GOLD PRICES IN INDIA- MACRO ECONOMIC FACTORS AFFECTING IT

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INTRODUCTION

Today, like most commodities, the price of gold is driven by supply and demand including demand for speculation. However, unlike most other commodities, saving and disposal play a larger role in affecting its price than its consumption. Most of the gold ever mined still exists in accessible form, such as bullion and mass-produced jewellery, with little value over its fine weight — and is thus potentially able to come back onto the gold market for the right price. Prices of gold depend upon various qualitative as well as quantitative factors.

The US Dollar, Gold Production, Crude Oil Prices, Inflation Rate, Stock Markets, Silver Prices, Interest Rates, Central Bank Reserves are Quantitative factors. Whereas, Global Demand and Geo-Political Situations are some of the Qualitative factors that affect Gold prices.

OBJECTIVES OF THE STUDY

- To analyze the different factors that affects the price of gold.
- To study and analyze the impact of Exchange Rate of USD with INR on gold prices.
- To study and analyze the impact of Inflation on the gold price.
- To study and analyze the impact of BSE on the gold prices.
- To study and analyze the impact of NIFTY on the gold prices.
- To study and analyze the impact of Central Bank Reserves on the gold prices.
- To study and analyze the impact of Prices of Silver on the gold prices.

RESEARCH METHODOLOGY

The monthly data from the period Jan 2003-Feb 2015 is taken for analysis and considered the following factors:

Dependent Variable:
• Gold Prices (Per Troy Ounce)

Independent Variable:
• Exchange Rate (INR/US dollar)
• Inflation rate
• BSE
• NIFTY
• Central Bank Reserves (in 1000 crores)
• Silver Prices (Per Troy Ounce)

DATA FROM JANUARY 2003 TO FEBRUARY 2015

Month	Gold Prices (Per Troy Ounce)	India/US Exchange Rate	Inflation Rate	BSE	NIFTY	Central Bank Reserves ('000 crores)	Silver Prices
01/01/2003	17104.25	47.96	3.43%	3250.38	1100.15	339.75	232.76
01/02/2003	17135.72	47.75	3.86%	3283.66	1041.85	351.73	223.45
01/03/2003	16224.16	47.68	4.06%	3048.72	1063.4	347.41	216.64
01/04/2003	15548.35	47.39	5.12%	2959.79	984.3	355.75	214.92
01/05/2003	16746.68	47.11	4.66%	3180.75	934.05	364.7	223.78
01/06/2003	16649.12	46.7	4.41%	3607.13	1006.8	382.6	212.87
01/07/2003	16229.25	46.22	4.16%	3792.61	1130.7	380.98	224.92
01/08/2003	16526.12	45.96	3.10%	4244.73	1195.75	392.03	231.01
01/09/2003	17374.81	45.85	2.89%	4453.24	1375.95	395.59	238.71
01/10/2003	17199.35	45.4	3.29%	4906.87	1420.85	409.74	228.73
01/11/2003	17748.7	45.55	3.07%	5044.82	1555.9	419.66	236.99
01/12/2003	18553.38	45.57	3.72%	5838.96	1657.65	441.11	257.74
01/01/2004	18806.25	45.46	4.35%	5695.67	1912.25	458.64	289.57
01/02/2004	18329.5	45.27	4.13%	5667.51	1809.75	475.87	293.23
01/03/2004	18306.02	44.97	3.49%	5590.6	1852.7	490.46	328.37
01/04/2004	17716.56	43.89	2.23%	5655.09	1819.65	493.68	311.3
01/05/2004	17362.97	45.18	2.83%	4759.62	1796.1	525.74	266.05
01/06/2004	17859.21	45.5	3.02%	4795.46	1507.9	543.44	267.81
01/07/2004	18329.56	46.06	3.19%	5170.32	1537.2	547.94	293.55
01/08/2004	18560.59	46.32	4.61%	5192.08	1632.3	549.4	311.06
01/09/2004	18682.41	46.05	4.81%	5583.61	1635.45	544.3	295.92
01/10/2004	19250.39	45.74	4.57%	5672.27	1775.15	545.79	327.21
01/11/2004	19821.18	45.03	4.17%	6234.29	1797.75	551.05	338.98
01/12/2004	19442.83	43.85	3.78%	6602.69	1962.05	571.72	313.33
01/01/2005	18554.21	43.62	4.37%	6555.94	2375.1	571.68	291.23
01/02/2005	18490.66	43.58	4.17%	6713.86	2059.85	567.83	308.92
01/03/2005	18954.91	43.59	4.17%	6492.82	2084.4	592.69	317.53
01/04/2005	18775.16	43.64	4.96%	6154.44	2067.65	617.51	313.07
01/05/2005	18347.86	43.41	3.74%	6715.11	1902.5	619.43	306.74
01/06/2005	18770.58	43.52	3.32%	7193.85	2087.55	608.6	319.76
01/07/2005	18480.7	43.43	4.06%	7635.42	2211.9	605.06	306.68
01/08/2005	19105.09	43.55	3.45%	7805.43	2318.05	611.48	306.57
01/09/2005	20028.03	43.85	3.63%	8634.48	2405.75	628.92	315.91
01/10/2005	21062	44.76	4.18%	7892.32	2601.4	629.32	345.09

01/11/2005	21796.08	45.63	5.33%	8788.81	2386.75	647.76	359.58
01/12/2005	23290.06	45.56	5.57%	9397.93	2698.95	650.57	396.65
01/01/2006	24413.14	44.2	4.37%	9919.89	2492.91	618.38	407.79
01/02/2006	24603.51	44.23	4.57%	10370.24	2971.55	616.29	422.09
01/03/2006	24776.99	44.34	4.57%	11279.96	3123.1	629.15	461.44
01/04/2006	27448.49	44.82	4.65%	12042.56	3402.55	676.39	567.78
01/05/2006	30668.98	45.2	5.93%	10398.61	3557.6	722.56	607.5
01/06/2006	27455.73	45.89	7.27%	10609.25	2962.25	744.93	496.21
01/07/2006	29439.75	46.37	6.33%	10743.88	3128.2	750.7	520.88
01/08/2006	29440.3	46.45	5.94%	11699.05	3147.8	763.39	570.29
01/09/2006	27588.91	46.01	6.40%	12454.42	3435.45	774.55	534.97
01/10/2006	26634.49	45.36	6.92%	12961.9	3588.4	759.75	528.14
01/11/2006	28162.44	44.73	5.95%	13696.31	3767.05	756.05	582.45
01/12/2006	28110.41	44.48	6.53%	13786.91	3997.6	783.97	593.56
01/01/2007	27985.57	44.21	6.72%	14090.92	1929.76	783.98	570.48
01/02/2007	29356.7	44.02	7.56%	12938.09	4137.2	792.12	615.88
01/03/2007	28832.08	43.79	6.72%	13072.1	3811.2	855.08	579.5
01/04/2007	28636.08	42.02	6.67%	13872.37	3821.55	868.22	578.83
01/05/2007	27220.91	40.57	6.61%	14544.46	4087.9	840.09	537.93
01/06/2007	26726.01	40.59	5.69%	14650.51	4297.05	844.88	536.2
01/07/2007	26892.24	40.27	6.45%	15550.99	4318.3	869.94	522.76
01/08/2007	27160.49	40.68	7.26%	15318.6	4345.85	912.4	503.37
01/09/2007	28748.42	40.17	6.40%	17291.1	4464	937.36	521.56
01/10/2007	29816.8	39.37	5.51%	19837.99	5068.95	984.6	542.19
01/11/2007	31798.42	39.33	5.51%	19363.19	5866.45	1,037.11	578.66
01/12/2007	31678.33	39.38	5.51%	20286.99	5762.75	1,085.06	564.48
01/01/2008	35025.78	39.27	5.51%	17648.71	6144.35	1,087.00	632.29
01/02/2008	36,642.46	39.67	5.47%	17578.72	5317.25	1,151.99	701.87
01/03/2008	39,082.77	40.15	7.87%	15644.44	5223.5	1,202.53	775.49
01/04/2008	36,416.00	39.97	7.81%	17287.31	4739.55	1,239.56	700.96
01/05/2008	37,435.38	42	7.75%	16415.57	5165.9	1,256.91	718.2
01/06/2008	38,087.88	42.76	7.69%	13461.6	4870.1	1,339.94	729.63
01/07/2008	40,256.56	42.7	8.33%	14355.75	3896.75	1,333.96	773.8
01/08/2008	36,026.85	42.91	9.02%	14564.53	4413.55	1,294.41	625.97
01/09/2008	37,815.02	45.53	9.77%	12860.43	4348.65	1,293.16	555.58
01/10/2008	39,235.79	48.62	10.45%	9788.06	3950.75	1,352.62	507.2
01/11/2008	37,284.82	48.85	10.45%	9092.72	2885.6	1,245.44	483.55
01/12/2008	39,696.27	48.51	9.70%	9647.31	2682.9	1,234.46	501.82
01/01/2009	41,938.42	48.7	10.45%	9424.24	3033.45	1,220.87	556.73
01/02/2009	46,416.55	49.25	9.63%	8891.61	2874.8	1,218.69	661.39

