

## ECONOMIC IMPACTS OF COVID-19

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### ABSTRACT

The COVID-19 pandemic, and the resulting changes in society due to the lockdown and the social distancing measures, has witnessed inequities in access to decent work, health facilities, and experiences of discrimination resulting in many of the vulnerable populations in India experiencing a much harsher impact of economic and work-related factors. The agenda of this research is to describe how the COVID19 pandemic has exceedingly affected the people during the lockdown. The impact of the pandemic can be seen not only in the sectors globally but its impact in marginalized sections, women and children has been immense in India. This crisis is going to affect the economy as never before leading to massive psycho-social impact as well. This study uses different approaches to explore the relationship between unemployment, economic growth as GDP per capita, and increasing cases of COVID-19 in India and the world. The results highlight the prediction of GDP per capita of countries and the effect of lockdown on unemployment across India. To achieve the following result, we have performed Random Forest algorithm on data by different sources and analyzed it through various plotting libraries.

**Keywords:** Coronavirus, Machine Learning, Prediction, Analysis, Economy, GDP Per Capita, Unemployment.

### I. INTRODUCTION

The world has witnessed various epidemics such as the Spanish Flu of 1918, an outbreak of HIV/AIDS, SARS (severe acute respiratory syndrome), MERS (Middle East Respiratory Syndrome), and Ebola. In the past, India has had to deal with diseases such as smallpox, plague, and polio. All of these individually have been pretty severe. However, the year 2020/2021 will be forever marked in history by the worldwide outbreak of the pandemic caused by SARS-CoV-2. COVID-19, a plague of respiratory illness that showcased itself as a difficult illness that can make appearances in various forms and levels of severity starting from mild to severe with the danger of organ failure and death. From mild, self-restraint tract illness to severe progressive pneumonia, multiorgan failure, and death.[1] The virus appeared to initiate in December 2019 began to spread globally, the World Health Organization (WHO) declared on the 30th of January 2020 that COVID-19 was a Public Health Emergency of International Concern (PHEIC).[2] Even in 2021, we are in the middle of a global Covid-19 pandemic, which is inflicting two kinds of disturbances on countries: a health disturbance and an economic disturbance. Since the nature of the disease is highly contagious, the ways to contain the spread include policy actions such as the imposition of social distancing, self-isolation at home, closure of institutes, and public facilities, restrictions on mobility, and even lockdown of an entire country as well as region wise lockdown. These actions can potentially lead to direct consequences for economies around the world. In other words, effective containment of the disease requires the economy of a country to put a stop to its normal functioning. This has incited fears of a deep and prolonged global recession. On April 9 2020, the chief of the International Monetary Fund, Kristalina Georgieva said that the year 2020 could see the destruction of global economic fallout since the Great Depression in the 1930s, with about 170 countries or more likely to encounter negative per capita GDP growth due to the coronavirus pandemic.[2] How does a health crisis relate to an economic crisis? The answer lies in two ways by which coronavirus halted economic activities. First, the spread of the virus which encouraged social distancing resulting, the shutdown of financial markets, corporate offices, businesses, and events. Second, the exponential spread of the virus, and the uncertainty about how worst it could get, led to a flight to safety in consumption and investment among consumers, investors, and international trade partners.[3]

Although the COVID-19 pandemic has widely affected the World's economy but it has provided an opportunity for researchers to define and describe how precarious work creates physical, relational, behavioral,

psychological, economic, and emotional vulnerabilities that exacerbate outcomes from crises like the COVID19 pandemic (e.g., unemployment, psychological distress).

## II. LITERATURE REVIEW

The determination of finding the relevant and irrelevant approaches for determining solutions to COVID19 related problems has received an excellent deal of attention. However, it is another huge problem that researchers and decision makers have to deal with is the ever-increasing vast volume of data, known as big data, that challenges them in the process of fighting against the virus. Globally, as of 16 June 2021, the confirmed cases of COVID19 have been 176,156,662, including deaths of 3,815,486, reported to WHO. AND as of 14 June 2021, total vaccine doses of 2,310,082,345 have been administered. In India, from 3 January 2020 to 16 June 2021, there have been 29,570,881 confirmed cases of COVID19 with 377,031 deaths, reported to WHO. As of 7 June 2021, a total of 238,840,635 vaccine doses have been administered.[4] India contributes 3.7% with 29,570,881 cases and features a death rate of 3.2% with 0.2 deaths per 100k population.[1]

