# DETERMINANTS OF GOLD PRICES IN INDIA

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*Abstract :*  The importance of gold in Indian culture and psyche need not be expounded to an economist or a layperson. Since pre-historic times, the yellow metal has been viewed as a valuable commodity and even today, it continues to have a profound effect on the economies of the world. This study has been conducted using data covering a period of 27 financial years from 1991-92 to 2017-18. The results of econometric techniques used in the study indicate that the individual impact of exchange rates, BSE Sensex, personal disposable income and crude oil prices on gold prices is positive and significant, whereas the individual impact of inflation and interest rates on gold prices is negative and insignificant. Further, the combined impact of exchange rate, inflation, interest rate and crude oil prices has been found to be statistically significant.

*Keywords* – **Gold prices, exchange rate, inflation, BSE Sensex, personal disposable income, interest rates, crude oil prices, VIF, multicollinearity, OLS, empirical**

## I. INTRODUCTION

Gold has held a dominant presence in Indian culture since time immemorial, as is evidenced from its mention in Vedas, Epics, Puranas, Upanishads, Buddhist, Jain, Sanskrit and other ancient texts.[1] Ancient India accumulated gold through trade of Indian spices with Roman Empire and by gold mining operations, predominantly in the regions of Hatti and Kolar of modern-day Karnataka.[2] The Bank of India has one of the largest stores of gold in the world. India is the second largest consumer of gold in the world and is one of the most reliable drivers of global demand. Gold accounts for nearly 5.5% of the total foreign reserve holdings of India. India's festival and wedding season, which runs from October to December, has historically been a huge boon to gold trade.[3]

No precious metal is as legendary and beautiful as Gold. Its rarity, beauty, and enigma have provided it with status as a valuable commodity throughout the history of humanity. Gold has always been used as a monetary standard, and ancient gold jewelry and ornaments dating back centuries have been found throughout the world.[4] Gold has a profound impact on the value of world currencies. Even though the gold standard has been abandoned, gold as a commodity can act as a substitute for fiat currencies and be used as an effective hedge against inflation. There is no doubt that gold will continue to play an integral role in the foreign exchange markets.[5]

The Gold Standard was a system under which nearly all countries fixed the value of their currencies in terms of a specified amount of gold, or linked their currency to that of a country, which did so. Unfortunately, gold prices and currency values dropped every time miners found large new gold deposits. Furthermore, when World War I broke out, European countries suspended the gold standard so they could print enough money to pay for their military involvement, which led to hyperinflation.[6]

After the chaos of the inter-war period, there was a desire for stability. While fixed exchange rates were seen as essential for trade, a need was felt for more flexibility than the traditional Gold Standard had provided. Consequently, the Bretton Woods system was drawn up, wherein the dollar was pegged to gold at US$ 35 per ounce, while all other currencies had fixed, but adjustable, exchange rates to the dollar. However, a chronic US trade deficit drained US gold reserves and at the same time weakened the US dollar in the international market. Ultimately, in August 1971, US severed the link between gold and the US dollar, which resulted in the collapse of the Bretton Woods system. This allowed gold to be traded freely in the global market and thus, gold lost the property of being a means of exchange.[7]

Nevertheless, despite the availability of alternative investment options, gold is still viewed as a lucrative investment avenue and a hedge against uncertainty.

**Reasons why People Buy Gold**

There are numerous reasons, which drive people towards purchasing or investing in gold. The most common factors behind purchase of gold have been described below:

1. **Gold provides liquidity:** Investments in gold can be liquidated much faster than other physical assets like real estate. Unlike many other assets, there is no lock-in period in gold investments except for sovereign gold bonds. However, in case of physical gold, the redemption amount will depend on the purity of the gold, denomination and other factors including the market price.

2. **Gold as collateral to obtain loans:** Gold loans are secured loans where gold jewelry is used as collateral. The loan amount is usually a percentage of the gold's value. After repayment, the borrowers get their gold jewellery back. Nationalized banks, private banks, and other financial institutions offer these loans at affordable interest rates. This is particularly useful for those borrowers who have to meet a sudden financial goal, such as a marriage or a child's education and instead of selling gold, they prefer to opt for a loan.

3. **Gold is considered as Status Symbol:** Traditionally, having a good collection of jewellery symbolizes power, good status and immense wealth of the owner.

4. **Gold is an effective portfolio diversifier**: From an investment perspective, gold offers true diversification as it shows no significant correlation with mainstream asset classes. In fact, evidence suggests that when share values fall rapidly, an inverse correlation can develop between gold and equities. Gold protects an investor's portfolio from volatility because factors that affect the returns of most asset classes, both at the macro-economic and micro-economic levels, do not significantly influence the price of gold. For a given level of returns from a portfolio, adding gold to it may be reduce the risk or volatility.

