IMPACT OF MACROECONOMIC VARIABLES ON THE PRICES OF GOLD

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Abstract:
The paper examines and analyses the impact of various macroeconomic variables on the gold prices and further studies the relationship of each variable with the gold prices in the Indian context. The macroeconomic variables include gold prices, exchange rate and inflation rate. The secondary data is collected on a daily basis for a period of 7 years from 1st January 2012 to 31st December 2018. The paper uses ADF-unit root test to test the stationarity of the data, descriptive statistics and histogram graphs to test the normality, ordinary least square test to analyze the impact of macroeconomic variables on gold prices and correlation test to find out the relationship of macroeconomic variables and gold prices. The results in this study show that there is a significant impact as well as positive relationship between US Dollar and gold prices. However, inflation does not have a significant impact and has a negative relationship with the gold prices.

Keywords: *Gold Prices, Exchange rate, OLS analysis, ADF Unit Root test, Inflation Rate, Descriptive Statistics*

1. Introduction:

Since ancient times, gold has always been considered as one of the most precious metals and has always had a sentimental value in the minds of people. In the ancient period, when there were no separate legalized currencies for different countries, gold was used as a medium of exchange for goods and services. It has always been an attractive metal for the producers, consumers as well as investors in the world and has many uses. Its properties are what it makes the metal so precious - it is most malleable, ductile, dense, conductive, non-destructive, and a beautiful metal. Gold has always been considered as a symbol of pride, respect, purity and power. In the modern world, fold is used to make jewellery, medals, prestigious awards like Oscars, Olympic medals, luxury art and craft etc. Indians, being one of the largest consumers of gold, gives vital importance to the metal as a hedge against inflation in the long term and as a medium of wealth accumulation, and a medium to diversify their investment portfolios.
However, gold as a macroeconomic variable is very complex and the prices of the metal is driven by various fiscal policies, demand and supply, and other macroeconomic variables. The volatility of the prices of the metal are very difficult to understand and it is very difficult to predict the future prices of gold as they are dependent on various macroeconomic factors.
This study tries to analyse the impact of various macroeconomic variables like exchange rate and inflation rate on the prices of gold and find the relationship of each variable on the gold prices thereof.

2. Review of Literature:

(Gnanendra & Shri , 2018) studied the impact of various macroeconomic factors like crude oil prices, exchange rate, interest rates and stock prices on the price of gold in context of Indian market. The timeframe of the study in the article was 8 years (1-04-2009 to 31-3-2017) Major tools used by him in the study are regression tool (multivariate regression) and correlation analysis. The results in the article showed that there is a significant relationship of gold with stock prices (SENSEX) and interest rates, a moderate relationship with the prices of crude oil and a low relationship with crude oil.

(Sindhu, 2013) studied the relationship between various macroeconomic factors and gold prices. The paper focused on the factors like exchange rate, inflation rate, repo rate and crude oil prices, and each variable was studied individually with the prices of gold. Quantitative data, from secondary sources like World Gold Council, GJEPC, magazines, journals etc was collected for this study. Various tools like regression, correlation, standard deviation etc. were used in this paper to find out the relationship of each factor with the gold price. The findings depict an inverse relation between the US$ and gold prices; crude oil prices have an impact on the gold prices; interdependence between Gold prices and repo rates; and Gold prices and inflation rates are also dependent and positively correlated.

(Raju & Marathe, 2016) in their paper study the impact and relationship of crude oil prices, inflation rate and exchange rates on the prices of gold in three different countries namely India, China and USA. The timeframe of the study was 20 years (from January 1996 to December 2015). Secondary data from various sources like US Energy information Administration, World Gold Council and National Bureau of Statistics of China etc. was used for the study. The tools and techniques used were ADF unit root analysis, VAR, Johansen Co-integration Test and Granger Causality Test. It was found that Crude Oil Prices have the Short term Relationship with Gold Prices in India, China and USA and there is a bidirectional Causality in India and USA.

