Impact of Covid-19 on World Economy

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Abstract— **The outbreak of the COVID-19 pandemic has affected the world enormously. Along with everything else, the economic status of countries has had a major impact, and everything has come to a standstill. Several important parameters such as the GDP rates, unemployment rates, and international trade were highly impacted and if not for the pandemic, the trends could have been very different. In this study, the focus is to analyze the depth of the impact on various countries and industries.**

Keywords—GDP, Unemployment rate, Covid-19, Pandemic, Trade, SVR, ARIMA.

I. INTRODUCTION

The outbreak of COVID-19 has adversely affected the world in all aspects of life. Alongside chronic health issues that are associated with the disease, the lockdowns that have followed the pandemic have largely impacted the social and economic life of the people. The pandemic, with its consequences, has had an impact on multiple sectors of the economy. The biggest and the most obvious being the effect it has had on the world GDP, WHO (World Health Organisation) along with the world bank published a joint report which estimated the impact of such a pandemic at 2.2 to 4.8 percent. This fact has become a reality today with multiple countries going into recession and many others having a major impact on their GDP as well.

This stems from the fact that the pandemic has brought the work-life to a standstill, which has caused the Labour market to go into a shock and has led to major imbalances in the supply (of goods and services) and the demand. With major industries closed, the Employment rates have been at an all-time low, more and more people are being pushed below the poverty line. The extent of the impact depends a lot on the country, their response to the pandemic, and their initial conditions. It also varies from industry to industry and so, the impact has been multi-faceted. With little to no economic activity, the IMF (International Monetary Fund) has dubbed it the worst economic fallout since the Great Depression.

With all of this in mind, it is paramount that the Government and even the World bodies responsible should have efficient and exhaustive measures to respond to this appropriately, suited to the various needs of different countries and different types of industries. An efficient case study for the same facilitates this effort, as it provides a strong foundation for effective measures to be taken in the right direction.

II. PROBLEM STATEMENT

Looking at the impact the pandemic has had on various economic indicators, we analyze and forecast the expected trend in the various parameters (like, GDP, Labour costs, Unemployment rate, and International Trade) to the current date, using the data given, and using this forecast we compare the actual trend in the parameters with the effects of the pandemic, and then from these differences find which economic indicators are harder hit when compared to the others, and see how that varies for different countries.

Analyzing fluctuations in the unemployment rate, GDP, international trade of a country, and labor costs which have been a few of the most enormously affected parameters, play an important role in determining its socio-economic impact. Thus we take into consideration these factors for better understanding the differences in the impact of the pandemic on underdeveloped, developing, and developed countries, with frontier, emerging, and developed markets.

We try to understand how a given country is coping up with the pandemic by taking into consideration factors like the predicted conditions of these economic indicators and comparing them to the actual conditions brought on by the pandemic.

III. REVIEW OF LITERATURE

A. Effect of Covid-19 on Economy in India: Some Reflections for Policy and Programme [1]
This research paper focuses on assessing the damages caused by COVID-19 in the affected sectors, such as labor cost, tourism, and retail, the overall productivity loss, and the socio-economic impact of labor hours lost.

• MIGRATORY LABOUR:

About 400 million people (76.2% of the total workforce) working in the informal economy in India are at risk of falling deeper into poverty due to the pandemic. This report highlights existing major migration corridors in India along with the newly created corridors.

Economists have predicted three scenarios through simulation models of the socio-economic impact of the virus outbreak.

Scenario 1:The first scenario is the containment of the virus spread quickly, and the economy reviving very fast in the third quarter.

Scenario 2: This is of a community spread of the virus, the containment taking longer and the economic revival not being possible until September. In this case, there would be a shortage of essential commodities, resulting in demand shocks and inflation. A longer lockdown period for production houses will impact supply and will wipe out the revenues for the year. The costs of the healthcare sector will also increase and relief measures will have to be intensified.

Scenario 3: Second or the third outbreak of the virus happening during the year and all the containment efforts going haywire. The third scenario will not be controlled unless herd immunity develops or a vaccine is invented. Otherwise, a deep recession in the economy will set in, unemployment rates will be very high, there will be massive loss of life and millions of people will be pushed back to poverty.