01/03/2009	47,387.48	51.13	8.03%	9708.5	2763.65	1,264.59	672.41
01/04/2009	44,573.36	49.97	8.70%	11403.25	3060.35	1,275.44	626.9
01/05/2009	45,070.86	48.51	8.63%	14625.25	3473.95	1,264.05	684.92
01/06/2009	45,178.09	47.67	9.29%	14493.84	4529.9	1,240.44	700.33
01/07/2009	45,317.28	48.36	11.89%	15670.31	4340.9	1,282.32	649.34
01/08/2009	45,872.80	48.24	11.72%	15666.64	4636.45	1,308.22	697.27
01/09/2009	48,273.82	48.29	11.64%	17126.84	4625.35	1,349.90	798.5
01/10/2009	48,737.49	46.65	11.49%	15896.28	5083.4	1,343.89	806.59
01/11/2009	52,484.94	46.53	13.51%	16926.22	4711.7	1,335.50	832.51
01/12/2009	52,912.18	46.53	14.97%	17464.81	5122	1,342.42	822.77
01/01/2010	51,344.51	45.89	16.22%	16357.96	6531.61	1,322.68	815.23
01/02/2010	50,745.87	46.27	14.86%	16429.55	4899.7	1,302.79	735.29
01/03/2010	50,654.61	45.45	14.86%	17527.77	4922.3	1,286.85	780.5
01/04/2010	51,115.41	44.44	13.33%	17558.71	5290.5	1,257.71	808.47
01/05/2010	55,173.35	45.77	13.91%	16944.63	5278	1,242.69	843.2
01/06/2010	57,410.36	46.5	13.73%	17700.9	4970.2	1,261.85	863.04
01/07/2010	55,916.83	46.76	11.25%	17868.29	5251.4	1,288.89	840.87
01/08/2010	56,616.02	46.46	9.88%	17971.12	5367.6	1,320.31	861.13
01/09/2010	58,511.77	45.87	9.82%	20069.12	5471.85	1,324.63	948.87
01/10/2010	59,609.35	44.35	9.70%	20032.34	6143.4	1,314.79	1,042.42
01/11/2010	61,476.45	44.93	8.33%	19521.25	6117.55	1,327.10	1,192.47
01/12/2010	62,809.82	45.1	9.47%	20509.09	5960.9	1,342.06	1,326.77
01/01/2011	61,559.14	45.38	9.30%	18327.76	4477.36	1,332.35	1,295.79
01/02/2011	62,397.21	45.38	8.82%	17823.4	5417.2	1,366.32	1,402.67
01/03/2011	64,065.11	44.91	8.82%	19445.22	5522.3	1,365.93	1,617.20
01/04/2011	65,680.20	44.3	9.41%	19135.96	5826.05	1,364.00	1,899.62
01/05/2011	67,908.18	44.9	8.72%	18503.28	5749.5	1,391.37	1,664.75
01/06/2011	68,563.18	44.81	8.62%	18845.87	5592	1,400.51	1,607.53
01/07/2011	69,830.14	44.4	8.43%	18197.2	5627.2	1,411.88	1,693.08
01/08/2011	79,563.84	45.31	8.99%	16676.75	5516.8	1,409.10	1,824.81
01/09/2011	84,523.72	47.69	10.06%	16453.76	5001	1,465.01	1,819.89
01/10/2011	81,994.94	49.2	9.39%	17705.01	4943.25	1,524.08	1,578.80
01/11/2011	88,105.76	50.68	9.34%	16123.46	5257.95	1,564.45	1,686.23
01/12/2011	86,427.38	52.38	6.49%	15454.92	4936.85	1,579.00	1,586.19
01/01/2012	84,638.12	51	5.32%	17193.55	3590.96	1,580.40	1,576.20
01/02/2012	85,650.02	49.18	7.57%	17752.68	5235.7	1,469.00	1,679.75
01/03/2012	84,229.13	50.36	8.65%	17404.2	5339.75	1,449.43	1,657.11
01/04/2012	85,459.44	51.69	10.21%	17318.81	5295.55	1,506.13	1,634.37
01/05/2012	86,460.52	54.33	10.16%	16218.53	5248.15	1,551.86	1,569.59
01/06/2012	89,578.52	55.94	10.05%	17429.98	4841.6	1,599.80	1,567.92

01/07/2012	88,281.52	55.42	9.84%	17236.18	5278.9	1,632.95	1,523.65
01/08/2012	90,579.25	55.49	10.31%	17429.56	5240.5	1,601.73	1,598.43
01/09/2012	95,194.24	54.35	9.14%	18762.74	5258.5	1,618.46	1,833.63
01/10/2012	92,496.06	53.1	9.60%	18505.38	5718.8	1,553.57	1,757.55
01/11/2012	94,207.98	54.78	9.55%	19339.9	5645.05	1,581.01	1,793.35
01/12/2012	92,015.41	54.65	11.17%	19426.71	5879.85	1,605.85	1,740.87
01/01/2013	90,803.41	54.23	11.62%	19894.98	5950.85	1,625.76	1,687.06
01/02/2013	87,471.13	53.81	12.06%	18861.54	5998.9	1,573.80	1,629.97
01/03/2013	86,644.52	54.42	11.44%	18835.77	5719.7	1,581.23	1,565.88
01/04/2013	80,903.29	54.32	10.24%	19504.18	5704.4	1,590.06	1,378.70
01/05/2013	77,818.64	54.98	10.68%	19760.3	5930.2	1,609.35	1,267.87
01/06/2013	78,355.69	58.38	11.06%	19395.81	5985.95	1,643.17	1,231.26
01/07/2013	76,847.39	59.76	10.85%	19345.7	5898.85	1,691.98	1,178.27
01/08/2013	85,442.04	62.81	10.75%	18619.72	5727.85	1,652.23	1,383.89
01/09/2013	85,891.21	63.65	10.70%	19379.77	5471.8	1,834.06	1,437.07
01/10/2013	81,142.34	61.61	11.06%	21164.52	5780.05	1,717.96	1,350.77
01/11/2013	80,007.36	62.52	11.47%	20791.93	6307.2	1,740.28	1,301.68
01/12/2013	75,670.26	61.81	9.13%	21170.68	6176.1	1,815.47	1,218.52
01/01/2014	77,312.91	62.11	7.24%	20513.85	6301.65	1,835.84	1,234.87
01/02/2014	80,943.59	62.16	6.73%	21120.12	6089.5	1,818.51	1,298.32
01/03/2014	81,456.73	60.95	6.70%	22386.27	6276.95	1,827.15	1,262.99
01/04/2014	78,370.05	60.35	7.08%	22417.8	6721.05	1,829.20	1,191.20
01/05/2014	76,477.43	59.28	7.02%	24217.34	6696.4	1,891.89	1,147.81
S01/06/2014	76,378.35	59.74	6.49%	25413.78	7229.95	1,846.84	1,187.80
01/07/2014	78,718.95	60.1	7.23%	25894.97	7634.7	1,895.49	1,256.71
01/08/2014	78,867.16	60.87	6.75%	26638.11	7602.6	1,950.89	1,201.83
01/09/2014	75,285.57	60.89	6.30%	26630.51	8027.7	1,952.33	1,118.37
01/10/2014	74,997.34	61.35	4.98%	27865.83	7945.55	1,900.57	1,052.92
01/11/2014	72,491.16	61.69	4.12%	28693.99	8324.15	1,906.34	984.74
01/12/2014	75,291.99	62.82	5.86%	27499.42	8555.9	1,852.32	1,021.88
01/01/2015	77,715.80	62.03	7.17%	29182.95	8284	1,856.34	1,070.97
01/02/2015	76,113.23	62.44	5.24%	29361.5	8797.4	1,845.21	1,041.26

STATISTICAL TOOLS USED

- **TREND ANALYSIS**

I have used Microsoft Excel to predict the linear trend of a factor by using the trend line function after creatinga graphical representation of the factors from the given data. It basically shows whether the factor has a positive or negative trend i.e. whether it is increasing or decreasing over a period of time and at what rate.