(Erdoğdu, 2017) in his paper has studied the various factors which influence the prices of gold with respect to the US market. the aim of the study was to investigate various macro-economic factors affecting the gold prices and 13 years of historical data was collected. The author has taken various variables like Dow Jones Index, the US exchange rate, silver price, interest rate, oil price and inflation rate for this study. The study examines monthly data from January 2003 to June 2016 and the major sources of data (secondary) were Federal Reserve, the central bank of the United States, and United States Energy Information Administration. The main software package used in the study was eViews 8 and the techniques and tools used were GARCH model. The findings of the study show the highest negative correlation between gold prices and US exchange rate; and a positive correlation between gold prices, silver prices, and oil prices.

(Bilal, Talib, Haq, Khan , & Naveed , 2013) examine the relationship between gold prices and stock indices of Bombay Stock Exchange and Karachi Stock Exchange. To find out this relationship, secondary data (monthly data) was used and the time frame of the study was from January 2005 to June 2011. The statistical tools used in this study were Unit Root Augmented Dickey Fuller test, Phillips-Perron, Johnson Co-integration and Granger's Causality tests to find out the relationship. the results of the co-integration test show that there is no long-run relationship between gold prices and KSE stock index; but, a significant long-run relationship is between SENSEX and gold prices. Granger causality test indicate zero causal relationship among gold prices, KSE and BSE stock indices.

(Seemuang & Romprsert, 2013) investigates the simultaneous movement of gold prices w.r.t. macroeconomics. The main aim of this research is to find out the relationship among various macroeconomic variables and gold prices , especially in context of USA. There are mainly 5 variables used in this study, namely, US real GDP, US dollar, money supply level 2of USA and real interest rate in the US. Statistical tools used in the stud are Ordinary Least Square (OLS), correlation analysis, VAR and Augmented Dickey-Fuller test. It was found out that a change in US dollar index is the perfect factor which explains the movement of gold values. Movement of gold value and percentage change of US dollar index have mirror effects to each other.

(Toraman, Başarır, & Bayramoğlu, 2011) in their article study the gold prices and their relationship with the variables that have an impact on the gold prices. The main objective of their study is to estimate the gold prices with the help of variables that may affect the gold prices. The study is based out in USA and the variables used by the authors in their study were oil prices, dollar index, Dow Jones Industrial Production Index, USA reel Interest Rates and USA inflation rate. Monthly data for 18 years was collected (January 1992 to March 2010). The research techniques used in this study by the authors are ARCH Model, GARCH Model and Multivariate GARCH model. The findings of this study shows that there is highest negative correlation between gold prices and USA exchange rate. Moreover, there is a positive correlation between gold prices and oil prices.

(Hashim, Ramlan, Razal, & Nordin, 2017) in their paper try to analyse the various macroeconomic variables which affect the volatility and price movement of gold prices. The main aim of their study is to identify the significant relationship between macroeconomic factors and the price of gold, and further to find out the impact of those factors on the gold price. The timeframe of this study is 20 years (January 1996 to December 2015) and the data is collected from the countries which are the largest consumers of gold namely India, China, United States, Turkey and Saudi Arabia. The statistical tool used by the authors in this study is SPSS and the models used are multiple linear regression and correlation.. The variables taken for the study are gold prices, GDP, oil prices, exchange rate, interest rate and inflation. The results show that there is a positive correlation between crude oil prices and gold price; and negative correlation between inflation rate, GDP, real interest rate, exchange rate and gold price. The regression results, show that the independent variables except for exchange rate have significant impact on the price of gold.

