

Does Macroeconomic determinants Influence Silver price volatility? Evidence from India

¹Dr. Basuvaraj M1, ²Dr. S.P. Murugan

¹Assistant Professor, Department of Commerce and Business Administration, University of Allahabad, Uttar Pradesh, India

²Assistant Professor, PG & Research Department of Commerce, Government Arts College, Dharmapuri, Tamil Nadu, India

Abstract: This study examines the impact of macroeconomic factors on silver prices in India from 2000 to 2025. It uses secondary data collected from the World Bank and other published sources. The study focuses on five major macroeconomic factors: Gross Domestic Product (GDP), exchange rates, real interest rates, inflation, and crude oil prices. Descriptive statistics, correlation analysis, and regression analysis are used to examine the relationship between these factors and silver prices. The findings reveal that exchange rates have a significant positive impact on silver prices in India, while GDP, real interest rates, inflation, and crude oil prices do not show a significant influence. The study concludes that exchange rate fluctuations are the main macroeconomic factor affecting silver prices in India. These findings may help investors, industrial users, and policymakers better understand changes in silver prices and make informed decisions.

Keywords: Macro-economic variables, Silver price, Volatility, Correlation and Regression

1. INTRODUCTION

Silver occupies an unusual position among commodities: it is at once a precious metal, a store of value and an important industrial input. Its price is therefore shaped by monetary and financial forces as well as by real-sector demand from electronics, solar photovoltaics and other manufacturing uses. This dual character makes silver more volatile than gold, and sharp price swings affect investors, jewellery and industrial users, and policymakers who monitor commodity markets (Hillier, Draper, & Faff, 2006; Batten, Ciner, & Lucey, 2010). Silver, with its multifaceted nature as a precious metal, a store of wealth, and a crucial industrial raw material, holds a unique position in the commodities market. Therefore, its price is determined not only by demand arising from electronics, solar photovoltaic technology, and other manufacturing sectors, but also by monetary and financial factors. Sharp fluctuations in price, it affects investors, the jewelry and industrial sectors, as well as policymakers who monitor commodity markets; this dual nature of silver is the reason it experiences greater price volatility than gold (Hillier, Draper, & Faff, 2006; Batten, Ciner, & Lucey, 2010). Hedging, risk management, and portfolio allocation rely on understanding the reasons behind price fluctuations. Silver can serve as a hedge or a protective measure against inflation and stock market declines (Baur & Lucey, 2010; Baur & McDermott, 2010; Beckmann & Czudaj, 2013). Subsequent studies examined the macroeconomic factors influencing price fluctuations in precious metals. According to a study by Batten et al. (2010), the business cycle has a smaller-than-expected impact on price fluctuations in gold, silver, and platinum; however, monetary factors such as interest rates and inflation exert a significant influence. Sari, Hammoudeh, and Soytas (2010) have reported the existence of dynamic relationships among currency exchange rates, precious metal prices, and crude oil prices. As pointed out by Hammoudeh and Yuan (2008), metal price fluctuations respond to sudden changes in crude oil prices and interest rates. Collectively, these findings suggest that fundamental supply and demand factors alone are insufficient to explain the volatility in silver prices. Most available evidence is derived from developed markets, particularly the United States and Europe, and focuses primarily on gold. In contrast, silver receives less attention; in fact, due to its diverse industrial applications, silver is more sensitive to macroeconomic conditions than gold (Hillier et al., 2006; Bhatia, Das, Tiwari, Shahbaz, & Hasim, 2018). Indication from rising economies is quite limited; this represents a significant gap when considering the differences in their exchange rate regimes, inflation trends, capital account openness, and the role of precious metals in household savings. Highlighting India's unique characteristics helps the audience understand its significance. It is one of the world's largest consumers of precious metals; here, silver is widely used in jewelry, household items, and religious artifacts, while also serving extensively as an investment asset and an industrial raw material. Since domestic prices are determined by international benchmarks, the rupee-dollar exchange rate, and import duties, macroeconomic conditions impact the Indian market through various channels. Previous studies conducted in India have largely focused on gold. For example, Mishra et al. (2010) examined the relationship between gold price fluctuations and stock market returns in India, while Sindhu (2013) analyzed the impact of selected macroeconomic factors on gold prices. There is limited systematic evidence regarding the fluctuation of silver prices in India. Factors such as inflation, interest rates, foreign exchange rates, crude oil prices, industrial production, and stock market performance can each influence this; however, a clear understanding of their relative importance regarding silver price fluctuations in the Indian context has not yet fully emerged. Therefore, this study aims to explore this field, which has the potential to offer researchers new perspectives on the macroeconomic impacts on commodity markets.