- **CORRELATION**

Pearson's coefficient, also known as the zero-order coefficient measures degree to which a relationship conforms to a straight line. It lets us know that the linear model that I assumed here is correct to what degree. Partial and semi partial correlations provide another means of assessing the relative "importance" of independent variables in determining Y. Basically, they show how much each variable uniquely contributes to R square over and above that which can be accounted for by the other Independent Variables. The partial correlation analysis assumes great significance in cases where the phenomena under consideration have multiple factors influencing them, especially in physical and experimental sciences, where it is possible to control the variables and the effect of each variable can be studied separately. This technique is of great use in various experimental designs where various interrelated phenomena are to be studied.

- **MULTIPLE REGRESSION ANALYSIS**

I. I started with a multiple regression analysis of Gold Prices as the dependent variable and exchange rates, inflation rates, BSE SENSEX, NIFTY, total reserves and silver prices as the independent variables.

II. The regression equation will be:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

Where,
X_1= Exchange rate (INR/US dollar)
X_2= Inflation rate
X_3= BSE SENSEX
X_4= NIFTY
X_5= Total reserves (in 1000 crores)
X_6= Silver prices (per troy ounce)
3.The comparative analyses were conducted using ANOVA test and results were analysed to determine the significance of the model.

4.I also obtained the coefficient table to determine the value of β coefficients and test the significance of individual independent variables using their t-values.

- **CENTRALLIMIT THEOREM**

In probability theory, the central limit theorem (CLT) states that, given certain conditions, the arithmetic mean of a sufficiently large number of iterates (generally greater than 50) of independent random variables, each with a well-defined expected value and well defined variance, will approximately be normally distributed. That is, suppose that a sample is obtained containing a large number of observations, each observation being randomly generated in a way that does not depend on the values of the other observations, and that the arithmetic average of the observed values is computed. If this procedure is performed many times, the computed average will not always be the same each time. The central limit theorem says that the computed values of the average will be distributed according to the normal distribution.

- **LINEAR REGRESSION**

Linear regression is an approach to modelling the relationship between a scalar dependent variable *y* and one or more explanatory variables denoted *X*. The case of one explanatory variable is called simple regression. More than one explanatory variable is multiple regressions. A linear regression line has an equation of the form $Y = a + bX$, where *X* is the explanatory variable and *Y* is the dependent variable. The slope of the line is *b*, and *a* is the intercept (the value of *y* when $x = 0$).

- **STANDARD DEVIATION**

Standard deviation (represented by the symbol sigma, **σ**) shows how much variation or "dispersion" exists from the average (mean, or expected value). A low standard deviation indicates that the data points tend to be very close to the mean; high standard deviation indicates that the data points are spread out over a large
range of values.

- **VARIANCE**

Variance is a measure of how far a set of numbers is spread out. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value).

- **ANOVA**

Analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes *t*-test to more than two groups.

- **HYPOTHESIS TESTING**

Hypothesis testing refers to the process of choosing between competing hypotheses about a probability distribution, based on observed data from the distribution.

Statistical Hypotheses:

The best way to determine whether a statistical hypothesis is true would be to examine the entire population. Since that is often impractical, researchers typically examine a random sample from the population. If sample data are not consistent with the statistical hypothesis, the hypothesis is rejected.

There are two types of statistical hypotheses.

a**). Null hypothesis**: The null hypothesis, denoted by H0, is usually the hypothesis that sample observations result purely from chance.

b). **Alternative hypothesis**: The alternative hypothesis, denoted by H1 or Ha, is the hypothesis that sample observations are influenced by some non-random cause.

- **PARTIAL CORRELATION**

Partial correlation measures the degree of association between two random variables, with the effect of a set of controlling random variables removed.

- **MULTICOLLINEARITY**

Collinearity is a linear relationship between *two* explanatory variables. Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated.

- **COEFFICIENT OF DETERMINATION (R SQUARE)**

R_2 is most often seen as a number between 0 and 1.0, used to describe how well a regression line fits a set of data. An R_2 near 1.0 indicates that a regression line fits the data well, while an R_2 closer to 0 indicates a regression line does not fit the data very well. It is the proportion of variability in a data set that is accounted for by the statistical model. It provides a measure of how well future outcomes are likely to be predicted by the model.

- **MEAN AND MEDIAN**

The mean is equal to the sum of the values divided by the number of values. The mode is the value that appears most often in a set of data. Median is described as the numerical value separating the higher half of a sample, a population, or a probability distribution, from the lower half. Together they are a part ofsummary tables.

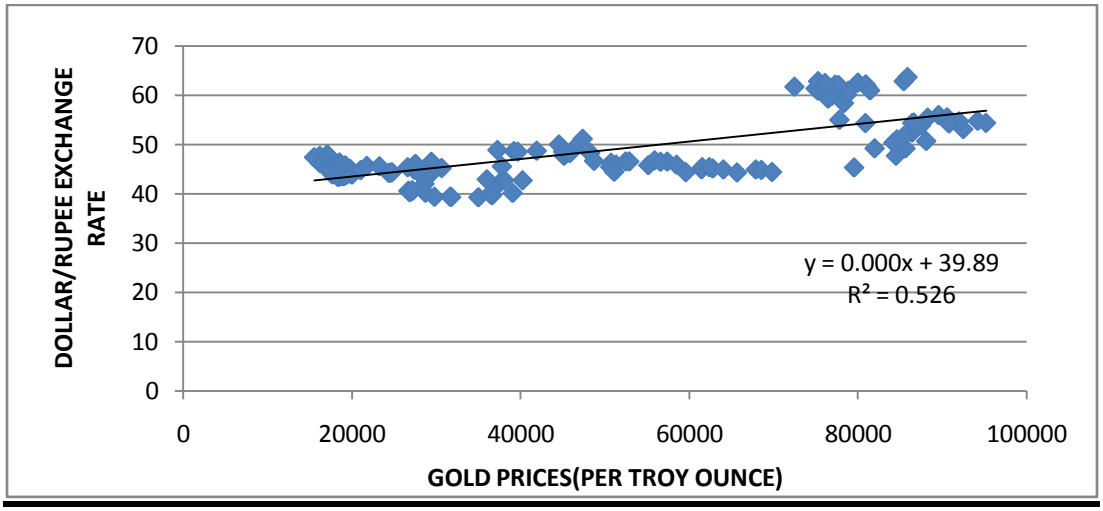
- **MS EXCEL**

By using MS Excel, I did the trend analysis and saw the various trends related to my study. I also formed certain graphs to show the above stated impact. And found out the values of Mean, Median, Mode, Standard Deviation and Skewness.

