Analysis of Influence on GDP by Gold Price and Monsoon Rainfall using ARIMA forecasting and a Linear Regression Model

Hypothesis

We hypothesized that the Indian GDP depends on: rainfall, since it influences the success of the agriculture/industrial sector that itself contributes 50% of the Indian GDP; and gold price, since gold price can be perceived as an indirect representation of the foreign exchange (forex) rates applicable to the service sector.

Method

To test this idea, using historical data for the three variables (GDP, gold price, inches of monsoon rainfall), we ran three ARIMA forecasts to predict their values for the next five years after the end of our data. The results of the forecasts can be seen in Table 1.1.

Table 1.1

Year	ARIMA-predicted GDP	ARIMA-predicted Gold Price	ARIMA-predicted Monsoon Rainfall
2016	2120000000000.00	72598.98517	863.0162162
2017	2230000000000.00	71582.80432	863.0162162
2018	2310000000000.00	70980.54277	863.0162162
2019	2370000000000.00	70623.59944	863.0162162
2020	2450000000000.00	70412.04926	863.0162162

To check the hypothesis, we ran an Analysis of Variances (in R) on the data, which was updated to include the forecasted values. As can be seen in the results below, both rainfall and gold price had significant p-values since the p-values of each was less than 0.05 .

```
                  Df    Sum Sq   Mean Sq F value Pr(>F)
thedata$rainfall   1 2.316e+23 2.316e+23   6.137 0.0177 *
thedata$goldprice  1 2.293e+25 2.293e+25 607.519 <2e-16 ***
Residuals         39 1.472e+24 3.774e+22
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

After this, we used the first 10 years of the data to train a linear regression model (in R) that was used to predict the values of each variable for the next 32 years. As can be seen in the results below, the p-value for rainfall was not significant, but that of gold price was highly significant.