According to John Hopkins Report the: % of the Population Fully Vaccinated 3.47%.[4] All countries are attempting to save lots of their people's lives by implementing measures like travel restrictions, quarantines, event postponements and cancellations, social distancing, testing, regional lockdowns, cancellation of BOARD examinations. Apart from lives taken by covid, the socioeconomic impact is far more disastrous and especially for developing and underprivileged countries. According to the transmission characteristics of an epidemic at different stages, this paper focuses on the forecast of COVID19 effect over the GDP of the world and Analysis of COVID19 effect on Unemployment in India by using Linear Regression and Random Forest algorithm on the COVID19 provided data by different sources to anticipate the epidemiological example of the ailment and pace of COVID2019 cases, in India and other parts of the world that are being infected by coronavirus.

Linear Regression is based on supervised learning, a machine learning algorithm. It performs a regression task. Regression model targets prediction values based on independent variables. It is used for finding out the relationship between variables and forecasting. Linear regression performs the task to predict a dependent variable value ( $y$ ) based on a given independent variable ( $x$ ).[5] "Random Forest is a classifier and regressor which contains a number of decision trees on different subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of depending on one decision tree, the random forest algorithm takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output. The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.[6] The Random Forest regressor provided higher accuracy and hence adopted in this paper as the best fit for predictions.

## III. PROPOSED WORK

### Dataset

The data gathering aspect of this research agenda optimally focuses on understanding the rate of employment in the country. This study provides an approach for analyzing the current situation of covid-19 on the different economic aspects of problems faced during the pandemic (Fig-1). The data helps in establishing which country is making progress to its goal to restrict coronavirus. We explore datasets with different characteristics like Population, Population per Density, GDP per capita, birth rate and death rate, etc. Here we statistically analyzed our dataset with various methods of data analysis and visualized those data to provide a proper understanding of the COVID-19 outbreak worldwide and its effects.

Our exploit analysis is carried out on the World bank dataset of 2018-19 and the World Health Organization (WHO) with the 2019- 20 coronavirus dataset. Here, we present an attempt to visualize and analyze the results. COVID-19 has so far propagated nearly 210 Countries/Regions or Territories have been registered. Using time-series data, it becomes easier to associate the countries with higher GDP to countries with lower GDP.

Country Name	Region	Population	Pop. Density (per sq. km.)	Area (sq. km.)	Net migration	Infant mortality (per 1000 births)	GDP (\$ per capita)	Literacy (%)	Phones (per 100)	Arable (%)	Birthrate	Deathrate	Agriculture	Industry	Service	
0	Aruba	LATIN AMER. & CARIB	1.058450e+05	588.027778	180.00	1004.0	13.20	29100.000000	97.807419	106.952579	11.111111	11.652	9.0530	5.296472	25.117223	59.325013
1	Afghanistan	ASIA (EX. NEAR EAST)	3.717239e+07	56.937760	652860.00	-314602.0	48.00	493.750418	43.019718	59.120848	11.798854	32.487	6.4230	22.042897	13.387247	59.477423
2	Angola	SUB-SAHARAN AFRICA	3.080976e+07	24.713052	1246700.00	32066.0	51.90	3289.646664	74.804321	43.130519	3.930376	40.729	8.1900	8.607742	47.931542	43.206909
3	Albania	EASTERN EUROPE	2.866376e+06	104.612263	27400.00	-69998.0	8.50	5284.380184	98.141151	94.176998	22.311898	11.780	7.8980	18.440931	21.284030	47.740051
4	Andorra	WESTERN EUROPE	7.700600e+04	163.842553	470.00	161318.0	2.90	41793.055260	98.186226	107.282549	1.765957	7.200	4.4000	1.263533	19.690158	66.331657
6	Argentina	LATIN AMER. & CARIB	4.448450e+07	16.258510	2736890.00	24000.0	8.70	11633.480010	99.003688	132.093151	14.323873	17.021	7.6090	5.296472	23.058930	55.926022
8	American Samoa	OCEANIA	5.546500e+04	277.325000	200.00	-3999.0	21.25	11466.690710	99.095772	104.594126	15.000000	22.820	6.3290	15.228412	15.228027	66.653233
10	Australia	OCEANIA	2.498269e+07	3.247871	7692020.00	791229.0	3.10	57354.964050	99.095772	111.012255	4.026771	12.600	6.3000	2.458346	24.158967	66.653233
11	Austria	WESTERN EUROPE	8.840521e+06	107.131859	82520.00	324998.0	2.90	51478.285260	98.186226	123.535268	16.082768	9.700	9.5000	1.134383	25.489212	62.731019
13	Burundi	SUB-SAHARAN AFRICA	1.117538e+07	435.178271	25680.00	10003.0	41.20	271.752044	74.804321	56.534707	46.728972	39.008	7.9290	29.011900	11.107217	49.114983
14	Belgium	WESTERN EUROPE	1.142705e+07	377.379591	30280.00	240000.0	2.80	47583.074940	98.186226	99.696086	28.071334	10.400	9.7000	0.565289	18.900637	69.706511
15	Benin	SUB-SAHARAN AFRICA	1.148505e+07	101.853920	112760.00	-10000.0	60.40	1240.829464	42.362400	82.384290	24.831501	36.221	8.8710	28.087266	14.653691	48.759046
16	Burkina Faso	SUB-SAHARAN AFRICA	1.975154e+07	72.191283	273600.00	-125000.0	55.30	813.096849	41.224449	97.912271	21.929825	37.930	8.1240	23.069500	24.514137	42.442117
17	Bangladesh	ASIA (EX. NEAR EAST)	1.613560e+08	1239.579312	130170.00	-1847503.0	26.70	1688.350394	73.912201	100.244713	59.708842	18.184	5.5290	13.074317	28.536988	52.964940
18	Bulgaria	EASTERN EUROPE	7.025037e+06	64.711100	108560.00	-24001.0	5.90	9427.730430	98.492825	118.939680	32.037583	8.900	15.4000	3.370010	22.345287	60.959594