DATA ANALYSIS

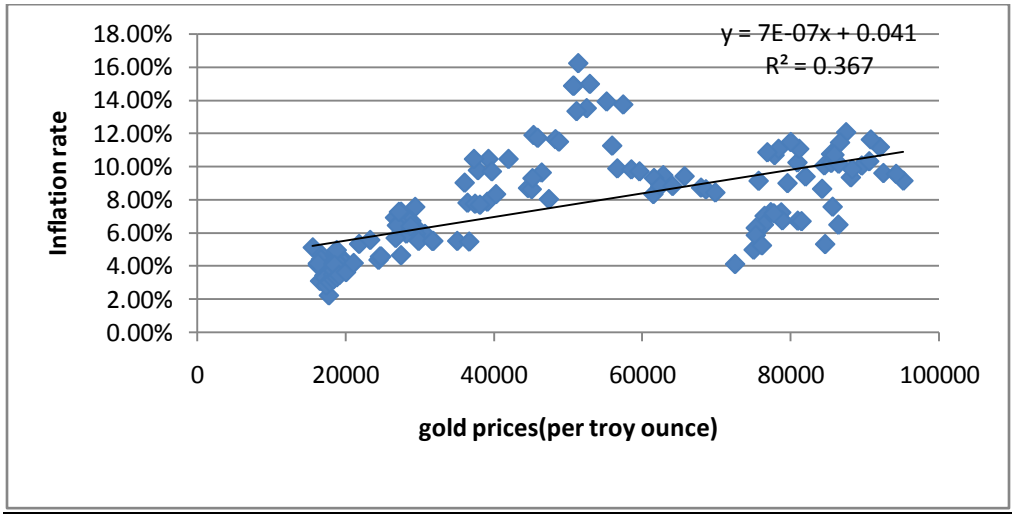
- **TREND ANALYSIS CHARTS**

1. **GOLD AND DOLLAR/RUPEE EXCHANGE RATE**



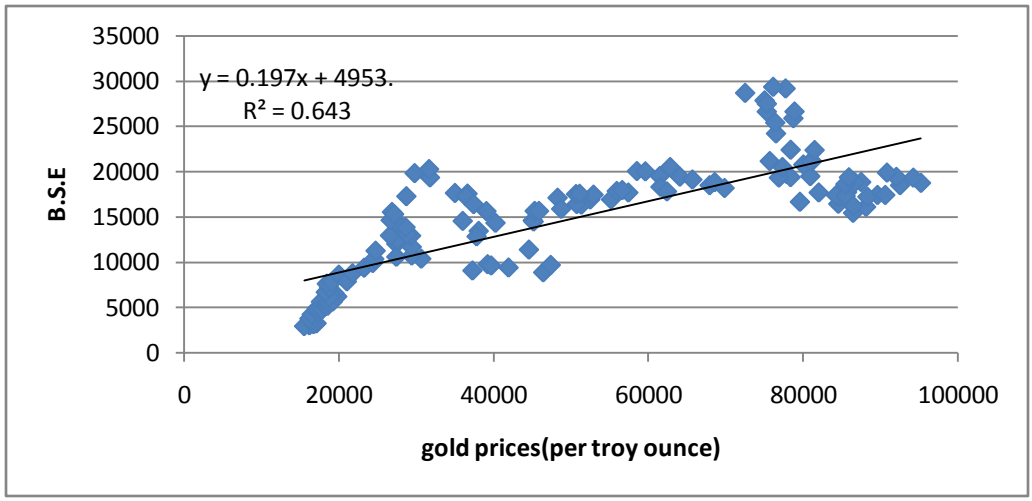
The above chart shows that there is a positive correlation between exchange rate and gold prices and the slope of the independent variable, i.e, exchange rate is **0.0002**.The correlation coefficient is **0.725**in this case. R square is **0.526**, which means that **52.6**% of variation in gold prices is explained by exchange rates.

2. **GOLD PRICES AND INFLATION RATE**



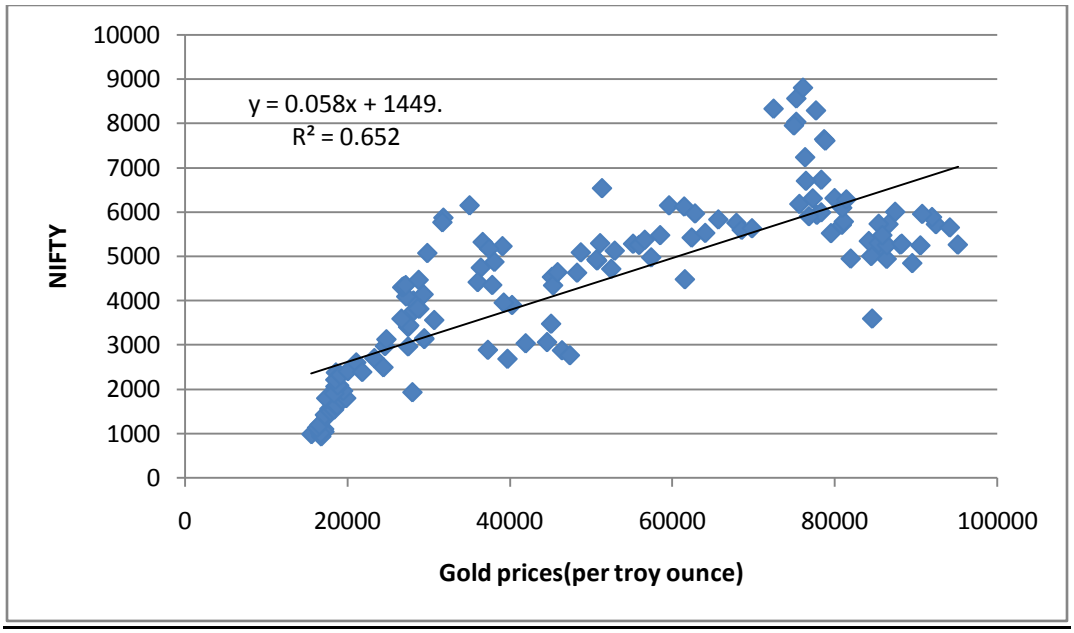
The above chart shows that inflation rate and gold prices have a positive correlation and the slope of the independent variable, i.e, inflation rate is **0.000007**. The correlation coefficient is **0.606**. R square is **0.367** which means **36.7**% of the variation in gold prices is explained by inflation rate.

3. GOLD PRICES AND B.S.E



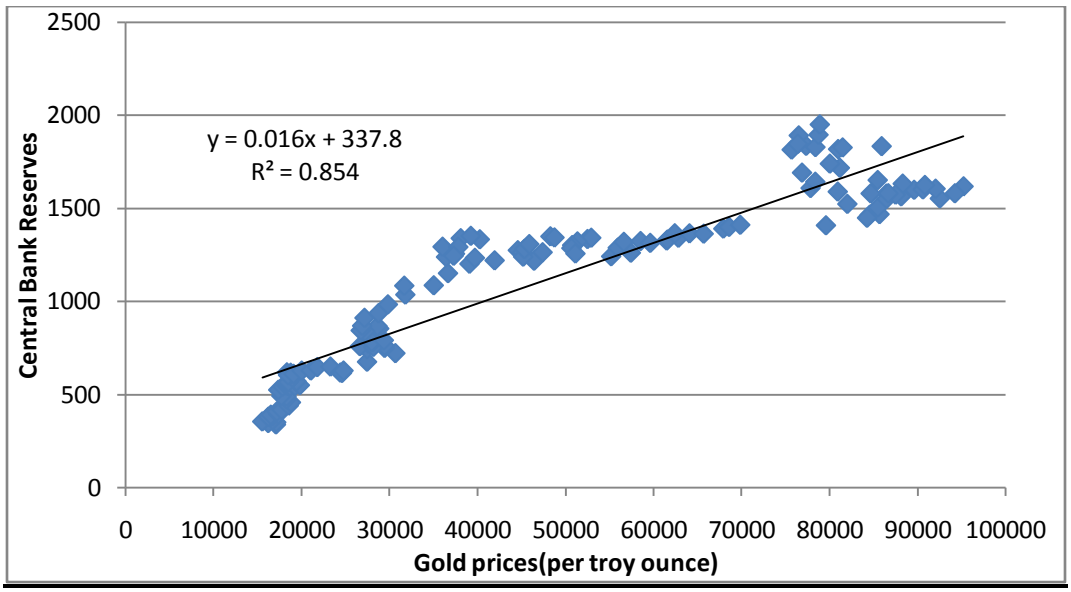
The above chart shows that BSE SENSEX and gold prices have a positive correlation and that the slope of the independent variable, i.e, BSE SENSEX is **0.197**. The correlation coefficient is **0.802**. R square is **0.643** which means that **64.3**% of variation in gold prices is explained by BSE SENSEX.

4. GOLD AND NIFTY



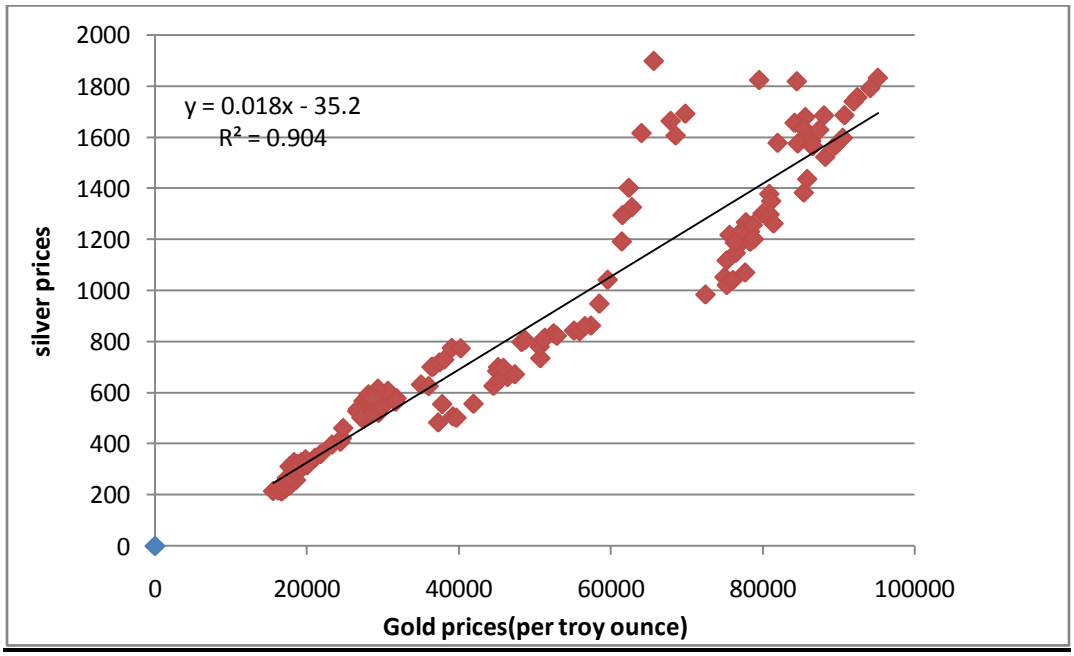
The above chart shows that the correlation between NIFTY and gold prices is positive and the slope of the independent variable, i.e, NIFTY is **0.058**. The correlation coefficient is **0.808**. R square is **0.652** which means that **65.2**% of the variation in gold prices is explained by NIFTY

