-03	30136.18	-97958	158230.3	-165767	226039.3
2022-08-04	30489.48	-101153	162132.4	-170841	231819.9
2022-08-05	29648.44	-105434	164731.1	-176943	236239.6
2022-08-06	28958.31	-109391	167307.8	-182629	240545.5
2022-08-07	29736.57	-111809	171281.7	-186738	246211.2
2022-08-08	28474.96	-116199	173148.8	-192785	249734.5
2022-08-09	29670.66	-118025	177366.6	-196211	255552.1
2022-08-10	30691.79	-120093	181476.8	-199914	261297.5
2022-08-11	30879.16	-123179	184937.8	-204733	266491.5
2022-08-12	30176.17	-127051	187403.1	-210282	270634.1
2022-08-13	29553.86	-130710	189818.2	-215549	274657.1
2022-08-14	30268.86	-132975	193513	-219392	279929.2
2022-08-15	29103.67	-137061	195268.1	-225023	283230.3
2022-08-16	30259.75	-138744	199263.5	-228209	288728.7
2022-08-17	31038.84	-140857	202934.8	-231853	293931.1
2022-08-18	31108.08	-143814	206030.3	-236412	298628.5
2022-08-19	30533.81	-147316	208383.9	-241464	302532.1
2022-08-20	29967.26	-150711	210645.9	-246357	306291.3
2022-08-21	30633.15	-152827	214092.9	-249944	311210.6
2022-08-22	29558.65	-156630	215747.5	-255193	314309.9
2022-08-23	30670.54	-158186	219527.2	-258161	319501.9

2022-08-24	31247.47	-160319	222813.9	-261728	324223
2022-08-25	31234.93	-163139	225609.2	-266035	328504.7
2022-08-26	30777.57	-166315	227869.8	-270649	332204.1
2022-08-27	30256.05	-169479	229990.7	-275212	335723.8
2022-08-28	30883.44	-171454	233221	-278565	340332.1
2022-08-29	29892.29	-175003	234787.7	-283468	343252.8
2022-08-30	30956.5	-176450	238363.5	-286245	348158.1
2022-08-31	31365.17	-178587	241316.9	-289728	352458.6
2022-09-01	31298.27	-181270	243866.8	-293797	356393.8
2022-09-02	30945.05	-184159	246049.4	-298029	359918.7
2022-09-03	30459.33	-187123	248042.1	-302305	363223.4
2022-09-04	31056.26	-188972	251084	-305447	367559.7
2022-09-05	30140.47	-192293	252574.3	-310043	370323.6
2022-09-06	31154.7	-193650	255959.9	-312655	374964.6
2022-09-07	31423.99	-195778	258626.4	-316052	378900
2022-09-08	31323.26	-198330	260976.1	-319900	382546.9
2022-09-09	31061.3	-200969	263092	-323799	385921.6
2022-09-10	30603.75	-203761	264968.9	-327827	389034.3
2022-09-11	31176.31	-205495	267847.2	-330781	393133.2
2022-09-12	30327.83	-208615	269270.9	-335104	395759.8
2022-09-13	31290.95	-209898	272480.4	-337576	400158.3
2022-09-14	31445.5	-212010	274901	-340888	403778.6
2022-09-15	31326.09	-214435	277087	-344533	407185
2022-09-16	31143.02	-216859	279144.7	-348143	410428.8
2022-09-17	30707.49	-219502	280917.3	-351955	413370.3
2022-09-18	31260.29	-221133	283653.1	-354741	417261.8
2022-09-19	30471.4	-224076	285018.4	-358825	419767.5
2022-09-20	31383.34	-225299	288065.4	-361178	423944.6
2022-09-21	31444.13	-227388	290275.9	-364405	427293.1
2022-09-22	31317.02	-229693	292327.5	-367864	430498.1
2022-09-23	31201.34	-231930	294333.1	-371224	433626.6
2022-09-24	30782.97	-234446	296011.7	-374849	436415.3
2022-09-25	31319.51	-235984	298623	-377486	440124.9
2022-09-26	30583.04	-238770	299936.5	-381357	442523.6
2022-09-27	31444.58	-239945	302833.9	-383610	446498.7
2022-09-28	31429.46	-242006	304865.1	-386754	449613.1