The data has been considered only for a very small period of time after the strike of the pandemic thus leading to a few unreliable results

The data from other countries other than India have not been considered for analysis.

B. US and UK Labour Markets Before and During the Covid-19 Crash [2]

In this research paper, the employment rates for the USA and the UK were analyzed and compared. In 2019, the Employment to Population rate had gone well above the pre-recession level during the Great Depression. Before the onset of Covid -19, the unemployment rates had gotten down drastically for both the countries. Unemployment rates have been in decline since 2014, falling below 4% in 2018. But after April 2020, the Employment to Population fell by 1.1%, which was the largest drop ever seen since the Great Depression. The Employment to Population rate for the young African-American community had seen the highest drop of 3.8% during the month of February and March 2020. The Mean unemployment expectations or the mean probability that the US unemployment rate will be higher one year from now increased drastically from 34.2% in February to a new high of 50.9%.

One of the limitations encountered in the paper is that the data from other countries other than the US and the UK have not been considered. The comparison of the decline from the expected has not been done.

IV. APPROACH AND PROPOSED SOLUTION

We analyzed datasets that have the information on the variation of parameters like GDP, Labour Costs, International Trade, and Unemployment, with Time for certain major countries that would be able to represent the various market types (developed, developing, frontier). After the exploratory data analysis on these datasets, we found how strong the correlations are between the various parameters with time. These parameters can then be used for forecasting by creating appropriate regression/ARIMA models, and then later compare the current value to the forecasted value and see how much they differ for countries with varying market types.

GDP for countries, for example, has a very strong positive correlation with time, and it would make sense to come up with appropriate models for forecasting and find out which type of countries are the worst hit in that aspect. This will be followed by models for other parameters as well, which would lead to important insights such as which countries are affected the most by what parameters.

Trade is another very important indicator we will be finding trends in the export and import frequency along with duty charges gives important information on how the different markets are performing and responding to the pandemic and if the current counter-measures are enough to keep it out of too many losses. [4]

Labour Costs will also be analyzed, and any intuitive hypothesis that can be made right now (say, the costs going up for countries with weak labor forces) can be challenged.

Unemployment rates are an obvious candidate and are one that especially affects the population along with the country as a whole in the long run. Here, this paper focuses on how the above mentioned four economic indicators are affected by different market types.

A. Analysis of GDP

For the analysis of the effect of the pandemic on GDP, we look at the curves for the USA, India, and South Africa, which represent the various market types that have been mentioned in this paper. The GDP values in the dataset were of the form of decrease and increase in value concerning the previous year, and hence, to get the absolute values we took the cumulative sum of these values first, as it is a Time-Series analysis, the regressor is Time and the Value of GDP is the regressand.

• *USA*

Starting with the USA, which represents a developed market [5] and hence shows a slower rate of increase in its GDP, the first model that was tested was a Simple Linear Regression model, which had below-par RMSE and R-squared values for the test split. To improve this, a Polynomial Regression model of degree 2 was used to fit the data. This model was then used to predict the value for GDP for the year 2020.

(refer to Appendix, Fig. 1)

• INDIA

Similarly for India, as it is a developing market [5], the rate of change in the GDP will be much different from the USA. And hence, different models had to be tested. Here, it was found that a Simple Linear Regression had the best fit, in terms of RMSE and R-squared values, when compared to Polynomial Regressions for the same data, so this model was therefore used to predict the value of GDP in India for the year 2020. SVR models are widely used for Time-Series forecasting in the industry, and so we will mention it extensively in this paper as well. (refer to Appendix, Fig. 2)

• SOUTH AFRICA

Moving to South Africa, a weaker market [5] when compared to the above-mentioned countries. A Polynomial Regression model was used to fit the data, but it returned high RMSE and negative R-squared values. Since simple models were not able to fit the curve, a Support Vector Regression model was chosen. This returned satisfactory RMSE and R-squared values and thus were used for predicting the GDP for the year 2020. (refer to Appendix, Fig. 3)

B. Analysis of Unemployment Rates

For the analysis of the effect of Covid-19 on unemployment rates, three countries, the USA, Russia, and South Africa were considered.