5. GOLD PRICES AND CENTRAL BANK RESERVES



The above chart shows that total reserves and gold prices have positive correlation and slope of the independent variable, i.e, total reserves is **0.016**. The correlation coefficient is **0.923**. R square is **0.854** which means that **85.4**% variation in gold prices is explained by total reserves.

6. GOLD PRICES AND SILVER PRICES



The above chart shows that silver prices and gold prices have a positive correlation and the slope of the independent variable, i.e, silver prices is 0.018. The correlation coefficient is **0.951**. R square is **0.904** which means that **90.4**% of the variation in gold prices is explained by silver prices.

- **CORRELATIONS**

	gold	exchange rate	inflation	BSE	NIFTY	Central Bank Reserves	silver
Gold	1.000	0.725	0.606	0.802	0.808	0.923	0.951
exchange rate	0.725	1.000	0.247	0.563	0.559	0.709	0.540
inflation	0.606	0.247	1.000	0.509	0.537	0.633	0.567
BSE	0.802	0.563	0.509	1.000	0.977	0.905	0.732
NIFTY	0.808	0.559	0.537	0.977	1.000	0.909	0.738
C.B.Reserves	0.923	0.709	0.633	0.905	0.909	1.000	0.826
Silver	0.951	0.540	0.567	0.732	0.738	0.826	1.000

INTERPRETATION:

By the above correlations table we analyse that:

1. The Correlation Coefficient between **GOLD** and **SILVER PRICES** is **0.951**, which is the highest in comparison to any other variable. This shows that these two variables are highly related to each other. Also, since the correlation coefficient is positive, the two are directly or positively related. Any increase(or decrease) in the Silver Prices leads to a tremendous proportional increase (or decrease) in the value of Gold.

2.The Correlation Coefficient between **GOLD** and **TOTAL RESERVES** is **0.923**, which is the second highest in comparison to any other variable. Again these two variables are very highly as well as directly or positively related. So, Gold prices increase (or decrease) very rapidly with a proportional increase (or decrease) in the value of Total Reserves.

3. The Correlation Coefficient between **GOLD** and **NIFTY** is **0.808**, which shows that the two are highly and directly related to each other. Any increase (or decrease) in NIFTY leads to a high increase (or decrease) in the value of gold prices.

4.The Correlation Coefficient of **0.802** between **GOLD** and **BSE SENSEX** shows a direct and a positive relationship between the two variables under consideration. Thus, any increase(or decrease) in BSE leads to a high increase (or decrease) in the value of gold prices.

5.The Correlation Coefficient of **0.725** between **GOLD** and **EXCHANGE RATE** again shows a direct and a positive relationship between the two variables. But relative to other variables of our study, this relation

between Gold and Exchange rate is the second lowest. Thus, when compared to other determinants, any change in exchange rate will not as significantly affect Gold prices as a change in other factors.

6. The Correlation Coefficient between **GOLD** and **INFLATION** is **0.606**, which means that there is a direct relation between the two factors. But this relationship is the weakest in our study. The correlation coefficient is the lowest between the two variables when compared to other determinants like Silver prices, Total Reserves, NIFTY, BSE Sensex and Exchange Rate. Therefore, we can say that any change in Inflation will not as significantly affect Gold prices as a change in other variables of the study.

- **DESCRIPTIVES**

In the table displayed below, I have shown the **mean, minimum** and **maximum values, standard error of mean, standard deviation and skewness** of all our variables taken in the study.

	N	Minimum	Maximum	Mean		St. Dev.	Variance	Skewness
	statistic	statistic	statistic	statistic	std. error	statistic	Statistic	statistic
INR/US$ exchange	146	39.27	63.65	48.45	0.5299	6.402843	40.99640142	0.9964
inflation rate	146	2.23%	16.22%	7.54%	0.25%	3.07%	0.09%	0.436977
B.S.E	146	2959.79	29361.5	14454.78	531.796	6425.714	41289806.18	-0.01752
NIFTY	146	934.05	8797.4	4273.09	156.907	1895.917	3594503.103	0.007259
Total reserves(Rs.'000cr)	146	339.75	1952.33	1136.41	39.4273	476.4017	226958.5525	-0.1116
silver prices	146	212.87	1899.62	841.08	41.3769	499.959	249958.9519	0.539332
Gold prices	146	15548.35	95194.24	48220.12	2165.14	26161.54	684426051.5	0.308094

Notes:

- **N** shows the number of observations taken for a variable. In our project we have taken 140observations for all variables.
- **Minimum** shows the smallest or minimum value of the variable.
- **Maximum** shows the largest or maximum value taken by the variable.
- Statistical **Mean** shows the arithmetic mean across the observations. It is equal to the sum of all observations divided by number of observations. It is the most widely used measure of central tendency. It is commonly called the average. The mean is sensitive to extremely large or small values.
- The **standard error of the mean** (SEM) is the standard deviation of the sample-mean's estimate of a population mean.SEM is usually estimated by the sample estimate of the population standard deviation divided by the square root of the sample size.
- **Standard deviation** shows the square root of the variance. It measures the spread of a set of observations. The larger the standard deviation is, the more spread out the observations are.
- The **variance** is a measure of variability. It is the sum of the squared distances of data value from the mean divided by the variance divisor. The Corrected SS is the sum of squared distances of data value from the mean. Therefore, the variance is the corrected SS divided by N-1. We don't generally use variance as an index of spread because it is in squared units. Instead, we use standard deviation.

- **Skewness** measures the degree and direction of asymmetry. A symmetric distribution such as a normal distribution has a skewness of 0, and a distribution that is skewed to the left, e.g. when the mean is less than the median, has a negative skewness.

- **MULTIPLE REGRESSION ANALYSIS**

COEFFICIENTS

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-40865.320	2886.185	-14.159	0.000	-46572.184	-35158.456
Dollar/Rupee exchange rate	916.433	69.614	13.165	0.000	778.786	1054.081
inflation rate	56765.075	12790.988	4.438	0.000	31473.409	82056.740
BSE	0.005	0.205	0.026	0.979	-0.400	0.411
NIFTY	-0.129	0.701	-0.184	0.855	-1.514	1.257
Central bank reserves	12.109	2.300	5.263	0.000	7.560	16.657
Silver Prices	32.231	0.959	33.613	0.000	30.335	34.127

HYPOTHESIS TESTING:

In order to prove that the above factors have an impact but cannot be wholly considered due to external factors, we use the method of regression analysis through MS-EXCEL with the help of Hypothesis testing. We first define our null and alternate hypothesis as follows:-

H0 = Null Hypothesis: The variable is insignificant

H1 = Alternative Hypothesis: The variable is significant

Firstly, we are going to check the significance of every variable at 95% Confidence Interval. For this we will be using P-value. If the p-value or significance level is less than 0.05, we will reject the null hypothesis, H0 and we will accept the alternative hypothesis, H1.

H0 = Exchange Rate is an insignificant variable

H1 = Exchange Rates is a significant variable

Since p-value is 0.00 which is less than 0.05, we will reject H0 and accept H1, thus, implying exchange rateis a significant variable.

H0 = Inflation Rates is an insignificant variable

H1 = Inflation Rates is a significant variable

Since p-value is 0.00 which is less than 0.05, we will reject H0 and accept H1, thus, implying inflation rate isa significant variable.

H0 = BSE is an insignificant variable
H1 = BSE is a significant variable

Since p-value is 0.979 which is more than 0.05, we will reject H1 and accept H0, thus, implying BSE is aninsignificant variable.

