

A Multiple Variable Regression Model for Gross Domestic Product Growth Rate Prediction in India Using Key Macroeconomic Indicators

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Abstract: This paper attempts to build a multi variable regression model to predict the GDP growth rate in India using key macroeconomic indicators such as CPI inflation, manufacturing and services purchasing manager's index, interest rates and the price of crude oil. The relationships between GDP and these parameters, as well as their inter-relationships are studied in this paper using linear regression models. An attempt is made to understand the relationships and understand the key driving factors for growth.

Keywords: GDP Growth Rate, Crude Oil Price, Inflation, CPI, Interest Rates, Rupee Exchange Rate, Regression Model, Multi Variable Regression, Macroeconomics

I. Literature Review

Significant efforts have been made in analyzing India's GDP and building empirical models for the same. Reference [1] presents a multi-variable regression model for GDP in India between 1981 and 2002. The paper finds GDP time series over the period to be stationary and builds a model that tracks the GDP values very well using measures on different components of the GDP. Reference [2] tries to analyze the relation between inflation and growth over the period from 1981 to 2004 and finds that the growth in the economy is not related to inflation and acceleration of economic growth should be the primary focus in the country. Reference [3] presents a multi variable regression model for GDP using FDI, net FII equity and imports in India between 2001 and 2012. Reference [4] finds that broad money supply M2/GDP and stock market value/GDP have notable positive direction influences on economic growth in India.

II. Introduction

De-regulation of the price of oil in India started in 2012 and was completed in 2015. This marked a significant shift in the government policy of providing oil subsidies to oil marketing companies since the start of liberalization in 1990. The primary reason for the change in policy was high budgetary spending on oil subsidies which did not leave opportunities for spending money on developmental causes. As the price of oil in India got linked to the global economy, it changed the underlying dynamics of the economy where in close to 50% of the total energy and 80% of the crude oil are imported [5].

Price of Crude Oil and Inflation

Since crude oil in general and energy in particular are input to all kinds of economic activity, the price of crude oil in the global market would now have a significant impact on inflation in the country. This is evident in the graph of inflation against the price of crude oil on quarterly data collected from 2012 to 2015 shown below. The reference [6] describes this effect in detail.

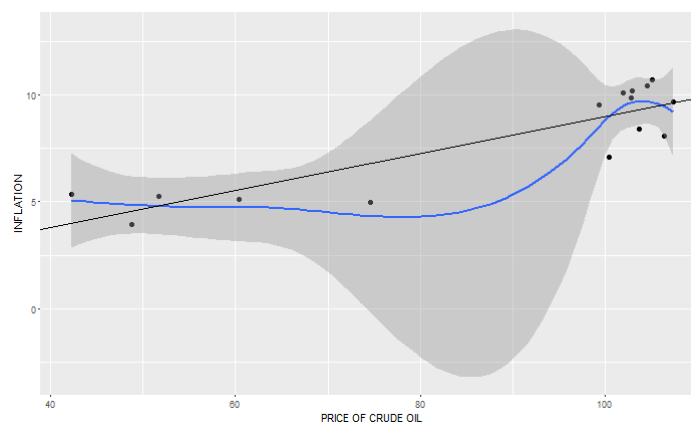


Figure 1: Regression model of CPI inflation on price of crude oil in India on data collected from 2012 to 2015 shows statistical significance with a p-value of 0.0000138. The R-squared value of 0.77 indicates most of the

variation in inflation can be explained by the price of crude oil. Source of data: <http://ieconomics.com/i/N1JLpFyCe1603>

The resulting high input costs from the cost of energy imports now have a direct impact on the growth of the economy. As shown in the graph below, there is a negative correlation between inflation and GDP growth rate on data collected between 2012 and 2015 which is statistically significant with a p-value of 0.004093.

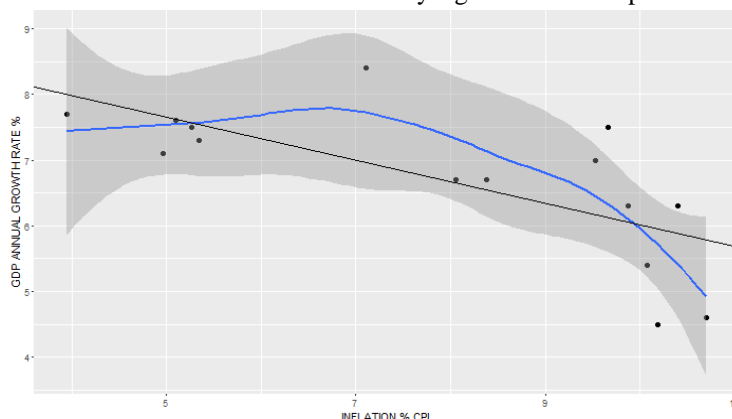


Figure 2: Linear regression model of GDP annual growth rate on Inflation is statistically significant with a p-value of 0.004093. The slope of the line is -0.32763 GDP percentage points per percent increase in CPI inflation.