5. **Gold has great religious significance:** In Indian culture, gold is the symbol of the Hindu Goddess Lakshmi and considered highly auspicious. Many of these gold coins and bars are bought on the occasion of Akshaya Tritiya and Dhanteras, when buying gold is believed to bring luck to the buyers. Festivals such as Pongal, Onam and Ugadi in the South; the Durga Puja in the east; Gudi Pavda in the west; Baisakhi and Karva Chauth in the north are also celebrated with gold purchases.

6. **Great Ornamental Value:** Women of every age and time have always loved wearing gold ornaments. Moreover, gold ornaments never go out of fashion.

7. **Great value as Heirloom:** Most people gift gold ornaments to their children during marriage and other important events in life. In this way, gold can be passed down from one generation to the other as ancestral property.[9,10]

## II. OBJECTIVES

(a). To identify various factors affecting gold prices in the Indian Economy.
(b). To evaluate and appraise empirically the relevance and significance of the factors identified on gold prices.

## III. FACTORS AFFECTING GOLD PRICES: A THEORETICAL BACKGROUND

Based on review of literature on factors affecting gold prices, 6 factors, namely exchange rate, inflation, stock prices, income, interest rate and crude oil prices, have been chosen to be determinants of gold prices in India:

**1. Exchange rate:** An exchange rate is the price of nation's currency in terms of another currency. In other words, it is the rate at which one currency can be exchanged for another.

Throughout history, many governments used gold to back their currencies, creating a gold standard. However, today, while governments maintain hoards of the yellow metal, none uses it to back their paper money. The U.S. dollar is the benchmark pricing mechanism for the gold. Therefore, there is a special relationship between the price of gold and the value of the currency of the United States.

Gold is an asset. As such, it has intrinsic value. However, that value can fluctuate over time, sometimes in a volatile fashion. As a rule, when the value of the dollar increases relative to other currencies around the world, the price of gold tends to fall in U.S. dollar terms. It is because gold becomes more expensive in other currencies. As the price of any commodity moves higher, there tend to be fewer buyers, in other words, demand recedes. Conversely, as the value of the U.S. dollar moves lower, gold tends to appreciate as it becomes cheaper in other currencies.[11]

Presuming that dollar price of gold remains constant, the price of gold in Indian Rupee increases when Indian Rupee depreciates (exchange rate = INR/USD rises) and if the Rupee appreciates (exchange rate = INR/USD falls), the price of gold decreases. This means that if the international price of gold remains constant, the gold price in INR has an inverse relation with INR or we can say a direct relationship with the exchange rate. Also, as shown by numerous studies done previously, gold prices generally move up when USD depreciates against other currencies.

Therefore, gold prices have a negative relationship with the domestic currency (here, INR), or in other words gold prices bear a positive relationship with the exchange rate.

**2. Inflation:** Inflation is defined as a sustained increase in the price of goods and services. Over time, it erodes the value of a nation's currency. In other words, it erodes purchasing power. For years, gold has been considered a store of value. As a physical commodity, it cannot be printed like money, and its value is not impacted by interest rate decisions made by a government. Because gold has historically maintained its value over time, it serves as a form of insurance against adverse economic events.[12]

Therefore, theoretically speaking, it can be said that rising inflation drives up demand for gold, which in turns increases gold prices.

**3. BSE SENSEX:** Sensex, otherwise known as the S&P BSE Sensex index, is the benchmark index of the Bombay Stock Exchange (BSE) in India. Sensex is composed of 30 of the largest and most actively traded stocks on the BSE, providing an accurate gauge of the overall growth, development of particular industries, and booms and busts of the Indian economy.

There exists an inverse relationship between Sensex and gold prices. Logically speaking, when investors perceive a bullish trend the stock market, they choose to invest more in stocks to benefit from even higher stock prices in the future. Because of this shift in preference, the demand for gold falls, thus bringing down gold prices. Conversely, when the stock market declines and investors expect this bearish trend to continue for some time, they prefer to invest their surplus funds in safe haven assets like gold, thus driving up the demand for gold and pushing up gold prices. It implies that there is an inverse relationship between gold prices and Sensex.

**4. Personal Disposable Income:** Personal Disposable Income (PDI) is the amount of money that households have available for spending and saving after income taxes have been accounted for. It is often monitored as one of the many key economic indicators used to gauge the overall state of the economy.