2. REVIEW OF LITERATURE

Pindyck and Rotemberg (1990) demonstrated that the prices of unrelated commodities tend to move together more closely than can be explained by fundamental factors alone, pointing to common macroeconomic shocks. Furthermore, Sjaastad and Scacciavillani (1996) found that exchange rate movements influence the dollar price of gold. Cappi, Mills, and Wood (2005) and Reboredo (2013) they stated that gold is inversely correlated with the US dollar, acts as a hedge and a safe haven during sharp declines in the dollar's value, and supports the currency-driven dynamics of precious metals. In studies concerning the relationship between gold and silver, Sener (2001) and Lucey & Tully (2006) found that the long-term connection between these two metals is unstable over time; Tully & Lucey (2007) identified that the US dollar has a significant impact on gold; and Sensoy (2013) documented that the interrelationships among precious metals vary over time. Furthermore, Bhatia, Das, Tiwari, Shahbaz, and Hashim (2018) demonstrated that the causal relationship between metal prices varies according to market conditions. All of this indicates that silver cannot be considered merely a simple substitute for, or a proxy of, gold. On hedge and safe-haven roles, Hillier, Draper, and Faff (2006) found diversification benefits in precious metals and noted that silver is more volatile than gold, Baur and Lucey (2010) and Baur and McDermott (2010) showed that gold acts as a hedge and, briefly, as a safe haven against equity declines, mainly in developed markets, Ciner, Gurdgiev, and Lucey (2013) found that these roles differ across countries and periods, and Beckmann and Czudaj (2013) found that gold's inflation-hedging ability changes over time and across economies. Turning to volatility, Hammoudeh and Yuan (2008) reported that metal volatility responds to oil and interest rate shocks, Batten, Ciner, and Lucey (2010) found that monetary variables such as interest rates and inflation influence precious metal volatility, with silver's link to the business cycle differing from gold's, Sari, Hammoudeh, and Soytas (2010) found short- and long-run links among oil prices, precious metal prices and exchange rates, and Hammoudeh, Malik, and McAleer (2011) compared volatility behaviour and risk measures across the metals. Indian evidence is limited and focuses mainly on gold: Mishra, Das, and Mishra (2010) linked gold price volatility to stock market returns, and Sindhu (2013) examined factors such as exchange rates and inflation in gold prices. Most of this literature therefore concerns developed markets and gold, and few studies examine silver price volatility against several macroeconomic variables in India, which is the gap this study addresses.

3. OBJECTIVE AND METHODOLOGY

The objective of this research paper is to analyze the influence of macro-economic variables on the volatility of silver prices in India. For this study, secondary data have been collected from World Bank data indices and other relevant published sources. The study covers a period of 25-years from 2000 to 2025. To fulfill the objective of the study, the following 'null hypothesis' is formulated: There is no significant relationship between macroeconomic factors and silver prices in India. In this study, the price of silver is treated as the dependent variable, while macroeconomic factors are considered independent variables. The independent variables include Gross Domestic Product (GDP), foreign exchange rates, real interest rates, inflation rates, and crude oil prices. Various statistical tools including descriptive statistics, correlation analysis, and multiple regression analysis were employed to analyze the relationships between silver price and macro-economic variables.

4. ANALYSIS AND INTERPRETATION

Descriptive Statistics

Table 1

Descriptive Statistics of silver price and macro-economic variables

Variables	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness	Kurtosis
Silver Price	25	0.858	2.418	1.492	0.389	.151	.009	-.101
GDP	25	0.000	0.986	0.782	0.206	.043	-2.430	7.534
Exchange Rate	25	1.617	1.958	1.760	0.107	.011	.329	-1.374
Real Interest Rate	25	-0.499	0.934	0.609	0.323	.104	-2.010	4.774
Inflation Rate	25	0.320	1.079	0.737	0.182	.033	.080	-.210
Crude Oil Price	25	-0.841	0.200	-0.136	0.277	.077	-1.084	.244