Considering these 2 relations, we also developed a regression model for GDP growth rate using price of crude oil as the predictor. This model is however not statistically significant as shown below.

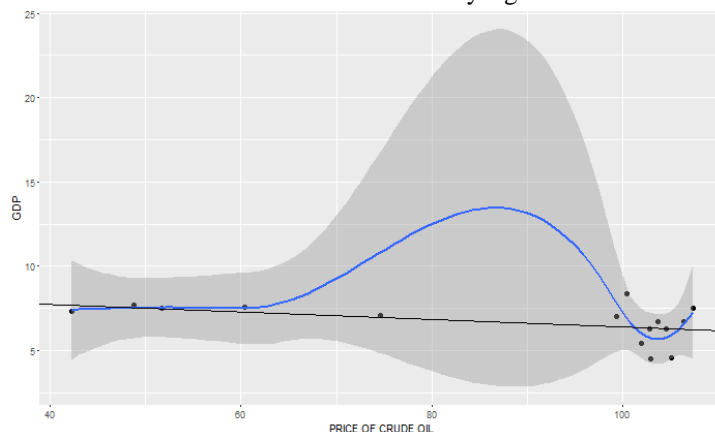


Figure 3: A linear regression model of GDP growth rate on price of crude oil is not statistically significant with a p-value of 0.06991

Based on this we can conclude that the price of crude oil and inflation combined could be good predictors for GDP growth rate in the economy.

Interest Rates and Purchasing Manager's Index

The interest rates set by the Central Bank have a very significant effect on the overall economy as they get transmitted to the businesses and individuals through the loan rates and savings rates in the banks. Central banks try to target neutral rates where the domestic consumption is equal to domestic spending. A rate below this incentivizes individuals to spend and the policy is called expansionary and a rate above is termed contractionary as it incentivizes the individuals to save. A high savings rate resulting from high interest rates would well capitalize the banks and lead to more growth in the banking sector. Higher interest rates may lead to higher yields in government bonds leading to more fund inflows in government and corporate debt. Higher spending rates resulting from low interest rates would stimulate the supply side of the economy to borrow more and spend more money. Thus interest rates would be neutral on growth in the economy overall. This is evident from the figure below depicting a regression relationship between GDP growth rate and interest rates.

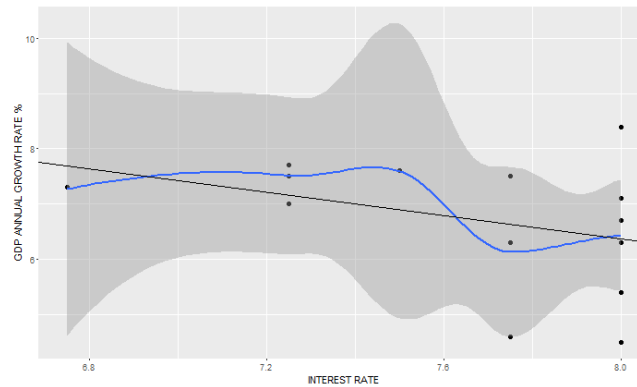


Figure 4: A regression model of GDP growth rate on interest rate is not statistically significant with a p-value of 0.1729.

Since central bankers try to target price stability (inflation) through the interest rates, we developed a regression model for CPI inflation as outcome with interest rate as the predictor and the result was not statistically significant as shown below.

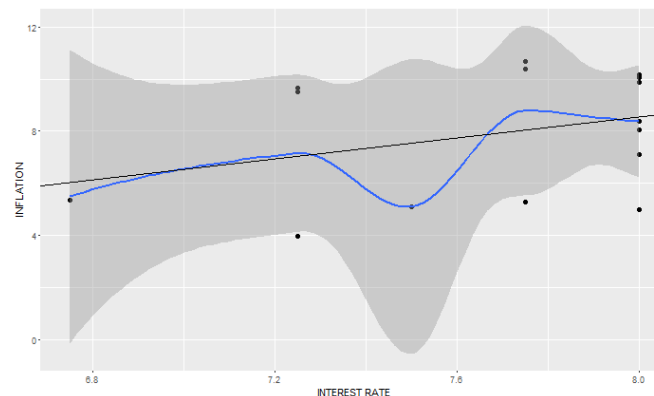


Figure 5: Regression model of CPI inflation on interest rate is not statistically significant with a p-value of 0.2275.

Lower interest rates are designed to incentivize businesses to borrow more money and spend more, leading to higher economic activity in the country and more growth. This effect is captured in the Purchasing Manager's Index reported by Markit Economics in India.

The Nikkei India Manufacturing Purchasing Managers' Index measures the performance of the manufacturing sector and is derived from a survey of 500 manufacturing companies. The Manufacturing Purchasing Managers Index is based on five individual indexes with the following weights: New Orders (30 percent), Output (25 percent), Employment (20 percent), Suppliers' Delivery Times (15 percent) and Stock of Items Purchased (10 percent), with the Delivery Times index inverted so that it moves in a comparable direction. A reading above 50 indicates an expansion of the manufacturing sector compared to the previous month; below 50 represents a contraction; while 50 indicates no change [7].