H0 = NIFTY is an insignificant variable
H1 = NIFTY is a significant variable

Since p-value is 0.855 which is more than 0.05, we will reject H1 and accept H0, thus, implying NIFTY is an insignificant variable.

H0 = Total reserves is an insignificant variable
H1 = Total reserves is a significant variable

Since p-value is 0.00 which is less than 0.05, we will reject H0 and accept H1, thus, implying total reserves isa significant variable.

H0 = Silver Prices is an insignificant variable
H1 = Silver Prices is a significant variable

Since p-value is 0.00 which is less than 0.05, we will reject H0 and accept H1,thus, implying silver prices is a significant variable.

Model Summary

Multiple R	R Square	Adjusted R Square	Standard Error	D.F.Regression	D.F.Residual	F	*Significance F*
0.992800208	0.985652253	0.985032926	3200.602369	6	139	1591.489	1.93E-125

Predictors: (Constant), Central Bank Reserves, India-US Exchange Rate, Inflation Rate, Silver Prices,BSE, NIFTY indices.

The "Model Summary" gives the following details:

1. The proportion of the variation in the dependent variable (Gold Prices) that was explained by variations in the independent variables The "R-Square" shows that 98.565% of the variation was explained. R-Square shows the proportion of variation in the dependent variable that can be explained by the independent variables.

2. The proportion of the variance in the dependent variable (Gold Prices) that was explained by variations in the independent variable, accordingly the adjusted R-square which in this case is 98.5%. Adjusted R-square shows the Proportion of variance in the dependent variable that can be explained by the independent variables or R-square adjusted for number of independent

variables. It has critical values lie below 1 and the closer it is to 1 the more it is preferred. It is summary measure of Goodness of Fit, and is superior to R-square because it is sensitive to the addition of irrelevant variables.

3.And the dispersion of the dependent variables estimate around its mean (the "Standard Error of the Estimate") is 3.254.Since, the R^2 and the Adjusted $R^2$of our model is extremely close to 1, we say that in our model all the variables together explain 98.5% of variation in the prices of gold in India.

The assumptions under ANOVA are:

- The sample belongs to a normal population. Since our sample is large, that is, the number of observation is more than thirty, we us the Central Limit Theorem to establish that our population has a normal distribution.
- The sample has common variance.
- The observations are independent. NOVA is used for statistical hypothesis testing. It is basically used for comparing group means using the F-test.

ANOVA

Model	Degrees of freedom	sum of squares	Mean Square	F	Significance F
Regression	6	97817881548	16302980258	1591.488695	1.93E-125
Residual	139	1423895918	10243855.52		
Total	145	99241777466			

a. Predictors: (Constant), NIFTY, INR/US$ Exchange Rate, Inflation Rate, Silver Prices, Total Reserves (Rs '000 cr), BSE
b. Dependent Variable: Gold Prices

The important component of the ANOVA table is the F value. It indicates whether the model is significant as a whole or not. It tests whether the R-square is significantly different from zero. The critical value of F lies below 0.05 for 95% confidence in the ability of the model to explain the dependent variable. If our F is insignificant, it means that our regression as a whole has failed. We will conclude that our dependent variables cannot be explained by the independent/explanatory variables. The last column shows the goodness of fit of the model. The lower this number, the better is the fit of the data empirically on the model. Typically, if "Sig" is less than 0.05, which is also the level of confidence in our case, we can conclude that our model is a good fit.

First we regress Gold Prices on Dollar/Rupee exchange rate variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on Dollar/Rupee exchange rate variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on Dollar/Rupee exchange rate.

ANOVA

	Degrees of freedom	Sum of squares	Mean Square	F	Significance F
Regression	1	52131318163	52131318163	161.58	0.00
Residual	143	46135584662	322626466		
Total	144	98266902825			

First we regress Gold Prices on Inflation rate variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on inflation rate variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on Inflation rate.

ANOVA

	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	1.00	35578971364	35578971364	81.16	0.00
Residual	143.00	62687931461	438377143		
Total	144.00	98266902825			

First we regress Gold Prices on BSE variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on BSE variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on BSE.

ANOVA

	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	1	62926181044	62926181044	254.62	0.00
Residual	143	35340721781	247137915		
Total	144	98266902825			

First we regress Gold Prices on NIFTY variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on NIFTY variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on NIFTY.

ANOVA

	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	1	63836999569	63836999569	265.14	0.00
Residual	143	34429903256	240768554		
Total	144	98266902825			

First we regress Gold Prices on Central Bank Reserves variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on Central Bank Reserves variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on Central Bank Reserves.

ANOVA

	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	1	83662357038	83662357038	819.18	0.00
Residual	143	14604545787	102129690.8		
Total	144	98266902825			

First we regress Gold Prices on silver prices variable and see if its F-test is significant or not. In my data, when I regress Gold Prices on silver prices variable, sig. level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on silver prices.

ANOVA

	Degrees of freedom	Sum of squares	Mean square	F	Significance F
Regression	1	88764516890	88764516890	1335.80	0.00
Residual	143	9502385935	66450251.3		
Total	144	98266902825			

MAIN FINDINGS

CHECKING FOR IRREGULARITIES

Multicollinearity :

Regression of Gold Prices (2003-2015) on:
1. India-US Exchange Rate
2. Central Bank Reserves
3. Inflation
4. Silver Prices
5. BSE
6. NIFTY

R^2explains 98.5% of the variation in Gold Prices. This high R_2 is due to high correlation between the individual variables. High R square and few significant variables show that there is a high possibility of multicollinearity in the data.

Multicollinearity should be checked by both the conditions:
1) Sufficient Condition (Partial pair-wise correlations between the explanatory variables)
2) Necessary Condition (Auxiliary Regression)

1) Partial Correlation

Correlation matrix shows that two correlations i.e. correlations between-

- BSE and NIFTY 0.977
- TOTAL RESERVES and NIFTY 0.909

Are very high(more than 0.90).

Correlations between-

- BSE and TOTAL RESERVES 0.905
- SILVER and TOTAL RERVES 0.826

Are high(between 0.80 and 0.90).

Correlations between-

- NIFTY and SILVER PRICES 0.738
- SILVER PRICES and BSE 0.732
- TOTAL RESERVES and INFLATION RATE 0.633

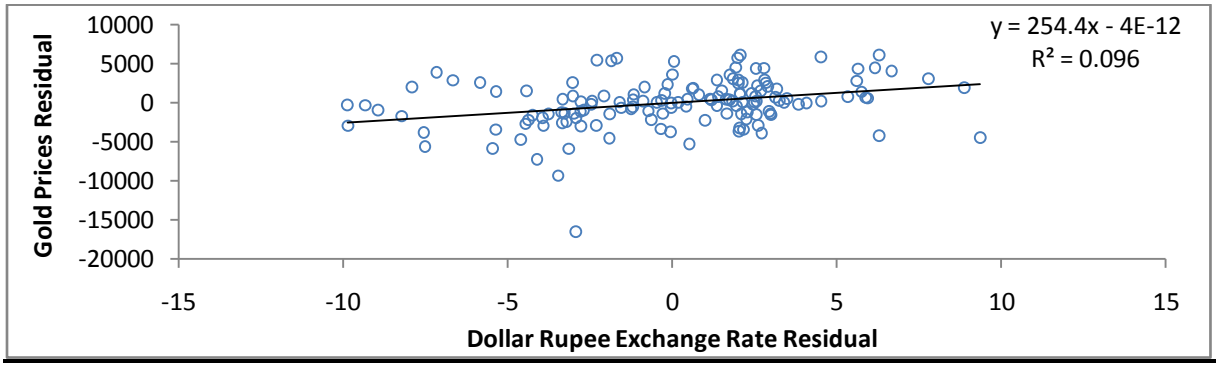
Are moderate(between 0.70 and 0.80).