2022-09-29	31302.43	-244201	306805.8	-390044	452648.4
2022-09-30	31243.65	-246276	308763.7	-393187	455673.9
2022-10-01	30838.72	-248680	310357.5	-396648	458325.8
2022-10-02	31361.63	-250136	312859.3	-399152	461875.2
2022-10-03	30671.07	-252784	314126.3	-402836	464178.4
2022-10-04	31483.68	-253919	316886.2	-405002	467969.2
2022-10-05	31407.75	-255949	318764.5	-408066	470882
2022-10-06	31286.13	-258041	320612.8	-411201	473773.1
2022-10-07	31274.88	-259976	322526.2	-414156	476705.4
2022-10-08	30880.61	-262282	324043.6	-417474	479234.7

2022-10-09	31391.85	-263665	326448.5	-419858	482642.1
2022-10-10	30741.36	-266191	327673.3	-423377	484859.6
2022-10-11	31507.06	-267293	330306.9	-425468	488482
2022-10-12	31383.07	-269289	332054.8	-428455	491220.9
2022-10-13	31270.3	-271285	333825.5	-431448	493988.5
2022-10-14	31298.33	-273100	335696.7	-434239	496835.5
2022-10-15	30912.69	-275320	337145	-437429	499254.7
2022-10-16	31413.68	-276636	339463.6	-439708	502535.4
2022-10-17	30798.16	-279053	340649.8	-443079	504675.3
2022-10-18	31519.3	-280129	343167.4	-445105	508143.9
2022-10-19	31357.96	-282088	344804	-448016	510732.4
2022-10-20	31256.08	-283996	346508.6	-450881	513393.2
2022-10-21	31316.2	-285707	348339.4	-453529	516161.4
2022-10-22	30937.78	-287850	349725.3	-456606	518481.2
2022-10-23	31429.54	-289107	351966.4	-458789	521648.3
2022-10-24	30844.53	-291428	353116.8	-462028	523717.5
2022-10-25	31523.71	-292481	355527.9	-463998	527045.4
2022-10-26	31333.96	-294402	357069.6	-466836	529503.6
2022-10-27	31243.95	-296229	358717.2	-469583	532071
2022-10-28	31329.99	-297849	360509	-472106	534765.8
2022-10-29	30957.83	-299923	361838.4	-475080	536996
2022-10-30	31441.06	-301127	364009.3	-477178	540060.2
2022-10-31	30882.73	-303361	365126.6	-480299	542064.7
2022-11-01	31522.67	-304395	367439.9	-482218	545263.7
2022-11-02	31311.92	-306276	368900.3	-484985	547608.7
2022-11-03	31234.03	-308030	370498.1	-487626	550093.6
2022-11-04	31340.72	-309571	372252	-490038	552719.6
2022-11-05	30974.23	-311582	373530.2	-492920	554868.4
2022-11-06	31449.39	-312738	375637.2	-494940	557839.2
2022-11-07	30914.47	-314895	376723.7	-497955	559784
2022-11-08	31517.92	-315911	378947	-499829	562864.8
2022-11-09	31292.29	-317753	380337.7	-502527	565111.2
2022-11-10	31226.22	-319439	381891.4	-505070	567522.3
2022-11-11	31349.09	-320910	383608.6	-507385	570083.5
2022-11-12	30987.94	-322865	384840.4	-510183	572158.6
2022-11-13	31455.3	-323978	386888.7	-512133	575043.8
2022-11-14	30941.03	-326064	387946.3	-515051	576933.5
2022-11-15	31510.7	-327065	390086.9	-516884	579905.6
2022-11-16	31275.19	-328867	391417.7	-519515	582065.7
2022-11-17	31220.28	-330491	392931.8	-521970	584410.3
2022-11-18	31355.61	-331902	394613.2	-524199	586910.1
2022-11-19	30999.66	-333804	395802.9	-526919	588918.1
2022-11-20	31459.35	-334878	397797	-528806	591724.5
2022-11-21	30963.41	-336901	398827.5	-531636	593563.1
2022-11-22	31501.94	-337888	400892	-533431	596435.2
2022-11-23	31260.6	-339650	402171.2	-535998	598519.4

2022-11-24	31215.97	-341217	403649.1	-538371	600803.3
2022-11-25	31360.64	-342574	405295.8	-540524	603245.1