Fig-1: Data set used for training and testing the GDP (per capita) for prediction model

The data set (Fig-1) represents the various countries having data of their population, area, infant mortality rate, GDP (per capita), literacy, birth rate, agriculture, industry, service, and other factors that contribute to their economy for the financial year 2018-19. In the next figure (Fig-2), we have worked on the unemployment dataset provided by Kaggle from January 2020 till October 2020 of different states of India and analyzed the impact of lockdown due to covid-19 on unemployment in different states of India. It has been analyzed from the dataset that the northern part of India has been hard hit from lockdown as compared to the southern part of India.

Region	Date	Frequency	Estimated Unemployment Rate (%)	Estimated Employed	Estimated Labour Participation Rate (%)	Region.1	longitude	latitude	
0	Andhra Pradesh	31-01-2020	M	5.48	16635535	41.02	South	15.9129	79.7400
1	Andhra Pradesh	29-02-2020	M	5.83	16545652	40.90	South	15.9129	79.7400
2	Andhra Pradesh	31-03-2020	M	5.79	15881197	39.18	South	15.9129	79.7400
3	Andhra Pradesh	30-04-2020	M	20.51	11336911	33.10	South	15.9129	79.7400
4	Andhra Pradesh	31-05-2020	M	17.43	12988845	36.46	South	15.9129	79.7400
5	Andhra Pradesh	30-06-2020	M	3.31	19805400	47.41	South	15.9129	79.7400
6	Andhra Pradesh	31-07-2020	M	8.34	15431615	38.91	South	15.9129	79.7400
7	Andhra Pradesh	31-08-2020	M	6.96	15251776	37.83	South	15.9129	79.7400
8	Andhra Pradesh	30-09-2020	M	6.40	15220312	37.47	South	15.9129	79.7400
9	Andhra Pradesh	31-10-2020	M	6.59	15157557	37.34	South	15.9129	79.7400
10	Assam	31-01-2020	M	4.66	13051904	52.98	Northeast	26.2006	92.9376
11	Assam	29-02-2020	M	4.41	10088268	40.77	Northeast	26.2006	92.9376
12	Assam	31-03-2020	M	4.77	11542888	46.73	Northeast	26.2006	92.9376
13	Assam	30-04-2020	M	11.06	6830817	29.55	Northeast	26.2006	92.9376
14	Assam	31-05-2020	M	9.55	11367897	48.26	Northeast	26.2006	92.9376
15	Assam	30-06-2020	M	0.60	9095944	35.07	Northeast	26.2006	92.9376
16	Assam	31-07-2020	M	3.77	10286757	40.88	Northeast	26.2006	92.9376

Fig-2: Data set used for analysis of unemployment in different states of India

The dataset in above figure (Fig-2) depicts the state wise data needed for analyzing the unemployment over different states of the country India. The various factors like Estimated unemployment rate, estimated employed, estimated labor participation Rate, and various other has been described. Further cleaning of the null values in the dataset has been done to properly examine the dataset and utilize it for further analysis.