According to a report by the World Gold Council, annual data from 1990 to 2015, revealed two significant factors affecting gold consumer demand (jewelry, and bar and coin combined) over the long-term. "All else being equal, gold demand is driven firstly by, income i.e. gold demand is seen to rise with income levels. For a 1 percent increase in income per capita gold demand rises by 1 percent and secondly, gold price level i.e. higher prices deter gold purchases. For a 1 percent increase in prices, the demand for gold by 0.5 percent."[8]

Therefore, we can conclude that higher income implies higher savings and gold, being a safe investment bet, will always be a top choice for the Indian public, thus a higher demand will drive up gold prices by a higher margin.

**5. Interest Rates:** Many people believe that the price of gold is inversely related to interest rates. However, it is only partially true. In fact, gold prices are driven not by nominal rates (which are not adjusted for inflation), but by real rates (which are nominal rates adjusted for inflation).

Generally, real interest rates are negatively correlated with the price of gold, i.e. rising interest rates adversely impact the yellow metal. The intuition behind this is that higher interest rates mean higher opportunity costs of holding non-interest bearing assets, like precious metals, making them relatively less attractive. Basically, gold pays neither dividend nor interest. Thus, it is relatively expensive to hold in the portfolio when real interest rates are high, and relatively cheap when real interest rates are low. In other words, the higher the interest rates are, the higher are carrying costs.[13]

However, the relationship is not linear. Gold prices tend to increase significantly only during the periods of negative real interest rates. This is because negative interest rates, i.e. the situation when the inflation rate is higher than the nominal interest rate (the rate which is actually paid), means that creditors are losing money, therefore they are more prone to buy gold, even though it does not bear interest or dividends. In other words, gold reclaims then its traditional role as money and a store of wealth, which will at least keep pace with inflation to preserve the purchasing power of the capital, while bonds guarantee a real loss at negative real interest rates.[13]

To sum up, changes in real interest rates are crucial to understanding movements in the price of gold. The adverse relationship between real interest rates and the gold price is quite well established in the literature and was confirmed by a few empirical studies.

**6. Crude oil prices:** Crude oil is one of the most important commodities in the world. It is a liquid fuel source located underground and is extracted through drilling. It is an unrefined petroleum product composed of hydrocarbon deposits and other organic materials and can be refined to produce usable products such as gasoline, diesel and various types of petrochemicals.

The oil and gas sector is among the eight core industries in India and plays a major role in influencing decision making for all the other important sections of the economy. Energy demand of India is anticipated to grow faster than energy demand of all major economies, on the back of continuous robust economic growth. Consequently, India's energy demand as a percentage of global energy demand is expected to rise to 11 per cent in 2040 from 5.58 per cent in 2017.[14]

Crude oil prices can be used as a reliable proxy of movements in gold prices since the two have a strong direct relationship. Over the long-term, gold prices tend to move up and down in tandem with crude oil prices. This is because, like oil, gold too is mined from the ground, is standardized and interchangeable.[15] Changes in long-term oil prices bear a direct relationship with gold price movements due to the fact that energy is the dominant production cost for gold. Further, soaring crude oil prices produce inflation, which is consistent with a growing economy.[16] Gold, being a reliable store of value, is deemed worthy of being included in investment portfolios since it is perceived as a hedge against inflation. Thus, there is a direct relationship between gold prices and crude oil prices.

## IV. REVIEW OF LITERATURE

There have been numerous studies and empirical researches on the gold. A brief account of the determinants of gold prices and results of the same are given below: -

**1. Exchange rates and Gold prices:** Gireesh et al (2015) studied the relationship between gold price and value of exchange rate in India. The study used the spot price of gold and exchange rate for the period of 2005 – 2013 and used Johansen co-integration test to check the long run relationship between these variables. The study reveals that exchange value of US Dollar is an important factor in determining the gold price in India. The appreciation or depreciation of US dollar creates fluctuations in gold price.[17]

Subashini and Poornima (2014) examined the relationship between Gold price, Exchange rate and Crude Oil price in India by using daily data for the period of 1st January 2009 to 31st December 2013. The Johansen co-integration method is used to find the relationship and the result shows that Indian Rupee, gold price and crude oil price has positive relationship together. That is, an increase in currency will increase crude oil price and gold price.[17]

Bhunia and Pakira (2014) studied the impact of gold price and exchange rate on Sensex in India by using daily data from January 1991 to October 2013. The result of Johansen cointegration test reveals that there is a long run relationship between these variables and investors are continuously watching the movements in gold price and exchange rate due to this reason.[17]

Ibrahim et al (2014) examined the factors affecting gold price in Malaysia. They used Multiple Linear Regression Model for a 10 year data ranging from 2003 to 2012 to find the relation between variables. The study found that the exchange rate and inflation are negatively related to the gold price. At the same time crude oil price affected positively with the gold price.[17]

Patel (2013) investigated the relationship between inflation, exchange rate and gold price in India by using monthly data from January 1991 to September 2012. The Cointegration test used in the study indicated that there exists a long run relationship between all these three variables.[17]