• USA

For the USA, an ARIMA model was used to forecast the unemployment rate for the year 2020. To check the stationarity of the data, rolling statistics and an augmented Dickey-Fuller test were performed. As no trend was noticed after plotting the rolling mean and the rolling standard deviation and the p-value obtained from the Dickey-Fuller test was below the threshold of 0.05, it was concluded that the data is stationary. To find the optimal values of the parameters of the ARIMA model, ACF(Autocorrelation Function) and PACF(Partial Autocorrelation Function) was used to determine the MA(Moving Average) and AR(Auto Regression) terms respectively. This was used to predict the value for the year 2020. (refer to Appendix, Fig. 4)

• RUSSIA

Russia is categorized as a developing market [5], a Polynomial Regression model of degree 3 was tested first on its dataset, but the RMSE value was too high and the R-squared value was negative indicating underfitting, and so an SVR model, which gave far better values for the evaluation, was implemented to fit the data and was used for predicting the unemployment rates for the year 2020. (refer to Appendix, Fig. 5)

• SOUTH AFRICA

An SVR model was initially used to fit the data for South Africa but the RMSE and R-squared values received indicated underfitting. Thus an Artificial Neural Network with one hidden layer, RMSprop as the optimizer and MSE as the loss function, was used to fit the data. RELU was used as the activation function for the hidden layer which had 16 neurons. As overfitting was observed, L2 regularization was implemented on the model and was trained for 600 epochs. This model was then used for predicting the rate for the year 2020. (refer to Appendix, Fig. 6)

C. Analysis of Labour Costs

For the analysis for the labor costs (average cost of labor per unit of output produced), Australia, Czech Republic, and Lithuania, which represent the three market types (Developed, Developing, and Frontier, respectively) were considered.

• AUSTRALIA

Australia comes under the category of developed market [5], the first model that we tried to fit the data with was Simple Linear Regression, for which the RMSE value was low enough and the R-squared value was high indicating that much of the information was not lost by this model. This model was therefore used for predicting the Labour Cost for 2020, for the country. (refer to Appendix, Fig. 7)

• CZECH REPUBLIC

The Czech Republic has been categorized as a developing market [5], the models used here for fitting its dataset first were Simple Linear Regression and Polynomial Regression, both of which returned high RMSE values and negative R-squared values. After which a Polynomial Regression model of degree 3 fit the data which greatly improved the above-mentioned evaluations. Hence, this model was used to predict the unit labor cost for 2020. (refer to Appendix, Fig. 8)

• LITHUANIA

Lithuania comes under the category of Frontier markets [5], the model used for this dataset was SVR, which seemed to give satisfactory RMSE and R-squared values indicating a good fit. And so this model was used for the prediction of the labor cost for 2020. (refer to Appendix, Fig. 9)

D. Analysis of International Trade (export)

Finally, the international export for countries belonging to different market types was put under scrutiny. The export values were analyzed for Australia, India, and South Africa.

• AUSTRALIA

Australia, as mentioned before, has a developed market. The model used here was a Support Vector Regression, which gave a good fit with a low RMSE value and a high R-squared value. Hence, this model was used for predicting

the amount of export from the country (in Billion US dollars) for 2020. (refer to Appendix, Fig. 10)

• INDIA

India is a developing market. The only model used to fit the data here was the Support Vector Regression model, it returned low RMSE values and high R-squared values indicating that the model was a good fit and information was not being lost. The model used for predicting the export rates in the country for 2020 was therefore SVR. (refer to Appendix, Fig. 11)

• SOUTH AFRICA

As mentioned in previous sections, South Africa has a comparatively weaker market. The model used here was again an SVR model which gave satisfactory RMSE and R-squared values, which made it a valid candidate for predicting the number of exports from this country for the year 2020. (refer to Appendix, Fig. 12)

V. RESULTS AND INSIGHTS

The predictions that were made for the various economic indicators for the different countries, was for comparison between the actual values for 2020, which will be used to analyze how adversely the pandemic has affected the world. The most logical hypothesis here would be to see a noticeable change in trends due to the sudden decrease in socio-economic activities. This fact, in our paper, has been further drilled down to observe the varying effects of the pandemic on countries that can be categorized into different 'market types' which are, Developed, Developing, and Frontier [5]. In this section, we will look at each model and its results, the evaluation of the model, and the insights that can be made by the predicted value vs the actual value of the respective indicators for the year 2020. To reiterate, the models were fit on the economy indicator datasets till the year 2019 and using these models, we predict what the values such as GDP, Unemployment rates, Labour Costs, and International Trade for 2020 *could* have been if there was never a pandemic, and then we see how those values differ from the actual values *during* the pandemic. Let's look at the results from these models.