2022-11-26	31009.88	-344427	406447.2	-543172	605191.8
2022-11-27	31461.94	-345467	408391	-545001	607925.2
2022-11-28	30982.4	-347431	409396.1	-547751	609716.3
2022-11-29	31492.28	-348406	411390.4	-549512	612496.3
2022-11-30	31248.36	-350128	412624.9	-552017	614513.5
2022-12-01	31212.99	-351644	414069.6	-554316	616741.7
2022-12-02	31364.46	-352954	415682.5	-556399	619128.2
2022-12-03	31018.95	-354761	416799.2	-558981	621018.9
2022-12-04	31463.36	-355769	418695.9	-560758	623684.4
2022-12-05	30998.61	-357680	419677.2	-563434	625431.2
2022-12-06	31482.21	-358642	421606.7	-565162	628126.1
2022-12-07	31238.29	-360326	422802.3	-567607	630083.8
2022-12-08	31211.1	-361794	424216.1	-569838	632260.4
2022-12-09	31367.27	-363062	425796.3	-571860	634594.4
2022-12-10	31027.12	-364827	426881.2	-574379	636433.7
2022-12-11	31463.83	-365806	428733.7	-576108	639035.7
2022-12-12	31012.56	-367668	429692.7	-578716	640741.2
2022-12-13	31472.04	-368618	431562.4	-580413	643357.4
2022-12-14	31230.14	-370264	432724	-582802	645262.1
2022-12-15	31210.06	-371689	434108.8	-584970	647390.4
2022-12-16	31369.24	-372919	435657.3	-586936	649674.4
2022-12-17	31034.6	-374644	436713.3	-589397	651466.6
2022-12-18	31463.5	-375597	438524.1	-591082	654008.9
2022-12-19	31024.64	-377413	439462.2	-593627	655675.9
2022-12-20	31462.03	-378352	441276.5	-595295	658219.1
2022-12-21	31223.7	-379961	442408.2	-597629	660076.1
2022-12-22	31209.68	-381346	443765.4	-599740	662159.3
2022-12-23	31370.52	-382542	445283.4	-601655	664395.6
2022-12-24	31041.51	-384230	446312.9	-604061	666144.3
2022-12-25	31462.52	-385159	448084.2	-605705	668630.4
2022-12-26	31035.18	-386932	449002.7	-608191	670261.4
2022-12-27	31452.32	-387861	450765.7	-609832	672736.8
2022-12-28	31218.73	-389434	451871	-612113	674550.8
2022-12-29	31209.8	-390782	453202.1	-614172	676591.3
2022-12-30	31371.2	-391948	454690.5	-616040	678782.2

Table 3.3.6.A. Forecasting points estimates from June 30, 2022 to December 30, 2022 with Confidence Intervals

dates	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2022-06-30	490.7192	-380.618	1362.057	-841.876	1823.315

2022-07-01	566.7611	-356.011	1489.533	-844.497	1978.019
2022-07-02	600.9087	-331.704	1533.522	-825.399	2027.217
2022-07-03	617.8053	-379.332	1614.942	-907.184	2142.795
2022-07-04	641.3901	-412.85	1695.63	-970.931	2253.711
2022-07-05	659.077	-459.245	1777.399	-1051.25	2369.403
2022-07-06	674.0836	-515.913	1864.08	-1145.86	2494.027
2022-07-07	687.2353	-577.151	1951.621	-1246.48	2620.947
2022-07-08	698.3214	-642.903	2039.546	-1352.91	2749.548
2022-07-09	707.7999	-711.594	2127.194	-1462.98	2878.575
2022-07-10	715.8994	-782.089	2213.887	-1575.08	3006.874
2022-07-11	722.8055	-853.656	2299.267	-1688.18	3133.795
2022-07-12	728.7011	-925.666	2383.068	-1801.43	3258.837
2022-07-13	733.7329	-997.654	2465.12	-1914.2	3381.661
2022-07-14	738.0271	-1069.28	2545.333	-2026.01	3502.062
2022-07-15	741.6921	-1140.28	2623.664	-2136.54	3619.92
2022-07-16	744.8201	-1210.47	2700.112	-2245.54	3735.181
2022-07-17	747.4896	-1279.72	2774.701	-2352.86	3847.842