Apergis and Papoulakos (2013) examined the relationship between Austrian dollar, US dollar, exchange rate and gold price by using daily data from 2000 to 2011. They used the Error Correction Model and the Generalized Autoregressive Heteroskedasticity (GARCH) approach to find the association and its result shows that there is a close relationship between these two variables, and the exchange rate is acting as a reference point in fixing the future price of gold.[17]

Omag (2012) studied the relationship between gold price and selected financial variables in Turkey. He used Regression model to analyze the relationship between variables from January 2002 to December 2011. The result indicates that there is a positive relationship between the gold price, Istanbul Stock Exchange 100 Index and the exchange rate between Turkish Lira and the Dollar.[17]

Arezki et al (2011) investigated the relationship between South African Rand and gold price volatility by using monthly data ranging from 1980 to 2010. The cointegration method is used to find out the relation between variables. The result shows that the gold price fluctuation is less important to the South African Rand especially after the liberalization and their economy is less depending on gold and its price variations.[17]

Sjaastad (2008) investigated the theoretical and empirical relationship between gold price and major exchange rates using data for January 1991 to June 2004 period. They used the asset pricing model to predict the relation, and the result reveals that the emergence of flexible exchange rate system created instability in the world gold market, and now it is dominated by the US dollar. That means, any change in the value of US dollar creates a strong impact on the price of Gold.[17]

**2. Inflation and Gold prices:** Dubey (2014) presented a study, which is based on the Gold price trends  and the  factors that determine the Gold price in India. The paper specially focuses on increase in Gold Prices in India in the years 2004 to 2013. According to empirical findings, highly positive correlation is found between Gold Prices and CPI rate of our country.[18]

Guntur Archana Raju (2016), studied the impact of inflation on gold prices fluctuations in India, China and USA. It was found in the study that there is a co-integration between the inflation and gold prices; however, there is a short-term relationship between inflation and gold prices. The variables used in the research were gold prices, co-integration. Granger causality, VECM and the tools used were unit root test, Vector auto regression, Granger causality test, Johansen cointegration test.[18]

Rahul Bishnoi (2014) analysed the critical factors affecting the price of gold using statistical techniques like ordinary least square, white-test, and weighted least square. The results proved that gold prices are positively inclined to US dollar, crude oil prices and is negatively related to rate of inflation and long run interest rates. The prime variables used in his study are GDP, Inflation and the tools adopted by him were multivariate regression model and statistical tests.[18]

In a recent paper looking at the relationship between gold and inflation in China, India, Japan, France, the United Kingdom and the United States (between 1978 and 2015 for both the UK and the US), Hoang et al. (2016) works with a nonlinear autoregressive distributed lags (NARDL) model and prove that gold was not a hedge in the long-run for all the observed countries. It seems however, that gold was a hedge against inflation in the short-run in the UK, the USA and India.[19]

Tufail and Batool (2013) analysed the relationship between inflation and gold price in Pakistan. Here they applied the co-integration test for the time series data from 1960-2010 to find the relationship and the result indicates that gold is a crucial determinant of inflation in Pakistan.[20]

**3. BSE Sensex and Gold prices:** Mishra et al. (2012) and Le et al. (2012) confirmed that there is a significant relationship between gold prices and the stock market. The study found that stock market is one of the drivers for increasing gold prices.[21]

On the other hand, Kaliyamoorthy and Parithi (2012) documented that Indian stock market is not associated with gold market and gold prices have increased consistently due to Indian stock market crash.[21]

Narang and Singh (2013) aimed at investigating the dynamic relationship between gold prices and stock market returns in India. In the study, an attempt has been made to investigate the existence of unidirectional or bidirectional relationship between gold price and Sensex for the period of 10 years (2002-2012). The results of the analysis show that there is no causality between the gold price and Sensex.[22]

According to Beckman et al.(2014), during the global financial crisis of 2007-08, major sectors of various stock exchanges around the world declined except for gold. At that time, gold market gave a tremendous response and encouraged investors to add gold to their investment portfolios.[23]

A recent study, Srinivasan & Prakasam, (2015), investigated the causal relationship between gold price, stock price and exchange rate by using the ARDL approach and Granger causality test in India and found that gold price and stock price tend to have long-run relationship with exchange rate in India but in short-run there is no causal relationship between gold price to stock price and vice versa.[24]

A recent study by Bhuyan, Dash (2018) investigated the causal relationship between gold price movements and stock market returns in India using secondary monthly time series data covering the period from 2001 to 2017. Using Johansen's approach and Granger causality approach in VAR framework, the study concluded that while there is a long-run relationship between gold and stock returns, there is no short term relationship between them. Further, investment in gold has the potential to safeguard short-term stock portfolios against extreme, negative market shocks.[25]