A. GDP ANALYSIS

As mentioned in the previous sections of the paper, the countries taken for analysis over this dataset [6] are the USA, India, and South Africa.

Country	Model	RMSE	R-Squared	The predicted value for 2020
USA	Polynomial degree 2	5.0332103	0.8436811	228.75532
India	Linear Regression	1.4690978	0.97666407	163.5835594
South Africa	SVR	0.06458733	0.74466405	166.9571587

Table 4(a)

India amongst the three countries shows the most decrease in the GDP value when we compare the predicted value and the actual value, with a decrease of 21.3% followed by South Africa with 6.12%% decrease and USA with 4.27%. This can be explained by the fact that developing countries have the highest rate of growth of GDP, and the near-complete shutdown of economic activity would present the most 'change' in its trend. (refer to the bar graph for the same in fig 4(a))
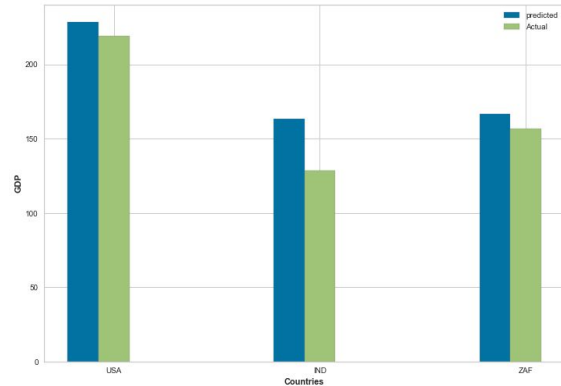

Fig. 4(a)

B. UNEMPLOYMENT RATE ANALYSIS

The [7] USA, Russia, and South Africa are considered for this analysis. To find the most accurate forecasted values, the data for each country was tested with different models.

Country	Model	RMSE	R-Squared	The predicted value for 2020
USA	ARIMA	NA	NA	4.008696
Russia	SVR	0.42365358	0.80231307	5.1335
South-Africa	ANN	0.412556	0.636809	26.062355

Table 4(b)

The USA shows the most increase in the Unemployment rate when we compare the predicted value and the actual value, with an increase of 8.9 followed by South Africa with 7.94 and then Russia with a 1.03 increase in Unemployment rates, this may seem counterintuitive at first, considering it is a developed country with many more resources that could, in theory, provide stability in unemployment rates if we consider hidden variables such as the poor response from the government against the pandemic, and the skyrocketing cases in the country forcing it to lockdowns and non-accessibility of jobs, it's not hard to believe that it has been performing poorly. (refer to the bar graph for the same in fig 4(b))
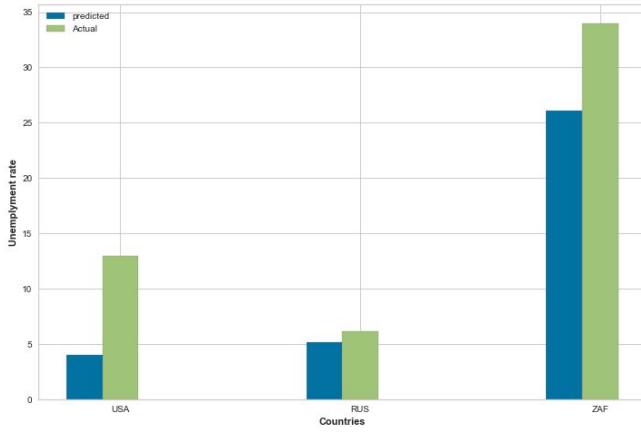
Fig. 4(b)

C. LABOUR COSTS ANALYSIS

The candidates [8] for the analysis of Unit Labour Cost were Australia, the Czech Republic, and Lithuania. Below mentioned are the evaluations for the models used to predict the value for 2020.