Source: Compiled and Computed from world bank data

The above table 1 depicts the descriptive statistics analysis of the silver price and macro-economic variables used in the study. The average silver price over the 25 observations is 1.492, with values ranging from 0.858 to 2.418. Moderate variations in silver prices were observed during the study period, as indicated by a standard deviation of 0.389. The kurtosis value of -0.101 indicates a distribution that is flatter than a normal distribution. Meanwhile, a skewness value of 0.009 indicates that the distribution is slightly positively skewed. The GDP values range from -0.000 to 0.986, with a mean of 0.782. The relatively low standard deviation (0.206) suggests minimal fluctuation in the GDP data. A skewness value of -2.430 indicates a strongly negatively skewed distribution; that is, most values are concentrated at the upper end, while only a very small number of values lie at the lower end. A kurtosis value of 7.534 points to a strongly 'leptokurtic' distribution, indicating the presence of extreme values or outliers in the data. The exchange rate variable exhibits a highly stable nature; its mean is 1.617 and the standard deviation is 0.107. Although its kurtosis value (-1.374) indicates a 'platykurtic' distribution characterized by fewer extreme values—its skewness value (0.329) shows a moderate positive skew. The average real interest rate is 0.609, with a range extending from -0.499 to 1.934. With a standard deviation of 0.323, the dispersion is moderate. A kurtosis value of 4.774 indicates a 'leptokurtic' distribution, characterized by 'tails' that are relatively heavier than those of a normal distribution, while a skewness value of -2.010 suggests negative skewness. The inflation rate exhibits very moderate fluctuation, with a mean of 0.737 and a standard deviation of 0.182. A skewness value of 0.080 indicates that the distribution has a slightly positive skew. A kurtosis value of -0.210 suggests a distribution that is slightly flatter than a normal distribution. Crude oil prices range from -0.841 to 0.200, with a mean value of -0.136. The standard deviation of 0.277 indicates moderate variability. The skewness value (-1.084) reveals moderate negative skewness, while the kurtosis value (0.244) indicates a slightly platykurtic distribution. Overall, the descriptive statistics suggest that most variables exhibit moderate variability

and non-normal distribution characteristics, particularly GDP and real interest rate, which show evidence of skewness and high kurtosis.

Figure 1
Silver price per gram

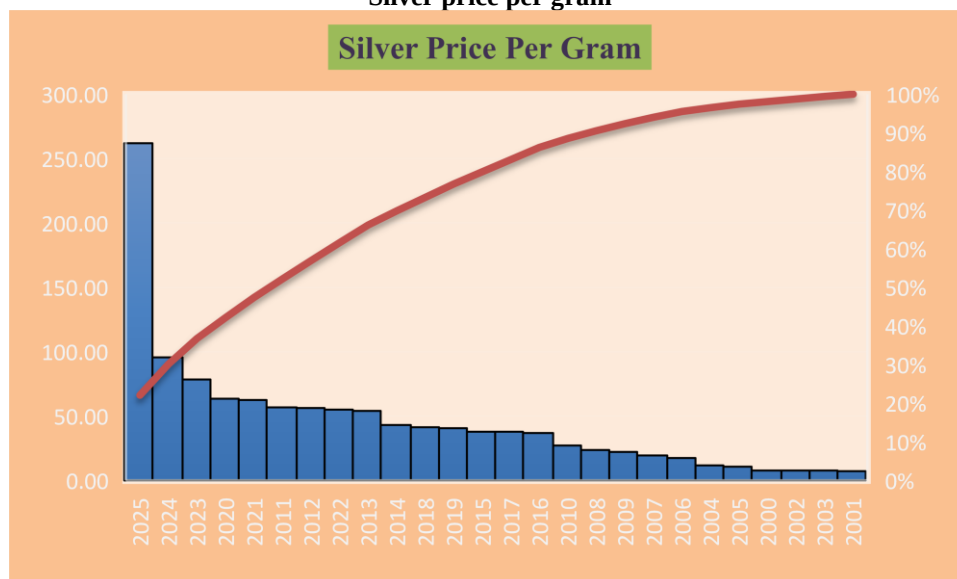


Table 2
Correlations Analysis of Selected Variables

Variables		Silver Price	GDP	Exchange Rate	Real Interest Rate	Inflation Rate	Crude Oil Price
Silver Price	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	25					
GDP	Pearson Correlation	.039	1				
	Sig. (2-tailed)	.850					
	N	25	25				
Exchange Rate	Pearson Correlation	.805**	.004	1			
	Sig. (2-tailed)	.000	.984				
	N	25	25	25			
Real Interest Rate	Pearson Correlation	-.339	-.209	-.074	1		
	Sig. (2-tailed)	.090	.306	.720			
	N	25	25	25	25		
inflation Rate	Pearson Correlation	.068	-.042	-.298	-.443*	1	
	Sig. (2-tailed)	.740	.837	.139	.023		
	N	25	25	25	25	25	
Crude Oil Price	Pearson Correlation	-.251	.262	-.523**	-.006	.206	1
	Sig. (2-tailed)	.216	.196	.006	.975	.313	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The above table 2 explains the relationship between silver prices and the selected macroeconomic variables. The results show that silver price has a strong positive and statistically significant relationship with the exchange rate (.805**). This means that when the exchange rate increases, silver prices also tend to increase. Inflation rate also has a moderate negative and significant relationship with real interest rate (-.443*), indicating that rising inflation prices are associated with a real interest rate. On the other hand, crude oil prices have negatively significant relationship with exchange rate (-.523**), Gross domestic products, real interest rate, inflation rate and crude oil prices suggesting that these variables do not have a strong influence on silver prices during the study period. Overall, the findings suggest that among all the variables, exchange rate has the strongest association with silver prices, followed by inflation, GDP, inflation, show only weak relationships.