**4. Personal disposable income and Gold prices:** Kanjilal and Ghosh (2014) investigated the co-integrating relationship between gold import demand, gold price and GDP for the Indian economy during the period 1998-2013 using Johansen-Juselius test, ARDL bound tests and threshold co-integration tests and concluded that in the long-run, income elasticity was highly elastic, suggesting that gold was a luxury commodity. In the short-run, however, gold demand exhibited high elasticity with respect to its price. The Granger Causality test showed that demand impacts gold prices in the short-run, whereas in the long-run, income and price impact demand for gold.[26]

Jayasathya and Rekha (2014) have stated that in India, generally all investment avenues are perceived to be risky by the investors. The major features of an investment are safety of the capital amount, liquidity, income stability, appreciation and easy transferability. A variety of investment avenues are available such as shares, bank deposits, gold and silver etc and investors invest their surplus money in the above mentioned avenues based on their risk taking attitude.[27]

Narayanan, Gopalakrishnan and Sahay (2017) conducted research in order to arrive at the  possible implications and suggestions relating to gold monetization policy in India. By studying the behavior of consumers and various stakeholders and using a regression-based analysis of secondary sample survey data across states, they concluded that higher income is correlated with higher proportion of assets held in gold and higher share of gold held in jewellery form in the urban segment but not in the rural segment.[28]

**5. Interest rates and Gold prices:** Abdullah, Adam & Abu Bakar, Mohd Jaffri. (2015) used Gibson's Paradox to determine a forecasting model of price of gold in relation to rate of interest from 1971-2013, using monthly data obtained from

various sources such as US Department of Labor, the Federal Reserve, the World Gold Council, the Office of Comptroller of Currency, the Bank of International Settlements (BIS) and the World Bank. The research demonstrated that price of gold and real interest rates are inversely related; however nominal interest rates are positively related to commodity prices, enabling the Federal Reserve to manipulate gold prices simply by varying these interest rates.[29]

Wang and Chueh (2013) dealt with the short-term and long-term dynamic interactions among interest rates, oil prices, gold prices and the U.S. dollar. The study employed the threshold cointegration model and the threshold error correction model for analysis covering the period 1989 to 2007. The researchers determined that interest rates had a negative effect on gold futures prices and that there was a price transmission from interest rates to gold prices.[30]

The theoretical interrelationship between gold, inflation and interest rates espoused by Feldstein (1980) and Fortune (1987) is given strong empirical backing by Batten et al. (2014) further analysis. They show that there is significant time variation in the relationship between gold and the CPI. Their relationship is weak in the 1980s and 1990s, but begins to strengthen in 2002. The relationship is found to be determined by interest rates: falling rates increase the importance of inflation. This possibly reflects a shift in opportunity cost from lost interest payments to declines in purchasing power as US interest rates fall.[31]

Baur (2011) argues that there is a different relationship between gold and long versus short-term interest rates. Using monthly data over a 30-year period he shows that lower short-term rates have a positive impact on gold prices while long-term interest rates have a negative impact. This fit both with the findings of Abken (1980) who found a negative relationship between gold and short-term interest rates, and with Fortune (1987) who found a negative relationship with long-term rates. This apparent dichotomy is seen to imply that short term interest rates represent an opportunity cost to an investor while long run rates are actually showing inflations expectations, where higher expected inflation (and therefore higher long term interest rates) encourages gold investment and drives prices up. This result points to a need for any short run modelling of gold prices to use short term interest rates, as long term rates are linked to inflation, which is already normally used in the long run gold models (e.g. Levin et al., 2006).[31]

But not all studies find that a link exists. Silva (2014) finds no relationship between gold prices and interest rates on using 10 years of annual data, though concerns remain over the presence of unit root issues in their analysis. Using quarterly data from 1979 to 2001 Lawrence (2003) finds that there is no statistically significant link between gold and 3 month US Certificate of Deposit rates, as well as many other macroeconomic variables such as inflation. The inclusion of bond yields, 3 month CD interest rates and the M2 measure of the money supply in the same equation may mean that there was some multi-collinearity here. The low frequency of observations in both the above studies also makes it more difficult to analyse the reactions between two financial variables, which under most sets of assumptions would react much faster than this to information.[31]

Tully and Lucey (2007) applied an asymmetric power GARCH model to daily gold prices, in a model including inflation and the trade weighted dollar, and found that interest rates had no significant impact on gold prices. The US Dollar was the sole variable with explanatory power.[31]