The reason cited for the sudden spurt in cases is due to the reopening of manufacturing and economic activities across the country, people have started moving out of their houses, even as usual crowds are once again returned at the market places.[1] But these were also the reason that contributed to some percentage for

developing the GDP of the countries. The GDP growth is highly required for any country to develop but that's not through putting the people's life at stake.

### Algorithm

Data is an essential component of any case study but as far as machine learning projects are concerned algorithms are the key to any research. This paper mainly required two algorithms i.e., Random Forest Regressor and Linear Regression.

Random Forest is a classifier algorithm also that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset [7].

Random Forest Regression is a supervised, machine learning algorithm that uses the ensemble learning method for regression. Ensemble learning method is a technique that combines predictions from multiple machine learning algorithms to make a more accurate prediction than a single model.[8]

Every decision tree has high variance, but when we merge all of them simultaneously in parallel then the resultant variance is low as each decision tree gets perfectly trained on that specific sample data and hence the output doesn't depend on one decision tree but various decision trees. In the case of, a classification problem, the final output of the model is taken by using the majority voting classifier. In the case of, a regression problem, the final output is the mean of all the outputs obtained so far. This part is Aggregation.

A Random Forest is an ensemble technique suited to carry out both regression and classification tasks with the use of multiple decision trees and a technique called Bootstrap and Aggregation, commonly known as bagging. The basic purpose behind this is to combine multiple decision trees in determining the final output rather than depending on individual decision trees. Random Forest has diverse decision trees as base learning models. We arbitrarily perform row sampling and feature sampling from the dataset creating sample datasets for every model.[9]

Linear regression is probably one of the most well-known and highly understood algorithms in statistics and machine learning.

Linear regression was developed for the field of statistics and is being studied as a model for understanding the input and output numerical variables, relationship, but has been borrowed by machine learning. It is both a statistical algorithm as well as a machine learning algorithm.

The linear equation assigns one scale factor to each and every input value or column, called a coefficient and exhibited by the capital Greek letter Beta ( $\beta$ ). One additional coefficient is also supplemented, giving the line an additional degree of freedom (e.g., On a two-dimensional plot, moving up and down) and is often called the intercept or the bias coefficient. Since the Random Forest regressor provided higher accuracy, hence is adopted in this paper as the best fit for predictions.

### Economy and Unemployment Analysis

The trauma is playing out in almost a similar manner in all countries of the world in terms of demand and supply disruptions and the resultant economic slowdown. In India however, the problem might be more critical and prolonged owing to the state the economy was in, in the pre-Covid-19 period. By the time the first Covid-19 case was reported in India, the economy had deteriorated significantly after years of feeble performance.[2]

It is prevalent to use GDP as a measure of economic welfare or standard of living in a nation. GDP (gross domestic product) growth rate has been sinking trajectory since 2015-16. According to the official statistics, GDP growth slowed down to 4.2% in 2019-20, the lowest level since 2002-03. Industry, which accounts for 30% of GDP, shrank by 0.58% in Q4, 2019-20. Unemployment reached a 45-year high.

Over the period of time, it has been observed that the Growth of the country or its GDP largely effects the employment. The effects of economic growth on employment or unemployment rate are examined and whether growth creates employment is still the subject of research. The view that economic growth will lead to increased employment and reduce unemployment as known in Okun's law in the literature.[10]

From the provide data-graph [fig-3], we can see the GDP of the countries such as Monaco, Liechtenstein and Luxembourg are the countries with highest GDP whereas countries like Burundi, Somalia and Malawi are the countries with lowest GDP but finding the GDP per capita of countries is not suffice to identify the economic condition of its respective country.