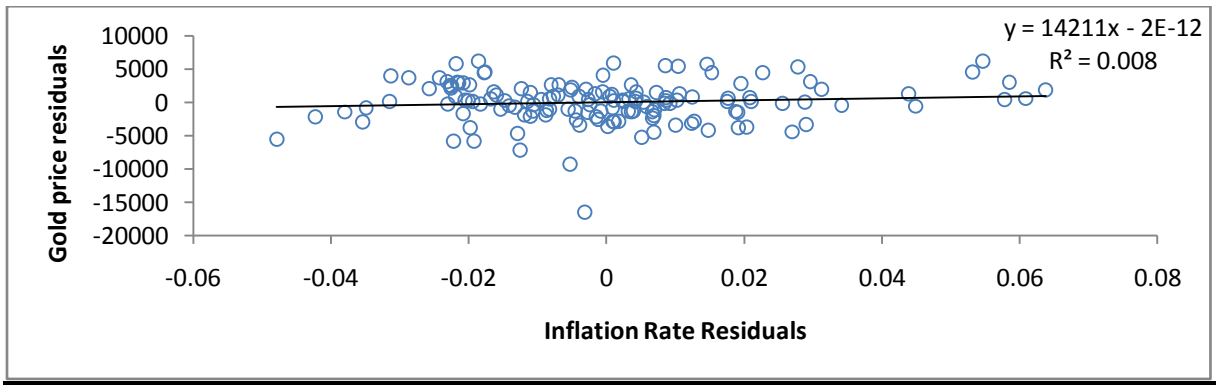
Therefore, multicollinearity is there in the data as per partial correlations coefficients. But such pair-wise correlation may be sufficient but not a necessary condition for the existence of multicollinearity.

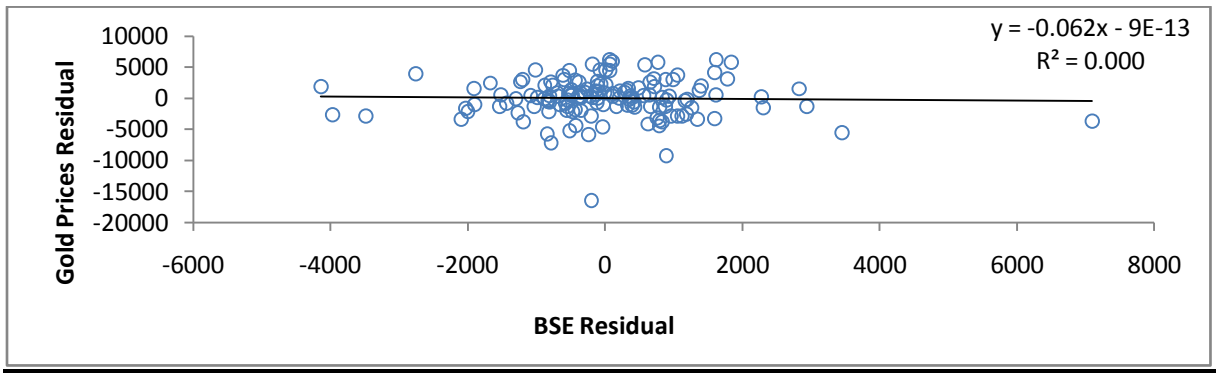
CORRELATIONS

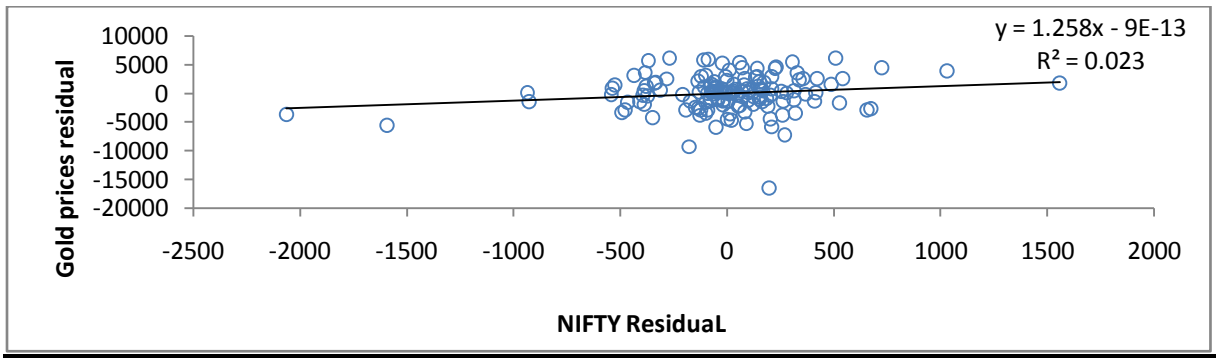
	gold	exchange rate	Inflation	BSE	NIFTY	Central Bank Reserves	silver
Gold	1.000	0.725	0.606	0.802	0.808	0.923	0.951
exchange rate	0.725	1.000	0.247	0.563	0.559	0.709	0.540
Inflation	0.606	0.247	1.000	0.509	0.537	0.633	0.567
BSE	0.802	0.563	0.509	1.000	0.977	0.905	0.732
NIFTY	0.808	0.559	0.537	0.977	1.000	0.909	0.738
Central BankReserves	0.923	0.709	0.633	0.905	0.909	1.000	0.826
Silver	0.951	0.540	0.567	0.732	0.738	0.826	1.000

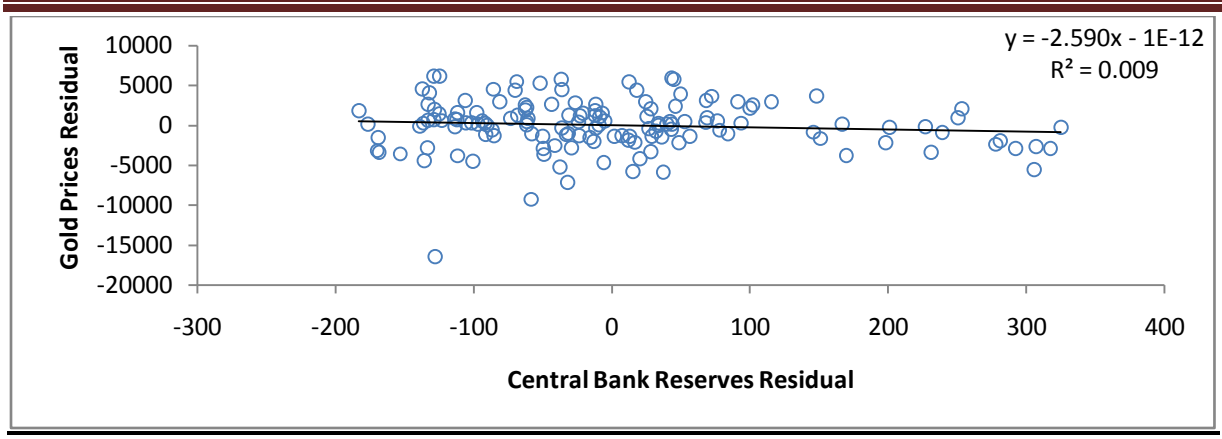
PARTIAL REGRESSION PLOTS

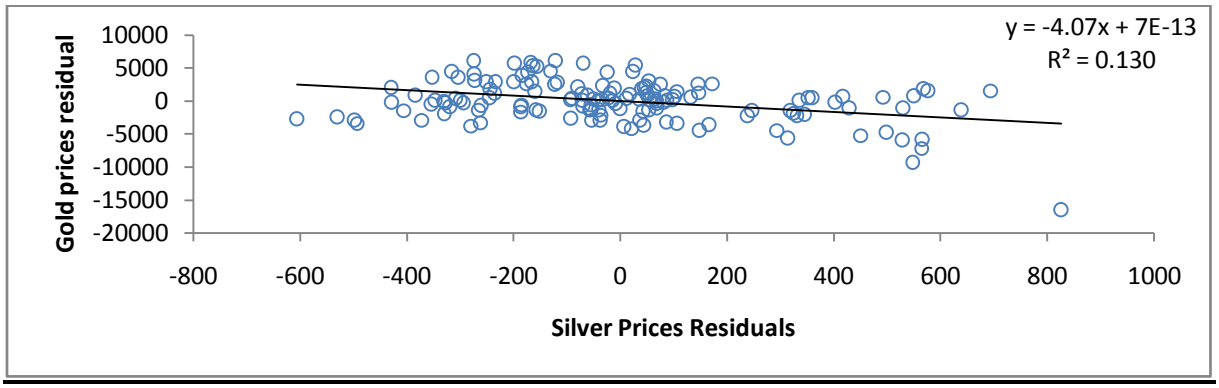












2. Auxiliary Regressions

To shed further light on the multicollinearity problem, let us run the auxiliary regression i.e. the regression of each explanatory variable on the remaining explanatory variables. First we regress Gold Prices on remaining explanatory variables and see if its F-test is significant or not. In my data, when Iregress Gold Prices on other explanatory variables, significance level is less than 0.05 which means F values are significant. Therefore, Gold prices are dependent on other explanatory variables.