(Bapna, Sood, Totala, & Saluja, 2012) examine the volatilities and changes in the various macroeconomic factors and their impact on the prices of gold thereof. The main aim of the study is to study rhe cause and effect relationship of gold prices and various macroeconomic variables and to examine the impact of each variable on gold prices. The time period of the study is 10 years i.e. 2002 to 2011 and the data is collected on a quarterly basis from secondary sources like NSE, RBI etc. . The variables taken in consideration by the authors in this paper are growth rate, exchange rate, interest rate, inflation rate, NIFTY, SENSEX, foreign reserves, fiscal deficit, and GDP. Research tools used by the researchers are unit root test, Regression Analysis and Granger Casualty Test using eviews. The findings show that exchange rate, fiscal deficit, forex reserve inflation rate have a significant impact on gold prices independently but, growth rate, GDP, Sensex and Nifty have a very low impact on gold prices independently. Moreover, gold does not affect exchange rate, BSE Sensex, NSE Index, forex reserves and fiscal deficit. It does affect interest rate and inflation and vice versa.

3. Objectives:

The main objectives of this study are:

- To find the individual impact of various macroeconomic variables like Exchange rate, Nifty etc on the volatility of gold prices.
- To find the relationship of each variable with the gold prices.

3.1. Scope:

The scope of this study is limited to the Indian context only.

4. Research Methodology:

4.1. Hypothesis:

H_{01}: There is no significant impact of US Dollar on gold prices.
H_{11}: There is significant impact of US Dollar on gold prices.
H_{02}: There is no significant impact of Inflation on gold prices.
H_{12}: There is significant impact of Inflation on gold prices.

4.2. Dependent variable

The dependent variable in this study is Gold price as the aim is to find out the impact of various variables on gold prices.

4.3. Independent variable

The independent variables are US Dollar and Inflation Rate as we have to study the impact of each variable (separately) on the prices of gold.

4.4. Data

The secondary data is collected for this of study from various sources like NSE website, MCX, RBI etc. Daily data for a period of 7 years from 1 January 2012 to 31 December 2018 is collected. The variables used in this study are Gold prices (spot prices), Exchange rate (U.S. Dollar), and Inflation rate. Excel was used for the purpose of data collection and data mapping.

4.5. Statistical tools and techniques used:

Various statistical techniques and tools are used in order to find out the impact and the relationship of the variables on the gold prices.

- ADF Unit root test is used to find out the stationarity of data.
- Descriptive statistics is used to test the normality of data
- Ordinary least square (regression analysis) is used to find out the significant impact of various variables on gold prices
- Correlation analysis is used to find out the relationship of each variable with the gold prices.
- The tests were run on eViews.

4.6. Limitations:

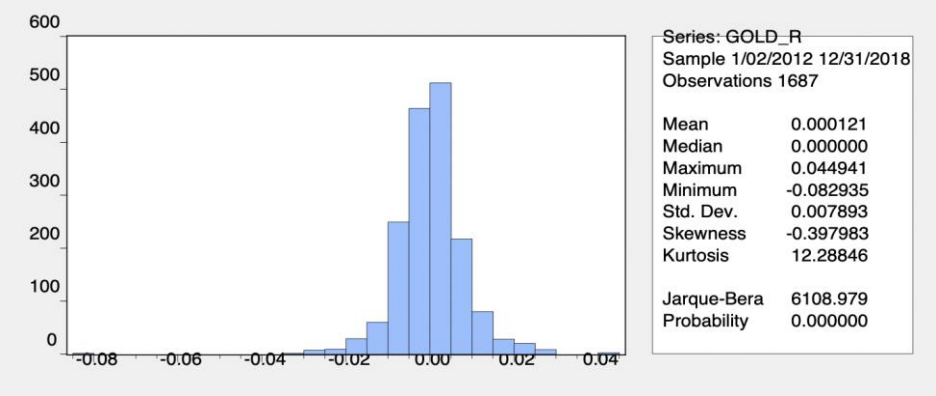
The limitation in this study is that since the data is collected on a daily basis, the results show a very little impact and relationship between the variables. Moreover, the extent to which the variables impact the gold prices is also very less as the daily impact is to be analysed.

5. Analysis:

5.1. Stationarity test and Normality test:

5.1.1. Gold:

Normality test:



The above histogram graph helps to check whether the data is normal or not. From the above histogram, it can be observed that the data is bell-shaped symmetrically, thus, indicating that it is forming a normal bell-curve. The coefficients of skewness and kurtosis is also zero. Thus, the above data is normal.