Country	Model	RMSE	R-Squared	The predicted value for 2020
Australia	Linear Regression	3.79712460	0.57590205	106.3909750
Czech Republic	Polynomial degree 3	4.09843529	0.60332635	125.8443781
Lithuania	SVR	0.14648114	0.96735788	114.8805292

Table 4(c)

Here, Lithuania shows a large increase in labor costs with a 17.99% increase, when we compare the predicted value and the actual value, followed by Australia with 3.48 % and the Czech Republic with 1.19%. These large variations in a frontier country can be explained by the 'hidden' facts such as a) [10] Lithuania has one of the lowest labor costs in the world (along with Romania, Hungary, etc) and hence is very sensitive to economic fluctuations, b) [11] Recently, Lithuanian trade unions have announced the requirement for the government to raise the minimum wage by more than 10 percent. (refer to the bar graph for the same in fig 4(c))
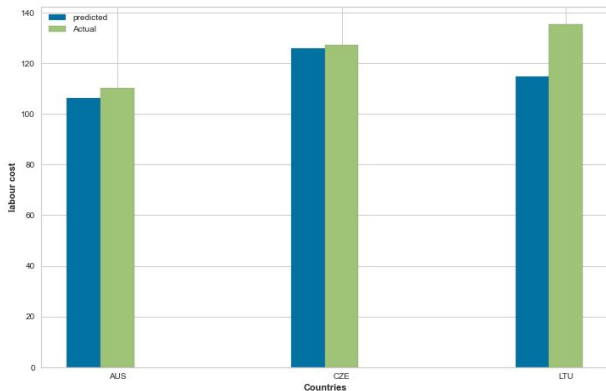
Fig. 4(c)

D. INTERNATIONAL TRADE ANALYSIS

The countries considered [9] for this analysis, were Australia, India, and South Africa. Table 4(d) mentions the evaluation and prediction results for the models.

Country	Model	RMSE	R-Squared	The predicted value for 2020
Australia	SVR	0.1089842	0.8800036	257.433326
India	SVR	0.1182769	0.9517314	221.4236977
South Africa	SVR	0.1165012	0.9308005	89.9684205

Table 4(d)

Australia and South Africa show the expected decrease in Exports (6.44% and 15.77% respectively), but the anomaly here, and also an example that exposes the limitation of our approach, India seems to show an increase in exports according to our model. Apart from the fact that India has been performing well in opening up trade during the pandemic, and consequently exports are actually doing better than imports [12] even matching 2019 values, a simple SVR model is not able to account for the steep decline by a record 34.57% in shipments of leather, gems and jewelry and petroleum products in 2019, and predicts a downward trajectory for 2020 as well. (refer to the bar graph for the same in fig 4(d))
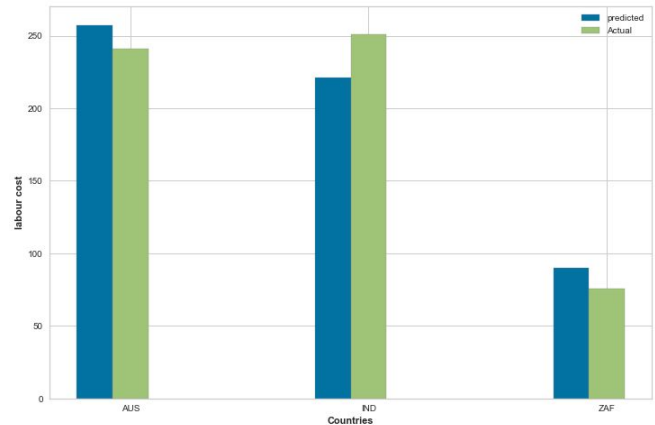

Fig. 4(d)

VI.   CONCLUSION

This paper has a seemingly simple aim of trying to quantify the effects of the pandemic on the world economy. The approach taken here revolves around where the Global Economies would be if not for the pandemic, and this is extended to an exhaustive study of how different Indicators for the economy such as GDP, Unemployment Rates, Labour Costs, and International trade have been affected in various types of countries, which have been very broadly classified as a Developed, Developing and a Frontier