Table 3

Multiple Regression Analysis of Gold Prices and Macro-Economic Variables

H_{01} = There is no significant relationship between macro-economic variables and silver prices in India.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.897 ^a	.805	.756	.19223691	.805	16.491	5	20	.000

a. Predictors: (Constant), GDP, Exchange Rate, Real Interest Rate, Inflation Rate, Crude Oil Prices

The above table 3 shows the model summary results of overall impact of macroeconomic variables on silver prices in India. The correlation coefficient ($R = 0.897$) indicates a very strong relationship between silver prices and the independent variables, namely GDP, exchange rate, real interest rate, inflation rate, and crude oil prices. The R Square value of 0.805 means that 80.5% of the variation in silver prices can be explained by these macroeconomic variables, while the remaining 12% is influenced by other factors not included in the model. The adjusted R Square value of 0.805 also confirms that the model has a strong explanatory power even after adjusting for the number of variables used. The F-statistic value of 16.491 with a significance value of 0.000 indicates that the overall regression model is statistically significant. Since the p-value is less than 0.05, the null hypothesis, which states that there is no significant relationship between macroeconomic variables and silver prices in India, is rejected. Therefore, it can be concluded that macroeconomic variables have a significant relationship with silver prices in India during the study period.

Table 4

ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	3.047	5	.609	16.491	.000 ^b
Residual	.739	20	.037		
Total	3.786	25			

a. Dependent Variable: Silver Price

b. Predictors: (Constant), GDP, Exchange Rate, Real Interest Rate, Inflation Rate, Crude Oil Prices

The table 4 shows the ANOVA results, that whether the overall regression model is statistically significant in explaining changes in silver prices. The regression sum of squares value (3.047) is much higher than the residual sum of squares value (.739), which indicates that the independent variables explain a large portion of the variation in silver prices. The F-value of 16.491 is high, and the significance value ($p = 0.000$) is less than 0.05, showing that the model is statistically significant. This means that GDP, exchange rate, real interest rate, inflation rate, and crude oil prices together have a significant effect on silver prices. Therefore, the regression model is reliable and suitable for analysing the relationship between silver prices and the selected macroeconomic variables.

H_{01} = The null hypothesis is there is no significant relationship between macro-economic variables and gold prices in India.

Table 5

Coefficients table of silver price and macro-economic variables

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-4.942	.894		-5.527	.000	-6.807	-3.076
GDP	-.093	.204	-.049	-.457	.653	-.518	.332
Exchange Rate	3.581	.448	.981	7.994	.000*	2.647	4.515
Real Interest Rate	-.205	.142	-.170	-1.445	.164	-.502	.091
Inflation Rate	.506	.258	.237	1.958	.064	-.033	1.044
Crude Oil Prices	.315	.172	.225	1.835	.081	-.043	.674

a. Dependent Variable: Silver Price

b. * Indicates the 5% level of significance

The above table 5 depicts the coefficient results of individual impact of each macroeconomic variable on silver prices in India. The exchange rate has a positive and highly significant effect on silver prices (0.000). This means that an increase in the exchange rate leads to an increase in silver prices. Since the significance value is less than 0.05, the null hypothesis for exchange rate is rejected, indicating a significant relationship with silver prices. Other variables like real interest rate, inflation rate and crude oil prices are not statistically significant at 5% significant level. Hence, the null hypothesis for these variables is accepted, meaning they do not have a significant relationship with silver prices.

5. CONCLUSION

This study examined whether macroeconomic determinants influence silver prices in India, using annual data for 2000-2025 and applying descriptive statistics, correlation analysis and multiple regression. The results show that GDP, exchange rate, real interest rate, inflation and crude oil prices jointly explain a substantial share of the variation in silver prices ($R^2 = 0.805$, adjusted $R^2 = 0.756$), and the model is statistically significant ($F = 16.491$, $p < 0.001$). Thus, the 'null hypothesis'—that there is no significant relationship between macroeconomic factors and silver prices—is rejected. Among the various factors, only the currency exchange rate exhibits a significant positive impact ($B = 3.581$, $p < 0.001$); this indicates that domestic silver prices rise when the value of the rupee depreciates. At the 5% significance level, Gross Domestic Product (GDP) and real interest rates did not have a significant impact; however, inflation ($p = 0.064$) and crude oil prices ($p = 0.081$) showed a significant impact (although their effect was relatively weak). These findings indicate that silver prices in India are primarily determined by fluctuations in currency values. This reflects the country's reliance on imports and international benchmark prices. Therefore, investors, hedgers, jewelry and industrial users, and policymakers should monitor foreign exchange rate fluctuations when assessing silver price risk.

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