2022-07-18	749.768	-1347.94	2847.474	-2458.4	3957.932
2022-07-19	751.7124	-1415.06	2918.485	-2562.08	4065.505
2022-07-20	753.372	-1481.05	2987.797	-2663.89	4170.63
2022-07-21	754.7883	-1545.9	3055.477	-2763.81	4273.388
2022-07-22	755.9971	-1609.6	3121.594	-2861.87	4373.866
2022-07-23	757.0288	-1672.16	3186.217	-2958.09	4472.152
2022-07-24	757.9092	-1733.6	3249.415	-3052.52	4568.339
2022-07-25	758.6607	-1793.93	3311.254	-3145.19	4662.515
2022-07-26	759.302	-1853.19	3371.797	-3236.16	4754.768
2022-07-27	759.8493	-1911.41	3431.107	-3325.49	4845.185
2022-07-28	760.3165	-1968.61	3489.241	-3413.21	4933.847
2022-07-29	760.7152	-2024.83	3546.256	-3499.4	5020.832
2022-07-30	761.0554	-2080.09	3602.204	-3584.11	5106.217
2022-07-31	761.3458	-2134.44	3657.134	-3667.38	5190.072
2022-08-01	761.5937	-2187.91	3711.094	-3749.28	5272.464
2022-08-02	761.8052	-2240.52	3764.126	-3829.85	5353.459
2022-08-03	761.9857	-2292.3	3816.274	-3909.14	5433.116
2022-08-04	762.1398	-2343.3	3867.575	-3987.21	5511.493
2022-08-05	762.2713	-2393.52	3918.067	-4064.1	5588.644
2022-08-06	762.3835	-2443.02	3967.783	-4139.85	5664.618
2022-08-07	762.4793	-2491.8	4016.756	-4214.51	5739.466
2022-08-08	762.561	-2539.89	4065.016	-4288.11	5813.231
2022-08-09	762.6308	-2587.33	4112.593	-4360.69	5885.956
2022-08-10	762.6903	-2634.13	4159.513	-4432.3	5957.682
2022-08-11	762.7412	-2680.32	4205.801	-4502.96	6028.446
2022-08-12	762.7845	-2725.91	4251.481	-4572.72	6098.285
2022-08-13	762.8215	-2770.93	4296.576	-4641.59	6167.232
2022-08-14	762.8531	-2815.4	4341.107	-4709.61	6235.32
2022-08-15	762.8801	-2859.33	4385.094	-4776.82	6302.579

2022-08-16	762.9031	-2902.75	4428.557	-4843.23	6369.037
2022-08-17	762.9227	-2945.67	4471.512	-4908.88	6434.721
2022-08-18	762.9395	-2988.1	4513.978	-4973.78	6499.658
2022-08-19	762.9538	-3030.06	4555.97	-5037.96	6563.872
2022-08-20	762.966	-3071.57	4597.504	-5101.45	6627.386
2022-08-21	762.9764	-3112.64	4638.594	-5164.27	6690.222
2022-08-22	762.9853	-3153.28	4679.254	-5226.43	6752.401
2022-08-23	762.9929	-3193.51	4719.496	-5287.96	6813.943
2022-08-24	762.9994	-3233.34	4759.334	-5348.87	6874.866
2022-08-25	763.0049	-3272.77	4798.78	-5409.18	6935.19
2022-08-26	763.0096	-3311.82	4837.844	-5468.91	6994.931
2022-08-27	763.0137	-3350.51	4876.537	-5528.08	7054.105
2022-08-28	763.0171	-3388.84	4914.871	-5586.69	7112.729
2022-08-29	763.02	-3426.81	4952.853	-5644.78	7170.817
2022-08-30	763.0225	-3464.45	4990.495	-5702.34	7228.384
2022-08-31	763.0247	-3501.76	5027.805	-5759.39	7285.443
2022-09-01	763.0265	-3538.74	5064.791	-5815.95	7342.008
2022-09-02	763.0281	-3575.41	5101.462	-5872.03	7398.09
2022-09-03	763.0294	-3611.77	5137.826	-5927.64	7453.703
2022-09-04	763.0305	-3647.83	5173.89	-5982.8	7508.858
2022-09-05	763.0315	-3683.6	5209.662	-6037.5	7563.566
2022-09-06	763.0323	-3719.08	5245.148	-6091.77	7617.837
2022-09-07	763.033	-3754.29	5280.356	-6145.62	7671.682
2022-09-08	763.0336	-3789.22	5315.291	-6199.04	7725.11
2022-09-09	763.0341	-3823.89	5349.96	-6252.06	7778.132
2022-09-10	763.0346	-3858.3	5384.369	-6304.69	7830.756