markets. Appropriate Regression models were used to predict the values for these economic indicators for 2020 based on the trends till 2019, and then later compared to the actual recorded values to achieve this goal. As shown by the previous sections of the paper, the results are not always intuitive, as unprecedented conditions like a pandemic and how a country responds to it has a lot of moving parts that can't always be accounted for, for example, the duration of its lockdowns, second or third waves of the infection extending the effects it has on the economy, government protocols unique to the country and many other such variables come into the picture. The approach taken in this paper has the aim of drawing insights from the extent of variation in economic factors a particular country shows, and even providing a possible impetus to the government, to funnel government budget towards factors that may have been overlooked previously, a good example from our observations would be Lithuania, and the sudden spike in the labor costs, even relative to the other countries that were directly compared to it, which can be explained by its already low labor costs and the fact that a pandemic would affect an already unstable Frontier market more than, say a developed country like Australia, which resulted in trade unions announcing an increase in minimum wages.

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APPENDIX

A. Contributions
• Raghav Roy: Literature survey, exploratory data analysis, building and analyzing SVR models, anomaly detection.
• Shreya Chowdhury: Literature survey, data cleaning, exploratory data analysis, ARIMA model building, analyzing results after forecasting.
• Anand Vardhan: Literature survey, exploratory data analysis, building and analyzing linear regression, ANN, Polynomial models.

B. Datasets
The datasets used in this paper have been mentioned in the references, however, this section is dedicated to shedding some more light on the kind of values that the models have been fitted on.
All datasets were taken from The Organisation for Economic Co-operation and Development (OECD.stats) website, which provided an intuitive way of selecting the type of values, choosing appropriate time slices, and switching between yearly and quarterly values.
• GDP
The values here are in terms of percentage change over the previous year, and so a cumulative sum needed to be taken for a more intuitive curve.
• Unemployment Rate
The dataset for this shows percentage changes in unemployment rates in the percentage of the labor force.
• Labour Costs
The values in this dataset are in terms of Unit Labour Cost that is defined as the multiplication of direct labor hourly rate by the number of direct labor hours required to complete one unit.
• International Trade in Goods
Here we take the export values for the countries in Million US dollars per year.

C. Visualizations

The following are graphs, that were the outputs of the models that were fitted over the above-mentioned datasets for various countries, these graphs show the forecasted vs the actual values from the dataset only for the models that had best fit the curve. They have been appropriately labeled.
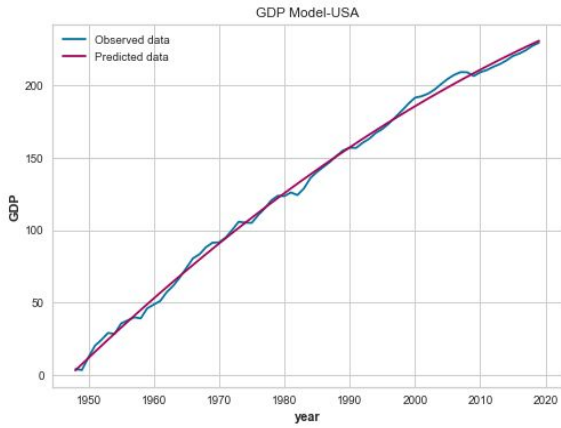

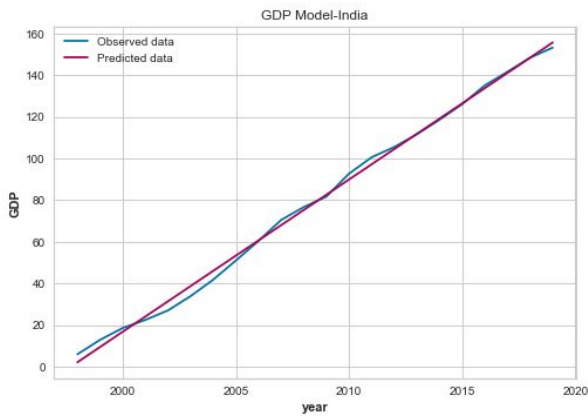Fig. 1: GDP Vs Time using Polynomial Regression of degree 2 for the USA