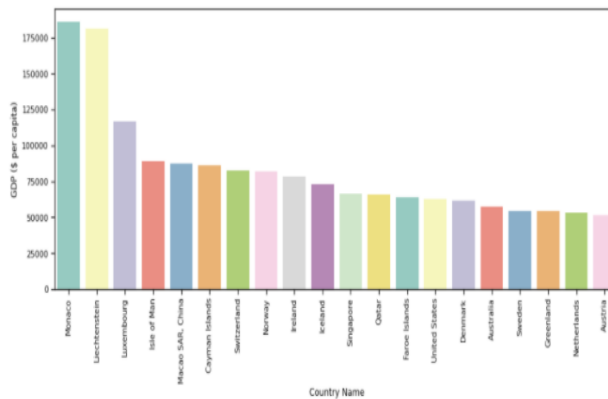
When collating the GDP of different nations for this purpose, two issues immediately arise. First, the GDP of a country is determined in its own currency: the United States has the U.S. dollar; Canada, the Canadian dollar; most countries of Western Europe, the euro; Japan, the yen; Mexico, the peso; and so on.[3] Therefore, comparing GDP between two countries it is essential to convert different currencies to a common currency. A second issue is that countries have very numerous people. For example, the United States has a much larger economy than Mexico or Canada, but it also has roughly three times as many people as Mexico and nine times as many people as Canada. So, if we are trying to compare standards of living across countries, we need to divide GDP by population and as many other factors which could affects the results.[3]

As the year 2019 ended there was a huge fall in GDP in the different parts of the world. Several countries have to go through total lockdown in order control the spread of virus and increasing covid cases. Due to which the industries were down, services we minimized and low scale organization started to minimize the employed members.

Even after the unlocking the rate of employment didn't increase, many industries couldn't contribute as they remained closed or their financial situation couldn't get better. Contribution in the Economy was mainly done by the services to the public or the transportation sectors even the educational sectors could help the decreasing GDP.

#### IV. RESULTS AND DISCUSSION

The first module of this research is based on visualizing the countries with their GDP per capita around the world. This also visualizes the GDP per capita of India. Fig-3 describes the countries with the highest GDP per capita across the world while Fig-4 describes countries with the lowest GDP per capita across the world.



Top Countries with lowest GDP per capita

Fig-3: Top countries with highest gdp per capita

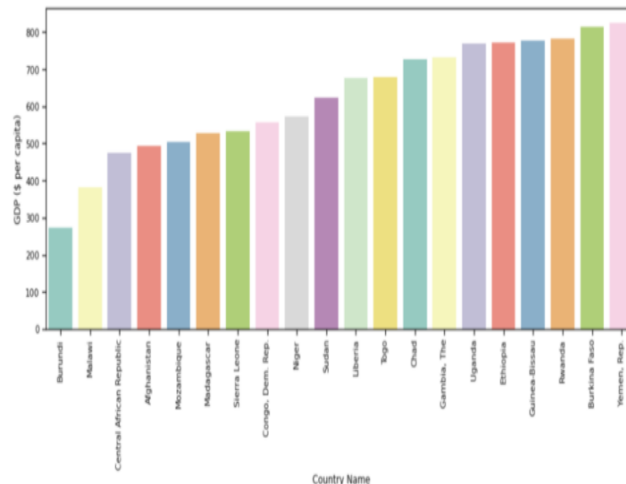


Fig-4: Top countries with lowest GDP per capita



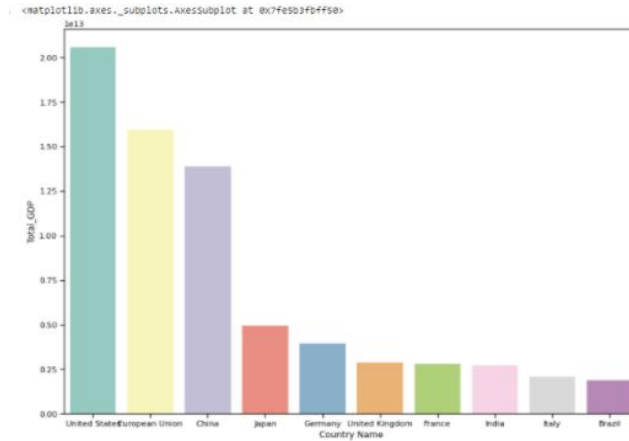


Fig-5: Top countries with highest total GDP

The Fig-5 describes the top countries having the highest total GDP which is product of GDP per capita and total population of a country. Fig-6 and Fig-7 describes the percentage contribution of top 25 countries in the world GDP and correlation graph of GDP per capita with various factors respectively.