ADF-Unit root test

Null Hypothesis: GOLD_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=24)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-39.20354	0.0000
Test critical values:	1% level	-3.434025	
	5% level	-2.863050	
	10% level	-2.567621	

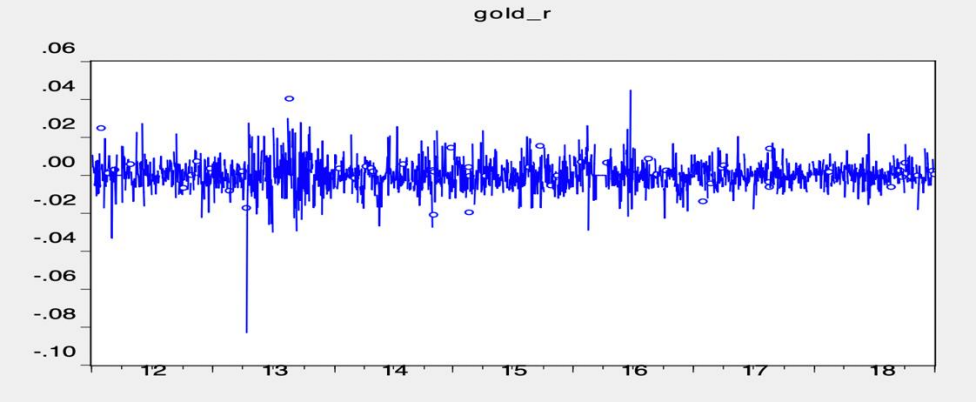
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD_R)
Method: Least Squares
Date: 02/26/19 Time: 13:22
Sample (adjusted): 1/04/2012 12/31/2018
Included observations: 1686 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOLD_R(-1)	-0.953808	0.024330	-39.20354	0.0000
C	0.000109	0.000192	0.567705	0.5703

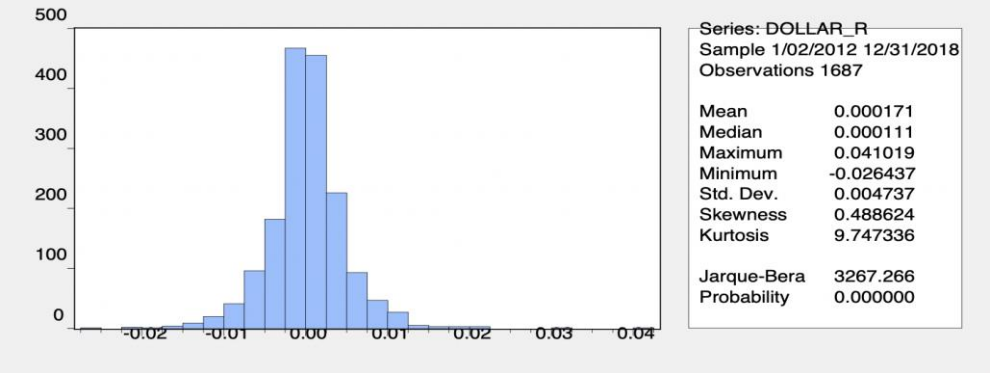
R-squared	0.477168	Mean dependent var	-5.96E-06
Adjusted R-squared	0.476857	S.D. dependent var	0.010902
S.E. of regression	0.007885	Akaike info criterion	-6.846446
Sum squared resid	0.104708	Schwarz criterion	-6.840005
Log likelihood	5773.554	Hannan-Quinn criter.	-6.844061
F-statistic	1536.917	Durbin-Watson stat	2.002425
Prob(F-statistic)	0.000000		

The ADF-unit root test is used to test if the data is stationery or not. Since the p-value is less than .05, (it is 0 in the above data), the data relating to gold is stationery at level. Thus, the data is stationery and is fit for regression and correlation analysis.