**6. Crude oil prices and Gold prices:** A recent study by Singh and Sharma (2017) investigated the linkage between gold and crude oil spot prices using co-integration and causality approach from 2012 to 2016. The results showed that there is low positive correlation between gold and crude oil prices. Johansen's co-integration results indicated that there is no long-run equilibrium between the two price series. However, the results of the Granger Causality test showed that gold prices bear a long-term causality to crude oil prices.[32]

Kumar (2017) examined the relation between gold and oil prices in India through ARDL tests and Granger causality tests. This relation was investigated in both short-run and long-run. Nonlinear Granger causality test pointed out that there was a strong bidirectional nonlinear relation between gold and oil prices while ARDL test revealed that compared to negative oil price shocks, positive oil price shocks have more significant effects on gold prices. In the long-term, the author found that gold prices were more sensitive to rising oil prices. As a result, he concluded that the interaction between gold and oil prices is asymmetric and nonlinear.[33]

Guntur Archana Raju (2016) analyzed the impact of Crude Oil prices on gold prices by applying Co-integration, Granger Causality and VAR framework to time series data from 1996-2015. The study concluded that in India, Crude Oil prices and gold prices have insignificant short-term relationship; however there is bi-directional causality between the variables. In other words, gold prices are affected by the past values of oil prices.[34]

Bishnoi (2014) analysed the critical factors affecting gold prices using the yearly data from 1994 to 2013 by employing OLS, White-Test for heteroscedasticity and also Weighted Least Squares model. It was concluded that gold prices and crude oil prices have a positive relationship. As the world's major Oil Spot and Futures are priced in dollars, fluctuations in oil prices relate to the dollar and thus, oil prices and gold prices indirectly influence each other.[35]

## V. RESEARCH METHODOLOGY

The study aims at performing a comprehensive analysis of the factors, which determine gold prices in the Indian economy by a careful consideration of the determinants, covering a period of 27 years (from 1991-92 to 2017-18).

**5.1 Population and Sample**

The data used in the analysis is for the period 1991-92 to 2017-18.

| Year | Gold Prices (in rupees per 10 gms) | Exchange Rate (₹ per US dollar) | CPI (in % p.a.) | BSE Index | PDI (in thousand billion rupees) | Interest Rate (in % p.a.) | Crude Oil Prices (in hundred rupees per barrel) |
|------|------|------|------|------|------|------|------|
| 1991-92 | 4.298 | 24.474 | 13.483% | 1.880 | 5.479 | 13.000% | 4.612 |
| 1992-93 | 4.104 | 30.649 | 9.825% | 2.896 | 6.385 | 11.000% | 5.865 |
| 1993-94 | 4.532 | 31.366 | 7.316% | 2.899 | 7.395 | 10.000% | 4.961 |
| 1994-95 | 4.667 | 31.399 | 10.275% | 3.975 | 8.678 | 11.000% | 5.253 |
| 1995-96 | 4.958 | 33.450 | 9.962% | 3.289 | 9.917 | 13.000% | 5.842 |
| 1996-97 | 5.071 | 35.500 | 9.432% | 3.469 | 11.837 | 12.750% | 7.492 |
| 1997-98 | 4.347 | 37.165 | 6.842% | 3.813 | 13.048 | 11.750% | 6.454 |
| 1998-99 | 4.268 | 42.071 | 13.127% | 3.295 | 15.232 | 11.000% | 5.249 |
| 1999-00 | 4.394 | 43.333 | 3.320% | 4.659 | 16.712 | 10.250% | 9.454 |
| 2000-01 | 4.474 | 45.684 | 3.923% | 4.270 | 18.315 | 9.750% | 12.835 |
| 2001-02 | 4.579 | 47.692 | 4.315% | 3.332 | 20.172 | 8.250% | 10.984 |
| 2002-03 | 5.332 | 48.395 | 3.975% | 3.206 | 21.358 | 5.875% | 13.313 |
| 2003-04 | 5.719 | 45.952 | 3.857% | 4.492 | 23.565 | 5.375% | 13.357 |
| 2004-05 | 6.145 | 44.932 | 3.831% | 5.741 | 25.823 | 6.250% | 18.531 |
| 2005-06 | 6.901 | 44.274 | 4.411% | 8.279 | 29.109 | 6.750% | 25.282 |
| 2006-07 | 9.240 | 45.250 | 6.729% | 12.277 | 33.286 | 8.125% | 28.698 |
| 2007-08 | 9.996 | 40.261 | 6.147% | 16.569 | 37.348 | 8.750% | 32.397 |
| 2008-09 | 12.890 | 45.993 | 9.113% | 12.366 | 45.314 | 8.125% | 37.572 |
| 2009-10 | 15.756 | 47.443 | 12.379% | 15.585 | 51.985 | 7.250% | 33.108 |
| 2010-11 | 19.227 | 45.563 | 10.462% | 18.605 | 60.041 | 8.625% | 38.544 |
| 2011-12 | 25.722 | 47.923 | 8.380% | 17.423 | 71.788 | 8.875% | 51.344 |
| 2012-13 | 30.164 | 54.410 | 10.439% | 18.202 | 77.657 | 8.750% | 56.046 |
| 2013-14 | 29.190 | 60.502 | 9.686% | 20.120 | 87.685 | 8.800% | 62.834 |
| 2014-15 | 27.415 | 61.144 | 6.261% | 26.557 | 96.968 | 8.375% | 50.653 |
| 2015-16 | 26.534 | 65.469 | 5.655% | 26.322 | 107.052 | 7.150% | 29.979 |
| 2016-17 | 29.665 | 67.072 | 4.137% | 27.338 | 118.168 | 6.625% | 32.115 |
| 2017-18 | 29.300 | 64.455 | 3.079% | 32.397 | 129.867 | 6.500% | 35.915 |