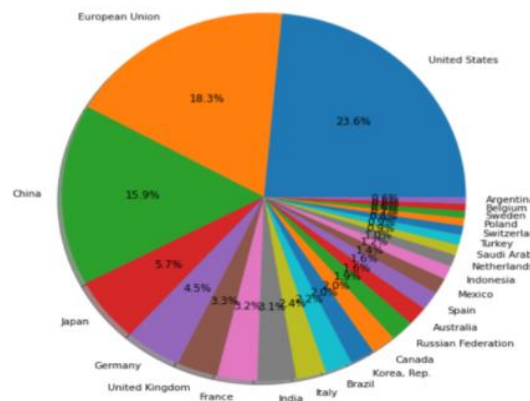


Fig-6: Share of top 25 countries

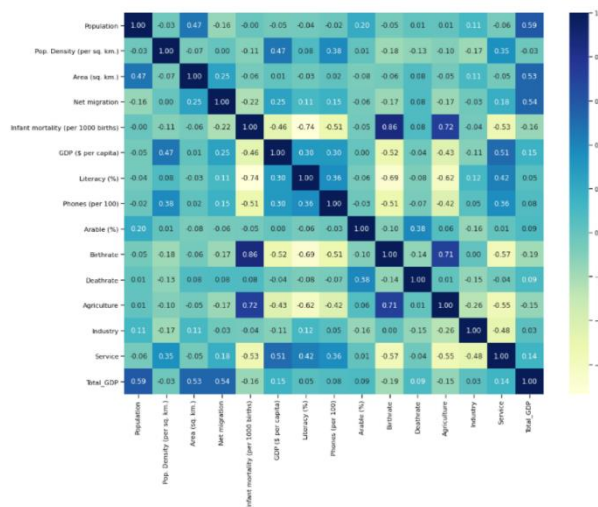


Fig-7: Top Factors affecting GDP per capita.

From Fig-8 to Fig-12, the correlation of various factors like Infant mortality rate, Literacy, Phones, Agriculture and Birth-rate with GDP per capita has been plotted through scatterplot for various regions across the world. It has been plotted so that, an understanding about the impact of these factors over GDP per capita could be made.