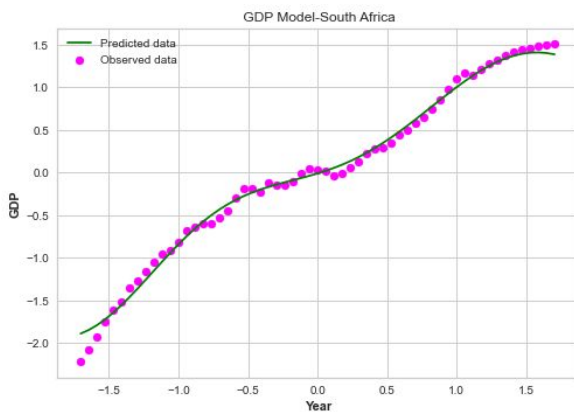Fig. 2: GDP Vs Time using Linear Regression for India
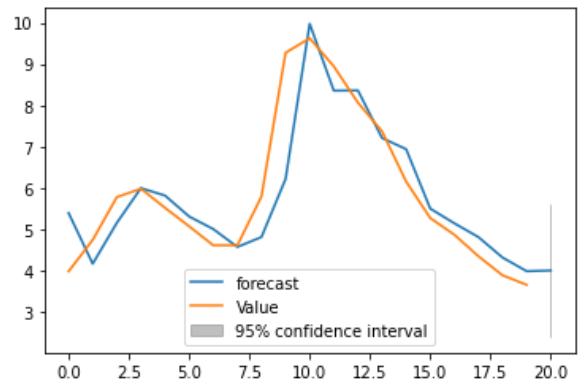

Fig. 3: GDP Vs Time using SVR for South Africa

Fig. 4: Unemployment rate Vs Time using ARIMA for the USA
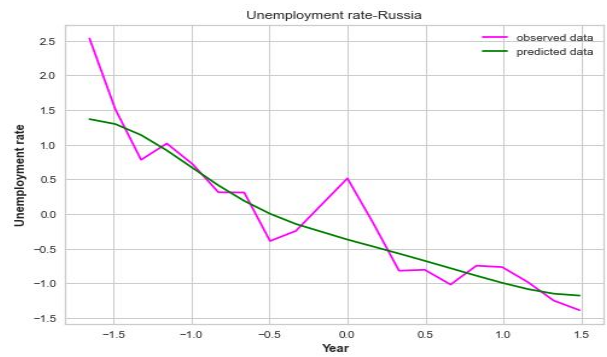
Fig. 5: Unemployment rate Vs Time using SVR for Russia
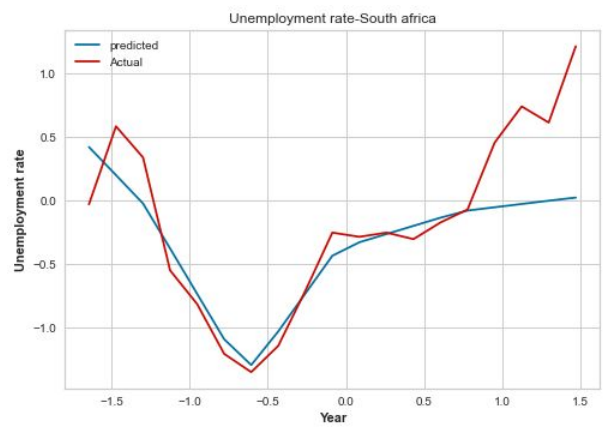
Fig. 6: Unemployment rate Vs Time using ANN for South Africa
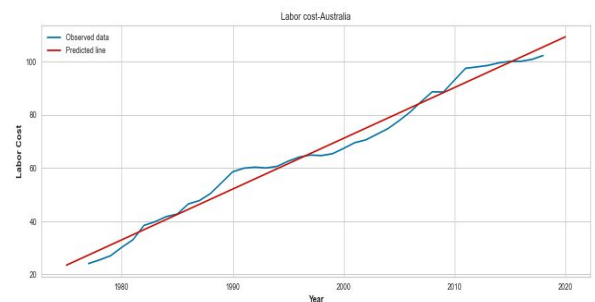
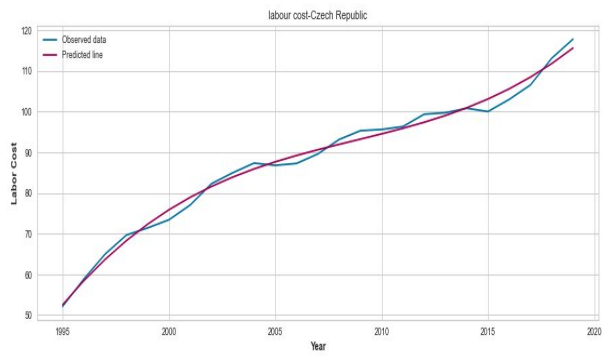Fig. 7: Labour Cost Vs Time using Linear Regression for Australia