```
Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)        1.268e+11  3.566e+11   0.355    0.724
thedata$goldprice  2.618e+07  1.062e+06  24.648   <2e-16 ***
thedata$rainfall   1.492e+07  4.067e+08   0.037    0.971
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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Residual standard error: 1.943e+11 on 39 degrees of freedom
Multiple R-squared:  0.9402, Adjusted R-squared:  0.9372
F-statistic: 306.8 on 2 and 39 DF,  p-value: < 2.2e-16
```

Insights Into Historical Data

Graph 1.1 depicts the historical relationship between gold price and GDP. Graph 1.2 depicts the historical relationship between rainfall during the monsoon and GDP. Graph 1.3 depicts the historical price of gold by year.
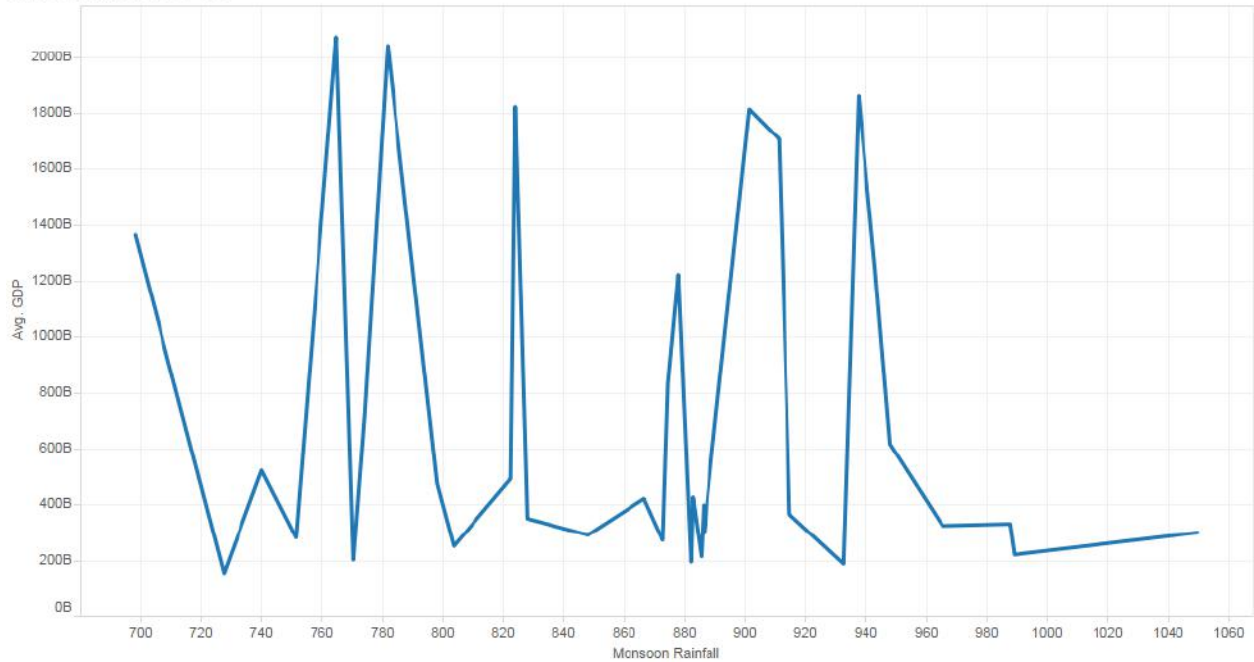
Gold Price vs GDP
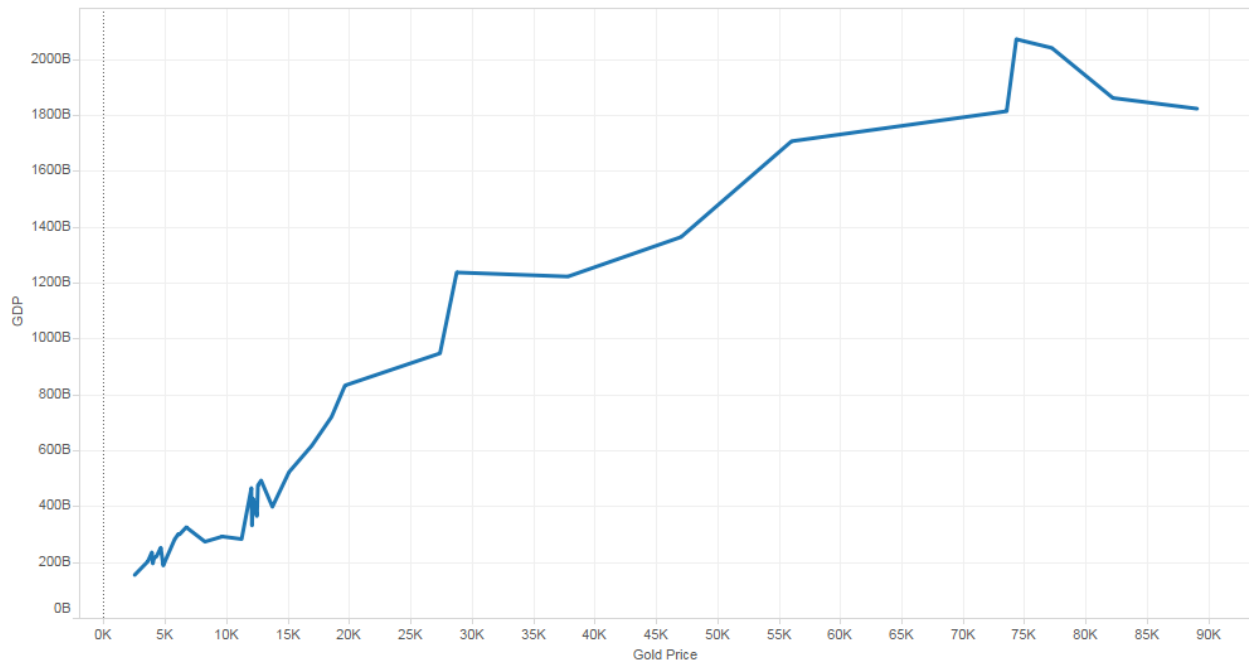
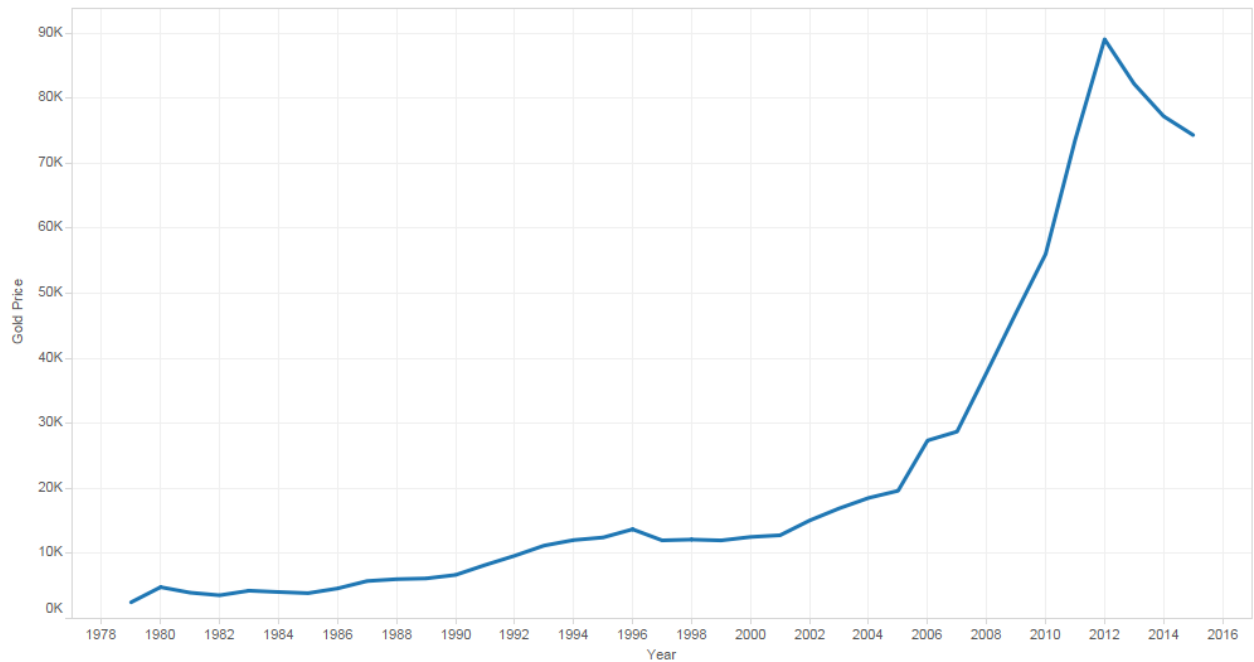The trend of sum of GDP for Gold Price.

Graph 1.1

Monsoon Rainfall vs GDP

The trend of average of GDP for Monsoon Rainfall.