5.1.2. Exchange rate (US Dollar)

Normality test



From the above histogram, it can be observed that the data about US Dollar is bell-shaped symmetrically, thus, indicating that it is forming a normal bell-curve. The coefficients of skewness and kurtosis is also zero. Thus, the above data is normal.

Stationarity test

Null Hypothesis: DOLLAR_R has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=24)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-30.97738	0.0000
Test critical values:	1% level	-3.434027	
	5% level	-2.863051	
	10% level	-2.567622	

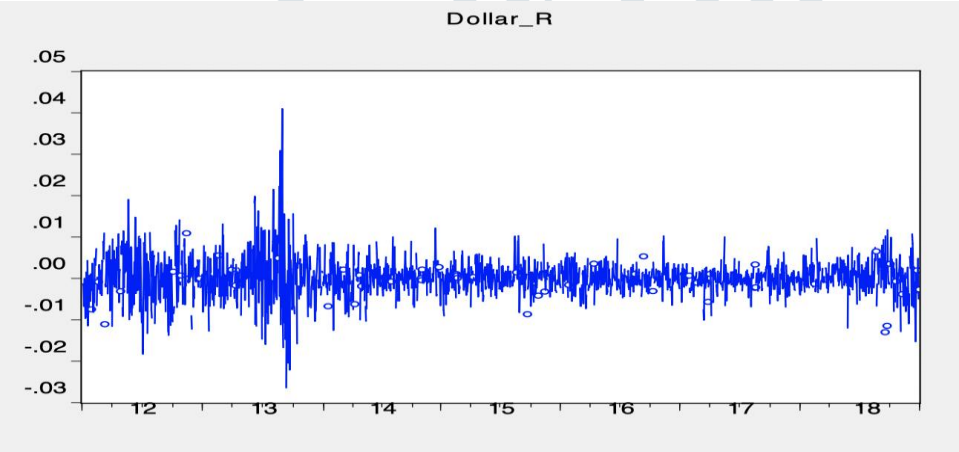
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOLLAR_R)
Method: Least Squares
Date: 02/26/19 Time: 13:31
Sample (adjusted): 1/05/2012 12/31/2018
Included observations: 1685 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOLLAR_R(-1)	-1.065308	0.034390	-30.97738	0.0000
D(DOLLAR_R(-1))	0.067044	0.024337	2.754777	0.0059
C	0.000184	0.000115	1.598369	0.1101

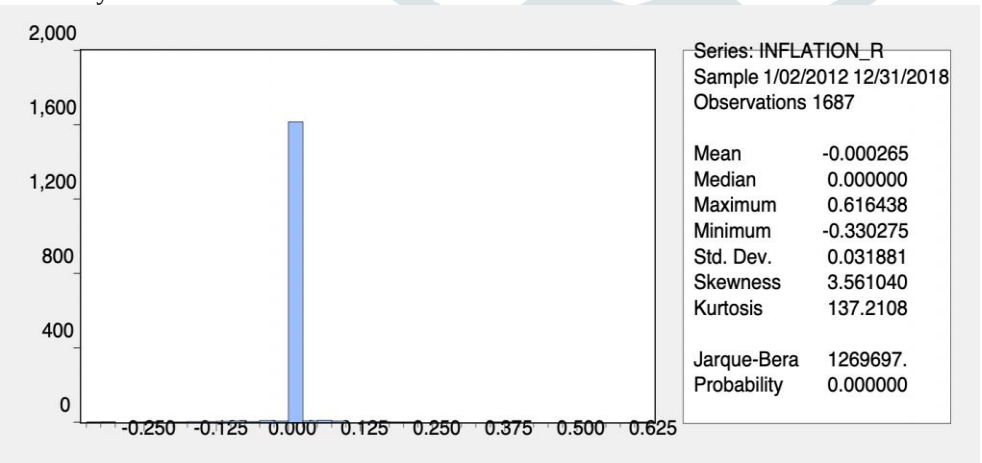
R-squared	0.501395	Mean dependent var	-5.90E-07
Adjusted R-squared	0.500803	S.D. dependent var	0.006696
S.E. of regression	0.004731	Akaike info criterion	-7.867476
Sum squared resid	0.037651	Schwarz criterion	-7.857809
Log likelihood	6631.349	Hannan-Quinn criter.	-7.863896
F-statistic	845.7075	Durbin-Watson stat	2.001160
Prob(F-statistic)	0.000000		

Since the p-value of the variable is 0, and is less than .05, the variables are stationery at level. Thus, the data is stationery and is fit for regression and correlation analysis.