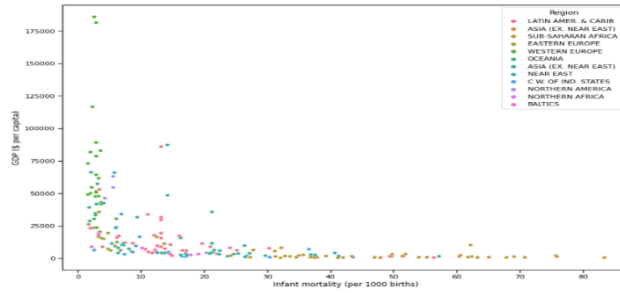


Fig-8: GDP per capita scatterplot correlated to Infant mortality

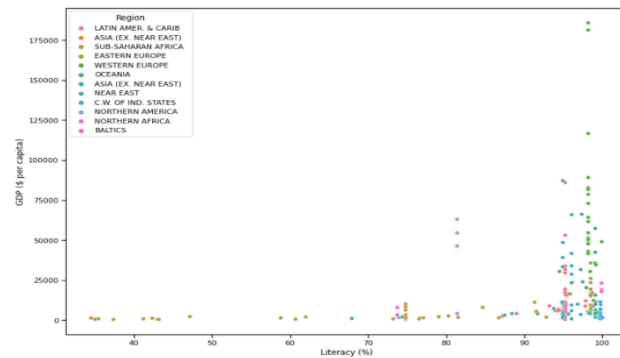


Fig-9: GDP per capita scatterplot correlated to Literacy

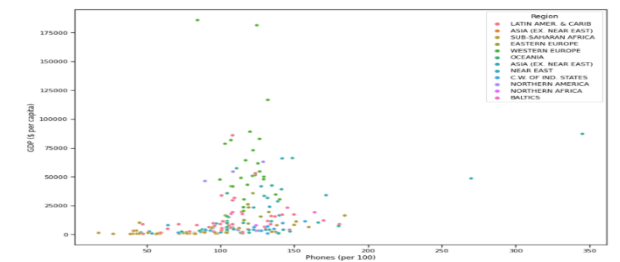


Fig-10: GDP per capita scatterplot correlated to Phones

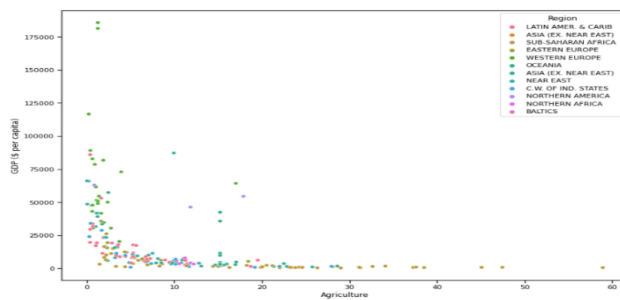


Fig-11: GDP per capita scatterplot correlated to Agriculture

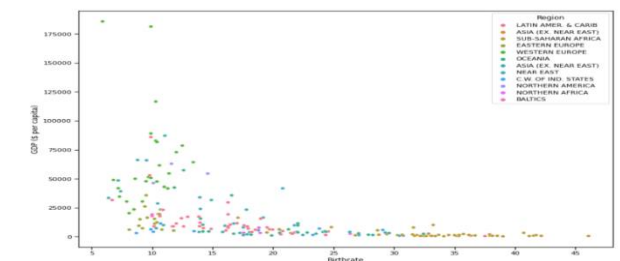
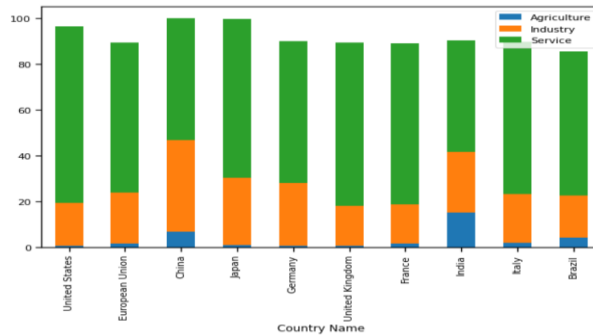


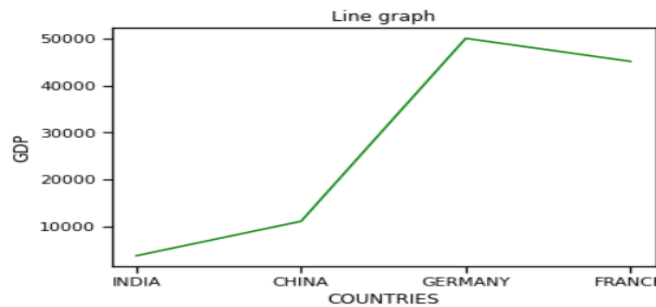
Fig-12: GDP per capita scatterplot correlated to Birth-rate

In Fig-13, Comparison of the economy structure for the ten countries with highest total GDP has been shown through bar plot for understanding the relation between agriculture, industries and services impact on total GDP of countries.

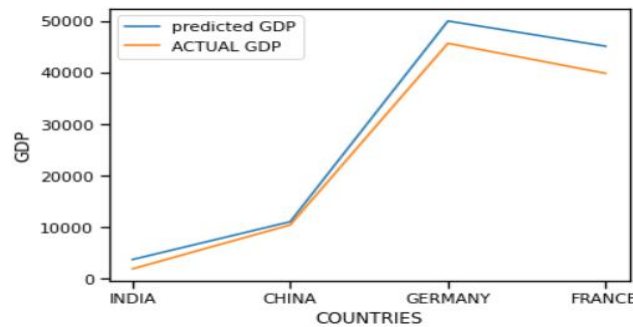


**Fig-13:** Comparison of the economy structure for the ten countries with highest total GDP

The second module of this research is forecasting the GDP per capita of different countries, compared with the actual GDP and the projected GDP, due to covid[fig-15], using random forest regressor from April 2020 to March 2021, resulted in average precision of model of 96.68%, considering (INDIA, CHINA, GERMANY, FRANCE) GDP's per capita predicted the average MAPE (Mean Absolute Percent Error) 3.32%.



**Fig-14:** Predicting the Gdp per capita of different countries 2020-21



**Fig-15:** Predicting the GDP per capita of different countries 2020-21

We have also analyzed the impact of unemployment in INDIA, region-wise and state-wise. The north region is the most impacted while the south region is the least impacted. Fig-16 describes the correlation between top factors that affect the employment rate in India.



**Fig-16:** Top Factors affecting employment rate of India.



Fig-17 and Fig-18 describes the unemployment rate in various states of India and its scatter plot for the year 2020. Fig-19 – Fig-22 describes the impact of lockdown and percentage change in unemployment across various states of India for the duration March 2020 to October 2020 because of Covid-19.