*The data pertaining to BSE Sensex and PDI has been modified by transforming the actual figures into their natural logarithmic values (log base e)

**5.2 Data and Sources of Data**

The data pertaining to gold prices reflects the average price of gold in domestic and foreign markets as announced in Mumbai (expressed as rupees per 10 grams) and has been adopted from the RBI Handbook of Statistics on Indian Economy[36] (Data source are Bombay Bullion Association and Press Trust of India for 1991-91 to 1999-2000; Business Standard/Business Line and Economic Times, Mumbai/IBJA Website for the period 2000-01 onwards).

The exchange rate is expressed as average rupees per unit of U.S. dollar and has been adopted from the RBI Handbook of Statistics on Indian Economy[36] (Data Source: Data from 1992-93 till April 2012 are based on indicative rates of Foreign Exchange Dealers' Association of India. RBI reference rates are used w.e.f May 2012).

Consumer Price Index (CPI) has been used as a measure of inflation (expressed in percent per annum) and has been calculated using monthly All India CPI data for industrial workers as published by the Labour Bureau of the Government of India.[37]

The S&P BSE Sensex is a free-float market-weighted stock market index of 30 well established and financially sound companies listed on Bombay Stock Exchange with base year 1978-79. The data has been adopted from the RBI Handbook of Statistics on Indian Economy[36] (Data Source: RBI and BSE Ltd).

The data pertaining to personal Disposable Income (expressed in thousand billion rupees) has been adopted directly from the RBI Handbook of Statistics on Indian Economy[36] for the period 1991-92 to 2012-13. From 2013-14 onwards, the figures have been estimated using the average of the ratio of PDI to NNDP for the last 5 years (Data Source: Central Statistics Office). Interest rates (expressed in percent per annum) have been adopted from the RBI Handbook of Statistics on Indian Economy[36] and reflect the average commercial bank deposit rate for deposit period above 5 years (Data Source: Financial Institutions and RBI).

Crude oil prices, expressed in hundreds of rupees per barrel, have been adopted as the average of the monthly prices published on the website.[38] Figures from 1991-92 to 1994-95 have been estimated by multiplying average of the monthly crude oil prices in dollar terms with the corresponding exchange rate (Data Source: Crude oil, average spot price of Brent, Dubai and West Texas Intermediate, equally weighed).

## 5.3 Econometric models and statistical tools

There are several statistical and mathematical models, which can be used to test the hypotheses of the data under study. A brief description of the econometric techniques used to analyze and interpret the data has been provided below:

### 5.3.1 Linear Regression Model

The approach attempts to model the relationship between two variables – the dependent variable Y and one or more explanatory (or independent) variables X – by fitting a linear equation to observed data.

$$Y = f(X) = \alpha + \beta X_i \qquad i = 1, 2 \dots n$$

For the purpose of this study, the dependent variable, Y refers to the Gold price, and set of independent variables, is as given below:

$X_1$ = Exchange Rate; $X_2$ = CPI; $X_3$ = BSE Sensex;

$X_4$ = PDI; $X_5$ = Interest Rate; $X_6$ = Crude Oil Price

The Beta coefficients, representing the slope the independent variables are:

$\beta_1$ = beta coefficient for exchange rate; $\beta_2$ = beta coefficient for CPI

$\beta_3$ = beta coefficient for BSE Sensex; $\beta_4$ = beta coefficient for PDI

$\beta_5$ = beta coefficient for interest rate; $\beta_6$ = beta coefficient for crude oil price

### 5.3.1.1 Simple Regression Model

The regression model in which the dependent variable is related to a single explanatory variable is known as simple or two-variable regression model and its stochastic form is expressed as:

$$Y = \alpha + \beta X + \mu$$

Where,

Y = dependent variable

X = independent variable

$\alpha$ = Intercept

$\beta$ = Slope coefficient which measures unit change in mean value of Y as a result of unit change in X

$\mu$ = Stochastic error term

This model has been used as a precursor to multiple regression model to explore the impact of each individual independent variable on the dependent variables.