5.1.3. Inflation:

Normality Test



From the above histogram, it can be observed that the data (inflation rate) is bell-shaped symmetrically, thus, indicating that it is forming a normal bell-curve. The coefficients of skewness and kurtosis is also zero. Thus, the above data is normal.

Stationarity test

Null Hypothesis: INFLATION_R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=24)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-41.03940	0.0000
Test critical values:	1% level	-3.434025	
	5% level	-2.863050	
	10% level	-2.567621	

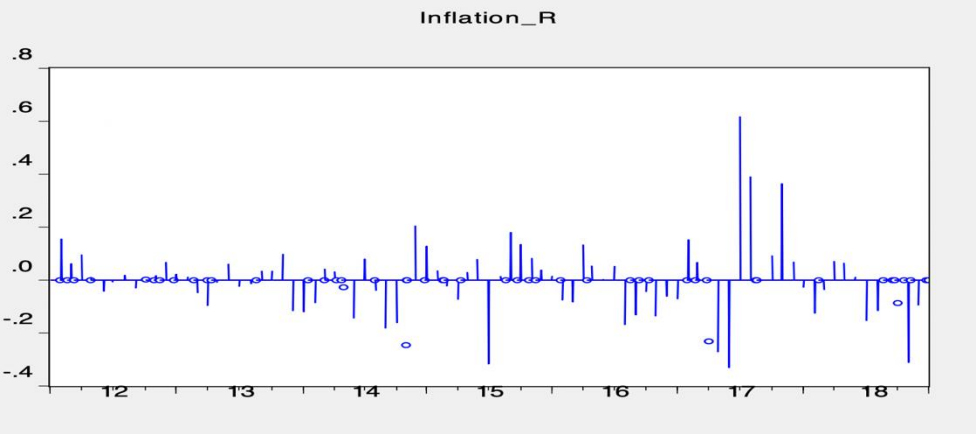
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INFLATION_R)
Method: Least Squares
Date: 02/26/19 Time: 14:10
Sample (adjusted): 1/04/2012 12/31/2018
Included observations: 1686 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFLATION_R(-1)	-1.000069	0.024369	-41.03940	0.0000
C	-0.000265	0.000777	-0.340831	0.7333

R-squared	0.500034	Mean dependent var	0.000000
Adjusted R-squared	0.499738	S.D. dependent var	0.045102
S.E. of regression	0.031900	Akaike info criterion	-4.051213
Sum squared resid	1.713695	Schwarz criterion	-4.044772
Log likelihood	3417.173	Hannan-Quinn criter.	-4.048827
F-statistic	1684.232	Durbin-Watson stat	2.000000
Prob(F-statistic)	0.000000		

Since the p-value of the variable is 0, and is less than .05, the variables of inflation are stationery at level. Thus, the data is stationery and is fit for regression and correlation analysis.



5.2. Regression and Correlation tests :

5.2.1. Gold-US Dollar

H_{01}: There is no significant impact of US Dollar on gold prices.
H_{11}: There is significant impact of US Dollar on gold prices.