Graph 1.2

Year vs Gold Price

The trend of sum of Gold Price for Year.

Graph 1.3

We find by examining Graph 1.1 that, as intuitively expected, gold price followed a general rise until 2013. However, in recent years, we see that gold prices have dropped. We cannot observe any general trend between monsoon rainfall and average GDP, but we see that when high monsoon rainfall (greater

than 950 inches) occurs, GDP remains low. Moreover, we find through Graph 1.3 that historically, gold price has increased when GDP increased (i.e. there is a general positive correlation between gold price and GDP).

Comparison of Model Predictions

Graph 1.4 compares the values predicted by the linear regression to the actual data. Graph 1.5 compares the values predicted by the linear regression to those predicted by the ARIMA model.
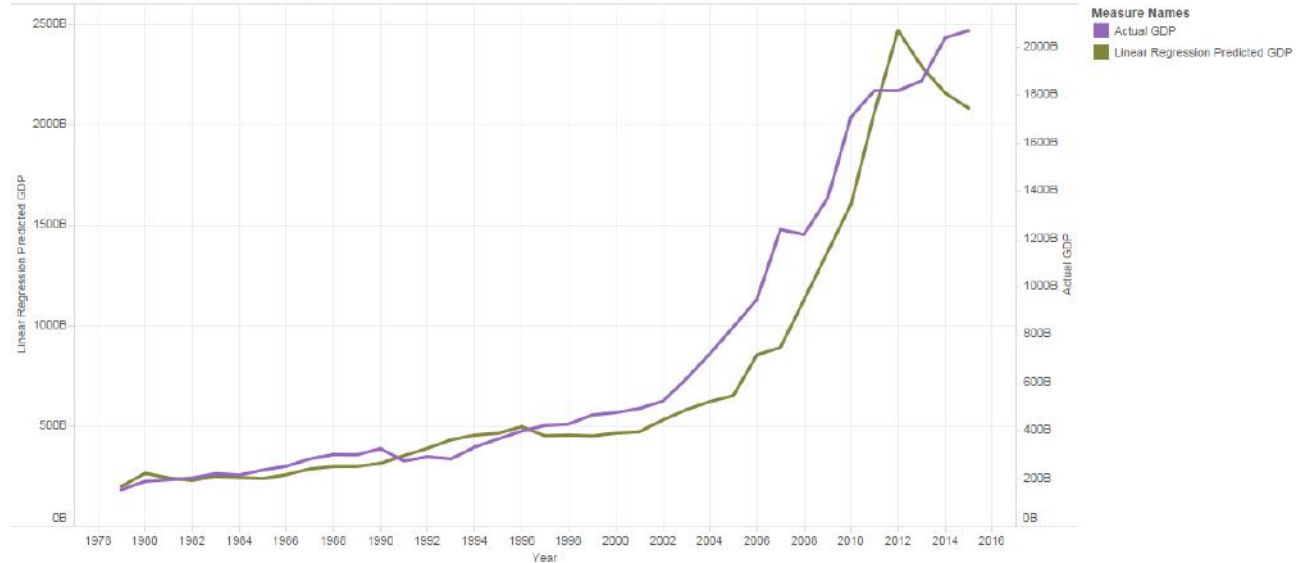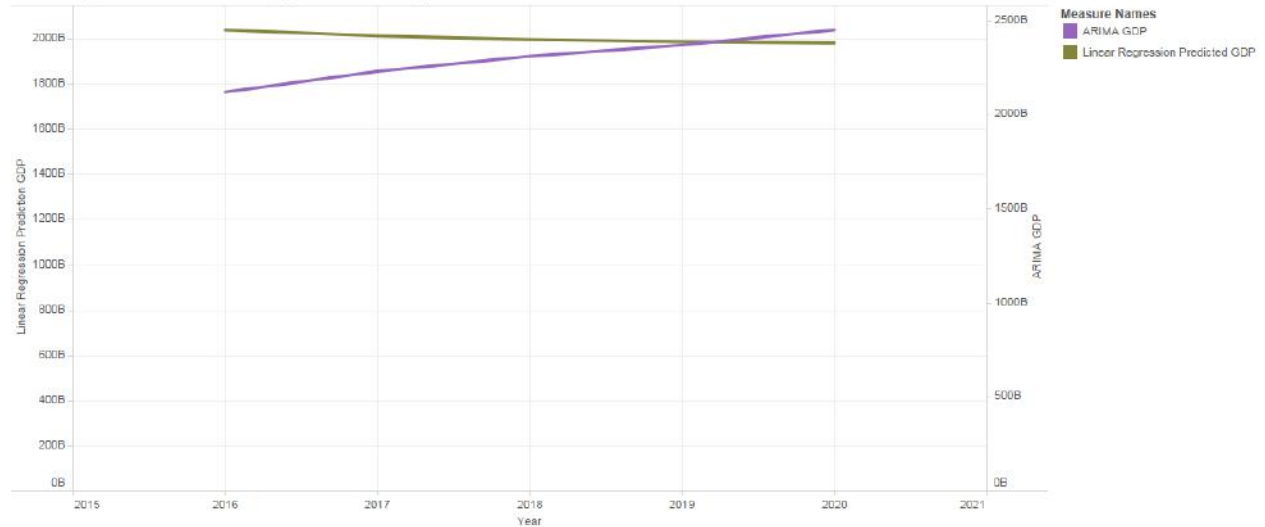

The trends of Linear Regression Predicted GDP and Actual GDP for Year. Color shows details about Linear Regression Predicted GDP and Actual GDP. The data is filtered on Year, which excludes 2016, 2017, 2018, 2019 and 2020.

Graph 1.4

The trends of Linear Regression Predicted GDP and ARIMA GDP for Year. Color shows details about Linear Regression Predicted GDP and ARIMA GDP. The data is filtered on Year, which keeps 2016, 2017, 2018, 2019 and 2020.

Graph 1.5

Looking at Graphs 1.4 and 1.5, we observe that while the ARIMA model predicted the GDP to continue the general trend of increase in the years 2016-2020, the linear regression model predicted that the GDP would drop consistently after 2015. Both models, however, found that: rainfall during the monsoon

season is not a significant factor in influencing India's GDP; but trends in gold price are significant representatives of India's GDP.

Conclusion

We conclude by stating that gold prices are a significant indicator of Indian GDP, whereas rainfall during the Indian monsoon season does not seem to have any significant relation to Indian GDP.