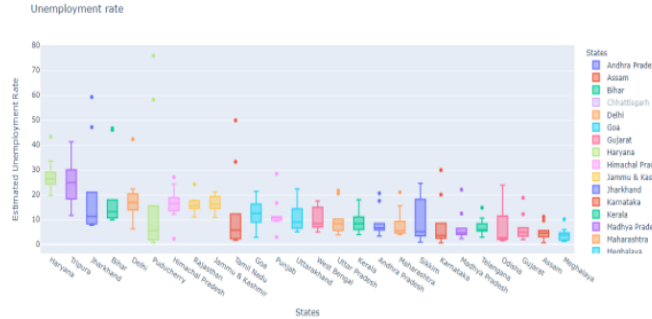


Fig-17: Unemployment rate in India 2020

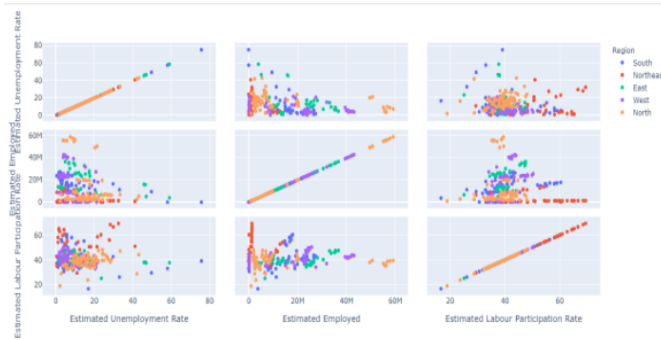


Fig-18: Estimates Employee

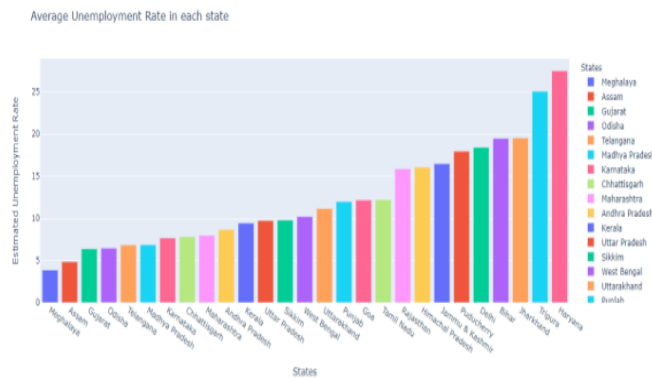


Fig-19: Impact of lockdown on employment across states in India 2020.

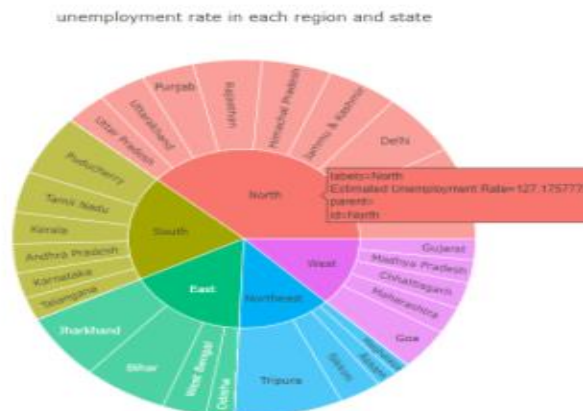
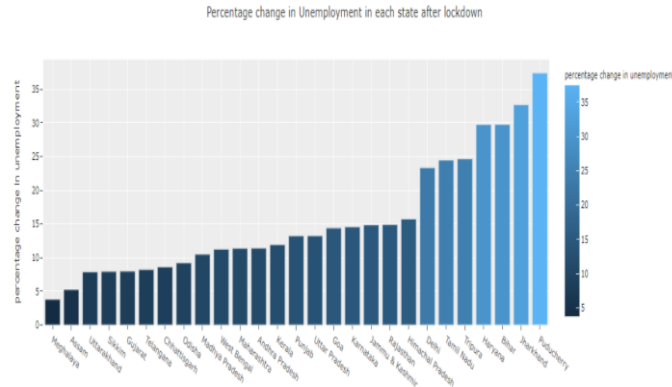


Fig-20: Unemployment rate in each region and state of India



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