Dependent Variable: GOLD_R
Method: Least Squares
Date: 02/20/19 Time: 10:41
Sample (adjusted): 1/03/2012 12/31/2018
Included observations: 1687 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.50E-05	0.000192	0.495703	0.6202
DOLLAR_R	0.151373	0.040428	3.744241	0.0002

R-squared	0.008251	Mean dependent var	0.000121
Adjusted R-squared	0.007663	S.D. dependent var	0.007893
S.E. of regression	0.007863	Akaike info criterion	-6.852132
Sum squared resid	0.104176	Schwarz criterion	-6.845693
Log likelihood	5781.773	Hannan-Quinn criter.	-6.849747
F-statistic	14.01934	Durbin-Watson stat	1.929759
Prob(F-statistic)	0.000187		

Covariance Analysis: Ordinary
Date: 02/20/19 Time: 11:39
Sample: 1/03/2012 12/31/2018
Included observations: 1687
Balanced sample (listwise missing value deletion)

Correlation	GOLD_R	DOLLAR_R
GOLD_R	1.000000	
DOLLAR_R	0.090837	1.000000

Here the Correlation value is 0.09 which shows that there is significant correlation between the US dollar and the gold prices. However the extent of this relationship is very less. This tells us that the current scenario of the US dollar does not affect the gold prices to a great extent.
The coefficient in the above case is .151, which means that 1 unit increase in US Dollar leads to .151 units increase in the gold price.
The p-value is 0.0002 which is less than 0.05, thus it can be said that there is significant impact of US Dollar on gold prices. Therefore the hypothesis is accepted that there is significant impact of US Dollar on gold prices, and the null hypothesis is rejected.
Moreover, the value of R square is 0.008251 which shows the extent to which the US Dollar value affects the gold prices. Since the value is less than 1% there is no major impact.

5.2.2. Gold- Inflation:
H_{02}: There is no significant impact of Inflation on gold prices.
H^{12}: There is significant impact of Inflation on gold prices.

Dependent Variable: GOLD_R
Method: Least Squares
Date: 02/20/19 Time: 10:46
Sample (adjusted): 1/03/2012 12/31/2018
Included observations: 1687 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000118	0.000192	0.615518	0.5383
INFLATION_R	-0.009887	0.006027	-1.640546	0.1011

R-squared	0.001595	Mean dependent var	0.000121
Adjusted R-squared	0.001002	S.D. dependent var	0.007893
S.E. of regression	0.007889	Akaike info criterion	-6.845442
Sum squared resid	0.104875	Schwarz criterion	-6.839004
Log likelihood	5776.130	Hannan-Quinn criter.	-6.843058
F-statistic	2.691391	Durbin-Watson stat	1.902582
Prob(F-statistic)	0.101078		

Covariance Analysis: Ordinary
Date: 02/20/19 Time: 11:45
Sample: 1/03/2012 12/31/2018
Included observations: 1687
Balanced sample (listwise missing value deletion)

Correlation	GOLD_R	INFLATION_
GOLD_R	1.000000	
INFLATION_R	-0.039934	1.000000

Here the Correlation value is -0.039 and which shows that there is significant negative correlation between the Inflation and the gold prices. However the extent of this relationship is very less. This tells us that there is very little or mere relationship between gold prices and inflation.
The coefficient in the above case is -0.0098, which means that 1% increase in inflation leads to 0.9% decrease in the gold price.
The p-value is 0.1011 which is more than 0.05, thus it can be said that there is no significant impact of inflation on gold prices. Therefore the null hypothesis is accepted that there is no significant impact of US Dollar on gold prices.

6. Conclusion:

The paper attempts to examine and study the impact as well as the relationship of macroeconomic variables with the prices of gold in context of the Indian economy. The variables considered for the study in this paper are gold prices, US Dollar and inflation rate. The two major questions concerned in this study were: Is there any individual impact of macroeconomic variable on the volatility of gold prices? Secondly, Is there any relationship (correlation) amongst the macroeconomic variables and gold prices?

The results and findings show that there is a significant impact of US Dollar on the gold prices, however, the inflation does not have a significant impact on the prices of gold. However, the extent to which the exchange rate impacts the gold prices on a daily basis is very low. Moreover, there exists a positive correlation between gold and US Dollar but a negative correlation in the case of gold and inflation.

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