ANOVA

Model	Degrees of Freedom	sum of squares	Mean Square	F	Significance F
Regression	6	97817881548	16302980258	1591.488695	1.93E-125
Residual	139	1423895918	10243855.52		
Total	145	99241777466			

a. **Predictors**: (Constant): India/US Exchange Rate, Inflation Rate, Silver Prices, Central Bank Reserves, BSE &NIFTY indices
b**. Dependent Variable**: Gold Prices

Similarly, we regress India/US Exchange Rate which depends on other explanatory variables and F-test for its significance (sig. is less than 0.05).Therefore, India/US Exchange Rate is affected by other explanatory variables.

ANOVA

Model	Degrees of Freedom	Sum of Squares	Mean Square	F	Significance F
Regression	6	4995.836	832.639	122.003	0.000
Residual	139	948.643	6.825		
Total	145	5944.478			

a**. Predictors**: (Constant), Gold Prices, Inflation Rate, BSE, Silver Prices, Central Bank Reserves, NIFTY
b**. Dependent Variable**: India/US Exchange Rate

Similarly, we regress Inflation Rate depends on other explanatory variables and F test for its significance (sig. is less than 0.05).Therefore, Inflation Rate is affected by other explanatory variables.

ANOVA

model	Degrees of freedom	sum of squares	mean squares	F	Significance F
Regression	6	0.082	0.014	34.274	0.000
Residual	139	0.055	0.000		
Total	145	0.137			

a. **Predictors**: (Constant): Gold Prices, India/US Exchange Rate, Central BankReserves, BSE &NIFTYindices, Silver Prices
b. **Dependent Variable**: Inflation Rate

Similarly, we regress BSE which depends on other explanatory variables and F-test for its significance (sig. is less than 0.05).Therefore, BSE is affected by other explanatory variables.

ANOVA

model	Degrees of freedom	sum of squares	mean square	F	Significance F
Regression	6	5741635948	956939325	542	0.00
Residual	139	245385947	1765367		
Total	145	5987021896			

a**. Predictors**: (Constant): Silver Prices, India/US Exchange Rate, Inflation Rate, BSE&NIFTY indices, Central Bank Reserves, Gold Prices
b. **Dependent Variable**: BSE

We now regress NIFTY which depends on other explanatory variables and F-test for its significance (sig. is less than 0.05). Therefore, NIFTY is affected by other explanatory variables.

ANOVA

model	Degrees of freedom	Sum of squares	Mean square	F	Significance F
Regression	6	500176485	83362747	551.087	0.000
Residual	139	21026465	151270		
Total	145	521202950			

a. **Predictors**: (Constant), BSE, India/US Exchange Rate, Inflation Rate, Silver Prices, Central Bank Reserves, Gold Prices
b.**Dependent Variable**: NIFTY

On regressing Central Bank Reserves and they depend on other explanatory variables and F-test for its significance (sig. is less than 0.05). Therefore, Central Bank Reserves are affected by other explanatory variables.

ANOVA

model	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	6	31272021	5212003	442.567	0.000
Residual	139	1636969	11777		
Total	145	32908990			

a. **Predictors:** (Constant): Inflation Rate, India/US Exchange Rate, Silver Prices, BSE &NIFTY indices, Gold Prices
b. **Dependent Variable**: Central Bank Reserves

Finally, we regress Silver Prices and they depend on other explanatory variables and F-test for its significance (sig. is less than 0.05). Therefore, India/US Exchange Rate is affected by other explanatory variables.

ANOVA

model	Degrees of freedom	Sum of squares	Mean squares	F	Significance F
Regression	6	35,022,851	5,837,142	664.400	0.000
Residual	139	1,221,197	8,786		
Total	145	36,244,048			

a. **Predictors**: (Constant), Central Bank Reserves, India/US Exchange Rate, Inflation Rate, BSE & NSE indices, Gold Prices
b. **Dependent Variable**: Silver Prices

So, we conclude that my data is plagued by severe multicollinearity problem.

INTERPRETATION

From the data analysis, we can interpret the following-

Trend Analysis

Individually, every independent factor has a positive correlation with the Gold prices.
Inflation, India/US Exchange rate, Central Bank reserves, Silver prices, NIFTY and BSE Sensex positivelyaffect or get affected by the Gold Prices.

Correlations

We see that all the independent variables are positively correlated with the dependent variable, whichmeans that a unit increase/decrease in gold prices will lead to a unit increase/decrease in thecorresponding independent variable.Correlation coefficient between silver prices and gold prices is 0.958, between total reserves and gold prices
is 0.924 and between NIFTY and gold prices is 0.815 which shows that they are highly correlated with eachother.Correlation coefficient between BSE and gold prices is 0.808, between exchange rate and gold prices is0.719 and between inflation rate and gold prices is 0.656 which shows that these are comparatively weaklycorrelated.

Hypothesis testing

When we do hypothesis testing for my model, we find that the R square comes out as 0.985 which means that 98.5% of the variation was explained. R-Square shows the proportion of variation in the dependent variable that can be explained by the independent variables. The proportion of the variance in the dependent variable (*Gold prices*) that was explained by variations in the independent variable, i.e. the adjusted R-square which in this case is 98.4 %. High value of R_2 is explained by multicollinearity between the different variables. Performing ANOVA, we find that the F value is 1466.759 which means that my model is significant. We also find that in our model, BSE SENSEX and NIFTY are insignificant variables. Hence we can conclude that, the model adopted by me is a 'good fit' model and can be used for predicting changes in gold prices.

Coefficients

The Betas are positive in cases other than BSE and NIFTY which is due to irregularities in the model (the problem of multicollinearity in time- series data) and out of 6, 4 variables are significant namely Inflation rate, Exchange rate, Silver prices and Total reserves.

Comparison between multiple and two variable regression analysis

Similar results: Silver prices, central bank reserves, inflation, and exchange rate all significant in both the analysis.

Different results: NIFTY and BSE are significant in two variable regression analyses but insignificant in multiple variable regression analysis. Reasons for such discrepancy:

1) Multicollinearity: NIFTY and BSE Sensex (stock indices) do affect Gold Prices but are coming out to be insignificant because of multicollinearity in the data. This has lead to a high R_2 which may be misleading.

2) Change in the model: NIFTY and BSE are insignificant in multiple variable analyses but significant in two variable regression analyses because the two models are different so results are likely to differ.

Multicollinearity and the model

I am not dropping insignificant variables i.e. BSE and NSE (insignificant as per t test but overall significant as per F test) from my model. I am including them because the betas are still BLUE. Multicollinearity is a data deficiency problem so we cannot overcome it.

CONCLUSION

From the above analysis the following models and their statistics are found:

S.NO.	Factors	Correlation	Trend
1	dollar/rupee exchange rate	0.725	Increasing
2	inflation rate	0.606	Increasing
3	B.S.E	0.802	Increasing
4	NIFTY	0.808	Increasing
5	Central bank reserves	0.923	Increasing
6	silver prices	0.951	Increasing

From my data analysis, we get the following equation for my model:

$$Y = (0.537)X_1 + (0.021)X_2 + (-0.082)X_3 + (0.020)X_4 + (0.230)X_5 + (0.402)X_6$$

Where,

X_1 = Exchange rate
X_2 = Inflation rate
X_3 = BSE SENSEX
X_4 = NIFTY
X_5 = Total reserves

X_6 = Silver prices
Y = Gold prices

1) EXCHANGE RATE (INR/ US $) has a positive relationship with **GOLD PRICES** in India since theslope coefficient is 0.537. This means that an increase in the exchange rate of India, CeterisParibus, by 1 unit increases the Gold prices in India by 0.537 units. And vice versa.

2)INFLATION RATE has a positive relationship with **GOLD PRICES** in India since the slope coefficientis 0.021. This means that an increase in the inflation rate by 1 unit, Ceteris Paribus, increases theGold prices in India by 0.021 units. And vice versa.

3)TOTAL RESERVES have a positive relationship with **GOLD PRICES** in India since the slope coefficient is 0.220. This means that an increase in the total reserves of India by 1 unit, CeterisParibus, increases the Gold prices in India by 0.220 units and vice versa.

4)SILVER PRICES have a positive relationship with **GOLD PRICES** in India since the slope coefficientis 0.402. This means that an increase in the silver prices in India by 1 unit, Ceteris Paribus, increases the Gold prices in India by 0.402 units. And vice versa.

5) NIFTY INDEX has a positive relationship with **GOLD PRICES** in India since the slope coefficient is **0.020**. This means that an increase in the NIFTY index by 1 unit, Ceteris Paribus, increases the Gold prices in India by .020 units. And vice versa.

6) However, only one variables namely **BSE SENSEX** does not have a significant impact on the Gold prices in India.

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