Fig. 8: Labour Cost Vs Time using Polynomial Regression for the Czech Republic
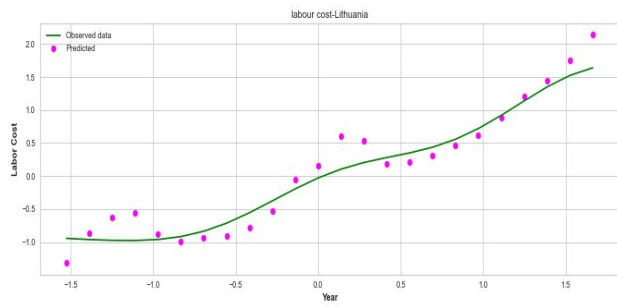

Fig. 9: Labour Cost Vs Time using SVR for Lithuania
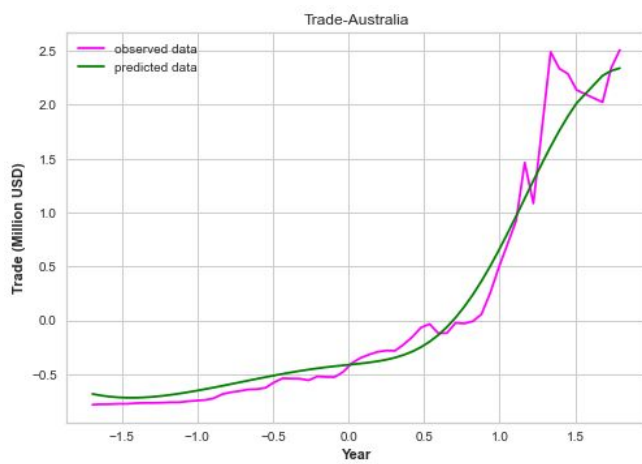

Fig. 10: International Trade Vs Time using SVR for Australia
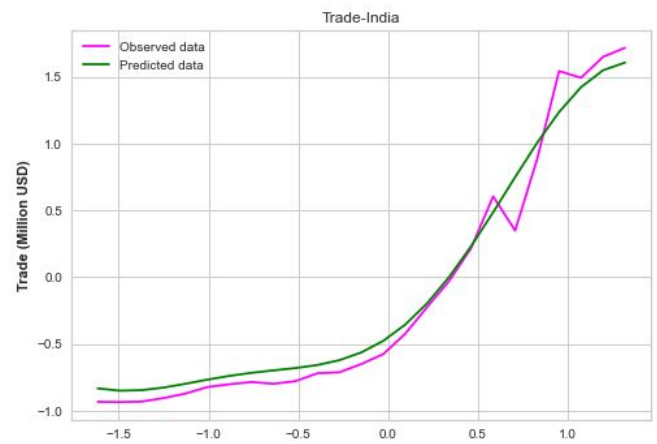

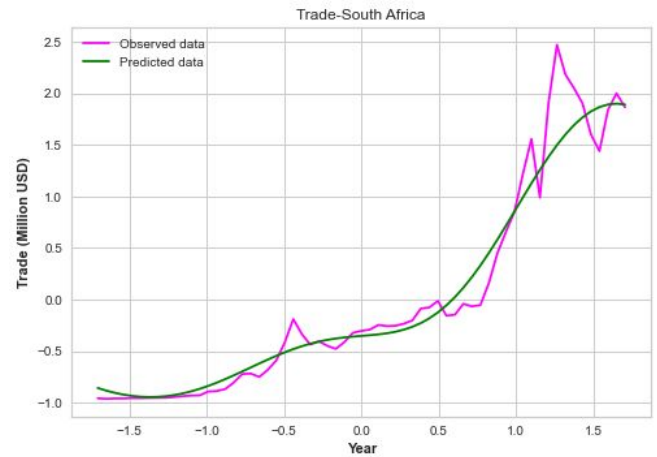Fig. 11: International Trade Vs Time using SVR for India

Fig. 11: International Trade Vs Time using SVR for South Africa