2022-09-11	763.0349	-3892.45	5418.524	-6356.92	7882.991
2022-09-12	763.0353	-3926.36	5452.43	-6408.78	7934.846
2022-09-13	763.0355	-3960.02	5486.093	-6460.26	7986.329
2022-09-14	763.0358	-3993.45	5519.518	-6511.38	8037.447
2022-09-15	763.036	-4026.64	5552.709	-6562.14	8088.209
2022-09-16	763.0361	-4059.6	5585.672	-6612.55	8138.621
2022-09-17	763.0363	-4092.34	5618.411	-6662.62	8188.692
2022-09-18	763.0364	-4124.86	5650.931	-6712.35	8238.426
2022-09-19	763.0365	-4157.16	5683.236	-6761.76	8287.832
2022-09-20	763.0366	-4189.26	5715.33	-6810.84	8336.916
2022-09-21	763.0367	-4221.14	5747.218	-6859.61	8385.684
2022-09-22	763.0367	-4252.83	5778.903	-6908.07	8434.142
2022-09-23	763.0368	-4284.32	5810.389	-6956.22	8482.295
2022-09-24	763.0368	-4315.61	5841.68	-7004.08	8530.151
2022-09-25	763.0369	-4346.7	5872.779	-7051.64	8577.713
2022-09-26	763.0369	-4377.62	5903.69	-7098.91	8624.987
2022-09-27	763.0369	-4408.34	5934.416	-7145.9	8671.979
2022-09-28	763.037	-4438.89	5964.961	-7192.62	8718.693
2022-09-29	763.037	-4469.25	5995.327	-7239.06	8765.134
2022-09-30	763.037	-4499.44	6025.518	-7285.23	8811.308

2022-10-01	763.037	-4529.46	6055.537	-7331.14	8857.218
2022-10-02	763.037	-4559.31	6085.387	-7376.8	8902.869
2022-10-03	763.037	-4589	6115.07	-7422.19	8948.266
2022-10-04	763.0371	-4618.52	6144.59	-7467.34	8993.412
2022-10-05	763.0371	-4647.87	6173.948	-7512.24	9038.312
2022-10-06	763.0371	-4677.07	6203.148	-7556.9	9082.969
2022-10-07	763.0371	-4706.12	6232.193	-7601.31	9127.388
2022-10-08	763.0371	-4735.01	6261.083	-7645.5	9171.573
2022-10-09	763.0371	-4763.75	6289.823	-7689.45	9215.527
2022-10-10	763.0371	-4792.34	6318.414	-7733.18	9259.253
2022-10-11	763.0371	-4820.78	6346.859	-7776.68	9302.755
2022-10-12	763.0371	-4849.08	6375.159	-7819.96	9346.037
2022-10-13	763.0371	-4877.24	6403.317	-7863.03	9389.101
2022-10-14	763.0371	-4905.26	6431.336	-7905.88	9431.952
2022-10-15	763.0371	-4933.14	6459.217	-7948.52	9474.592
2022-10-16	763.0371	-4960.89	6486.962	-7990.95	9517.024
2022-10-17	763.0371	-4988.5	6514.573	-8033.18	9559.252
2022-10-18	763.0371	-5015.98	6542.052	-8075.2	9601.278
2022-10-19	763.0371	-5043.33	6569.401	-8117.03	9643.105
2022-10-20	763.0371	-5070.55	6596.622	-8158.66	9684.735
2022-10-21	763.0371	-5097.64	6623.717	-8200.1	9726.173
2022-10-22	763.0371	-5124.61	6650.686	-8241.35	9767.42
2022-10-23	763.0371	-5151.46	6677.533	-8282.4	9808.478
2022-10-24	763.0371	-5178.18	6704.259	-8323.28	9849.351
2022-10-25	763.0371	-5204.79	6730.865	-8363.97	9890.042
2022-10-26	763.0371	-5231.28	6757.352	-8404.48	9930.551
2022-10-27	763.0371	-5257.65	6783.723	-8444.81	9970.882
2022-10-28	763.0371	-5283.91	6809.98	-8484.96	10011.04
2022-10-29	763.0371	-5310.05	6836.122	-8524.95	10051.02
2022-10-30	763.0371	-5336.08	6862.153	-8564.76	10090.83
2022-10-31	763.0371	-5362	6888.073	-8604.4	10130.47
2022-11-01	763.0371	-5387.81	6913.884	-8643.87	10169.95
2022-11-02	763.0371	-5413.51	6939.587	-8683.18	10209.25
2022-11-03	763.0371	-5439.11	6965.183	-8722.33	10248.4
2022-11-04	763.0371	-5464.6	6990.674	-8761.31	10287.39
2022-11-05	763.0371	-5489.99	7016.062	-8800.14	10326.21