The regression model on GDP Growth Rate on Manufacturing PMI is statistically significant with p-value of 0.01829. The negative correlation seen is counter intuitive. This maybe because manufacturing does not have significant impact on the overall economy which is dominated by services.

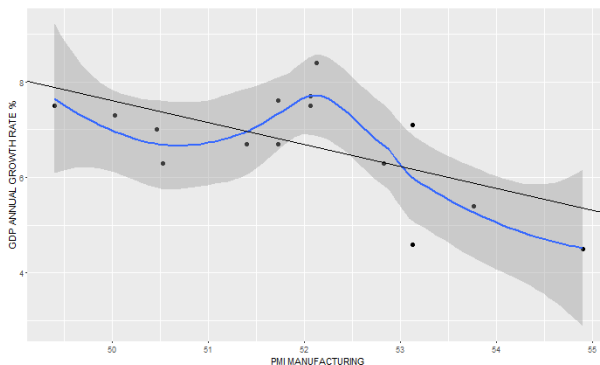


Figure 6: Regression model of GDP growth rate on Manufacturing PMI has a p-value of 0.01829 and a negative slope which is counter intuitive.

India manufacturing PMI recorded an all time high of 55.0 in June 2012. The GDP growth rate for the same quarter was 4.5%. The Manufacturing PMI for Q3 2014 was 52.1 averaged over the 3 months. India GDP growth rate in Q3 2014 was 8.4%.

The correlation between GDP and services PMI in India is not statistically significant as it has a p-value of 0.1034. Services PMI in India averaged 51.50 Index Points from 2012 until 2016, reaching an all time high of 57.50 Index Points in January of 2013 and a record low of 44.60 Index Points in September of 2013. The GDP annual growth rate in Q1 2013 was 4.6%. GDP annual growth rate in India in Q3 2013 was 7.5%.

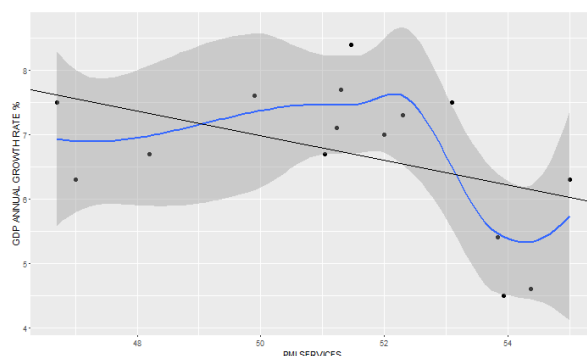


Figure 7: Regression model for GDP growth rate on Services PMI is not statistically significant with a p-value of 0.1034

Multi-Variable Regression Model for GDP Growth Rate

Based on the earlier discussion, it becomes evident that inflation, price of crude oil and interest rates will be good predictors for GDP growth rate. We would also like to add Services and Manufacturing PMI to the regression model since they are not strongly correlated to the other parameters and reflect the underlying principles of GDP growth. The resulting model is described in the table below:

Coefficients:	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	31.35076	5.21802	6.008	0.00020	***
INFLATION	-0.57278	0.16467	-3.478	0.00696	**
CRUDE.PRICE	0.02914	0.01959	1.487	0.17112	
INTEREST.RATE	0.42401	0.80499	0.527	0.61112	
PMI.Manufacturing	-0.57157	0.20544	-2.782	0.02132	*
PMI.Services	0.07338	0.08669	0.846	0.41924	
Signif. codes:	0 ‘***’	0.001 ‘**’	0.01 ‘*’	0.05 ‘.’	0.1 ‘ ’ 1
Residual standard error:	0.5286	on 9 degrees of freedom			
F-statistic: 10.97 on 5 and 9 DF				p-value: 0.001274	

Table 1: Parameters for multi variable linear regression model for GDP growth rate on inflation, price of crude oil, interest rate, Manufacturing PMI and Services PMI. The model is statistically significant with a p-value of 0.001274 and R-squared value of 85.91%.

The variance inflation factor for the model is also under 10 for all the parameters as shown below.

INFLATION	CRUDE.PRICE	INTEREST.RATE	PMI.Manufacturing	PMI.Services	
7.774178	11.432306	5.062997	4.594864	2.481451	

III. Conclusion

An attempt is made to understand the factors affecting GDP growth in India post the de-regulation of oil prices in 2011. A multi variable linear regression model is developed to predict the GDP growth rate using inflation, price of crude oil, interest rates, services and manufacturing PMI as predictors. Impact of each of these variables on GDP growth rate is studied individually.

IV. Data Sources

- [1]. <http://economics.com/i/N1JLpFyCe1603>
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