2022-11-06	763.0371	-5515.27	7041.346	-8838.81	10364.88
2022-11-07	763.0371	-5540.46	7066.53	-8877.32	10403.4
2022-11-08	763.0371	-5565.54	7091.613	-8915.68	10441.76
2022-11-09	763.0371	-5590.52	7116.597	-8953.89	10479.97
2022-11-10	763.0371	-5615.41	7141.483	-8991.95	10518.03
2022-11-11	763.0371	-5640.2	7166.272	-9029.87	10555.94
2022-11-12	763.0371	-5664.89	7190.966	-9067.63	10593.71
2022-11-13	763.0371	-5689.49	7215.565	-9105.25	10631.33
2022-11-14	763.0371	-5714	7240.071	-9142.73	10668.81
2022-11-15	763.0371	-5738.41	7264.484	-9180.07	10706.14

2022-11-16	763.0371	-5762.73	7288.807	-9217.27	10743.34
2022-11-17	763.0371	-5786.96	7313.039	-9254.33	10780.4
2022-11-18	763.0371	-5811.11	7337.181	-9291.25	10817.32
2022-11-19	763.0371	-5835.16	7361.235	-9328.04	10854.11
2022-11-20	763.0371	-5859.13	7385.202	-9364.69	10890.76
2022-11-21	763.0371	-5883.01	7409.082	-9401.21	10927.29
2022-11-22	763.0371	-5906.8	7432.877	-9437.6	10963.68
2022-11-23	763.0371	-5930.51	7456.588	-9473.87	10999.94
2022-11-24	763.0371	-5954.14	7480.214	-9510	11036.07
2022-11-25	763.0371	-5977.68	7503.758	-9546.01	11072.08
2022-11-26	763.0371	-6001.15	7527.22	-9581.89	11107.96
2022-11-27	763.0371	-6024.53	7550.601	-9617.65	11143.72
2022-11-28	763.0371	-6047.83	7573.901	-9653.28	11179.35
2022-11-29	763.0371	-6071.05	7597.122	-9688.79	11214.87
2022-11-30	763.0371	-6094.19	7620.265	-9724.19	11250.26
2022-12-01	763.0371	-6117.26	7643.329	-9759.46	11285.54
2022-12-02	763.0371	-6140.24	7666.317	-9794.62	11320.69
2022-12-03	763.0371	-6163.15	7689.228	-9829.66	11355.73
2022-12-04	763.0371	-6185.99	7712.064	-9864.58	11390.66
2022-12-05	763.0371	-6208.75	7734.825	-9899.39	11425.47
2022-12-06	763.0371	-6231.44	7757.512	-9934.09	11460.16
2022-12-07	763.0371	-6254.05	7780.125	-9968.67	11494.75
2022-12-08	763.0371	-6276.59	7802.666	-10003.1	11529.22
2022-12-09	763.0371	-6299.06	7825.135	-10037.5	11563.58
2022-12-10	763.0371	-6321.46	7847.532	-10071.8	11597.84
2022-12-11	763.0371	-6343.79	7869.859	-10105.9	11631.98
2022-12-12	763.0371	-6366.04	7892.117	-10139.9	11666.02
2022-12-13	763.0371	-6388.23	7914.304	-10173.9	11699.96
2022-12-14	763.0371	-6410.35	7936.424	-10207.7	11733.79
2022-12-15	763.0371	-6432.4	7958.475	-10241.4	11767.51
2022-12-16	763.0371	-6454.38	7980.459	-10275.1	11801.13
2022-12-17	763.0371	-6476.3	8002.376	-10308.6	11834.65
2022-12-18	763.0371	-6498.15	8024.227	-10342	11868.07
2022-12-19	763.0371	-6519.94	8046.012	-10375.3	11901.39
2022-12-20	763.0371	-6541.66	8067.733	-10408.5	11934.6
2022-12-21	763.0371	-6563.31	8089.389	-10441.7	11967.72
2022-12-22	763.0371	-6584.91	8110.981	-10474.7	12000.75
2022-12-23	763.0371	-6606.44	8132.51	-10507.6	12033.67
2022-12-24	763.0371	-6627.9	8153.976	-10540.4	12066.5
2022-12-25	763.0371	-6649.31	8175.38	-10573.2	12099.24
2022-12-26	763.0371	-6670.65	8196.722	-10605.8	12131.88
2022-12-27	763.0371	-6691.93	8218.004	-10638.4	12164.42
2022-12-28	763.0371	-6713.15	8239.224	-10670.8	12196.88
2022-12-29	763.0371	-6734.31	8260.385	-10703.2	12229.24
2022-12-30	763.0371	-6755.41	8281.486	-10735.4	12261.51