### 5.3.1.2 Multiple Regression Model

The regression model in which the dependent variable is related to two or more explanatory variables is known as a multiple regression model and is expressed as:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \dots \dots + \beta_n X_n + \mu$$

Where n denotes number of observations; the remaining symbols denote the same variables as explained above.

This model has been used to examine the impact of selected set of independent variables on the dependent variable.

### 5.3.2 Coefficient of Determination ($R^2$):

It is a measure that reveals about the 'goodness of fit' of the regression line to the observed data values. It is interpreted as the proportion of variance in dependent variable, which is explained by the independent variable. The value of $R^2$ lies between 0 and 1. The value of $R^2$ near 1 indicates that the regression line fits the data well, whereas an $R^2$ closer to 0 indicates that a regression line does not fit the data well. It is defined as:

$$R^2 = \frac{ESS}{TSS} \ or \ 1 - \frac{RSS}{TSS}$$

Where,

TSS = Total sum of squares or total variation of actual Y value

ESS = Explained sum of squares or explained variation of Y values

RSS = Residual sum of squares or unexplained variation of Y values

### 5.3.3 Adjusted $R^2$

It is a modified version of R-squared for the number of independent variables in a model. Unlike $R^2$, which is a non-decreasing function of the number of explanatory variables in the model, adjusted $R^2$ increases only if a newly added explanatory variable enhances the model above what would be obtained by probability and decreases if a newly added explanatory variable enhances the model less than what is predicted by chance. The adjusted R-squared can turn out to be negative, in which case, its value is taken as zero. It is defined as:

$$R^2_{adj} = 1 - \left[ \frac{(1 - R^2)(n - 1)}{n - k - 1} \right]$$

Where,

$R^2$ = Coefficient of determination

k = number of variables

n = number of observations

## 5.3.4 F-test

This has been used to test the overall significance of a linear regression model as to its relevance in the context. The hypotheses formed for this purpose are as follows:

$H_0 : \beta_1 = \beta_2 = \ldots\ldots = \beta_n = 0$

$H_A$ : Not all slope coefficients are simultaneously zero

The F-test is a measure of the overall significance of the estimated regression and therefore a test of significance of $R^2$. The test statistic F is calculated as:

$$F = \frac{R^2/(k-1)}{(1-R^2)/(n-k)}$$

Where,

$R^2$ = Coefficient of determination

n = number of observations

k = number of variables

Test Rule: If calculated F –Value > tabulated F-Value, the null hypothesis is rejected. Tabulated F-value is the critical value of F at specified level of significance (say 5%) and (k - 1) numerator d.f. and (n - k) denominator d.f.

## 5.3.5 T-test

This is used as a hypothesis testing tool that allows testing of an assumption applicable to a population. In regression analysis, the t-test is used to conduct hypothesis test on regression coefficients obtained in linear regression to determine whether there is a significant linear relationship between the dependent variable Y and an independent variable X.  We state the hypotheses as follows:

$H_0 : \beta = 0$  and  $H_A : \beta \neq 0$

If there is a significant relationship between the dependent variable Y and independent variable X, the slope $\beta_1$ will not equal zero.

The test statistic is a t-statistic defined by the following equation:

$$t = \frac{\beta}{SE} \sim t_{df}$$

Where,

$\beta$ = slope of sample regression line

SE = Standard error of the slope

d.f. = degrees of freedom; calculated as n-1, where n denotes sample size

Test Rule: If calculated value of t statistic exceeds tabulated t-value, null hypothesis is rejected and the slope of sample regression line, $\beta$ is said to be statistically significant at a particular level of significance, which is generally taken as 5%.

## 5.3.6 Variance Inflation Factor

This test is performed to explore the possibility of multicollinearity in a set of multiple regression variables. Multicollinearity exists when there is a linear relationship, or correlation, between one or more of the independent variables. Due to multicollinearity, it is difficult to test the outcome of multiple regression since the independent variables are not actually independent. VIF measures how much the variance of an independent variable is inflated by its correlation with other independent variables in the model. It is calculated as 1/Tolerance and is always greater than or equal to 1. Even though there is no formal VIF value for determining multicollinearity, values of VIF that exceed 10 are often regarded as indicating multicollinearity. However, in weaker models, values above 2.5 may be a cause of concern.

## VI. EMPIRICAL ANALYSIS AND INTERPRETATION

The observed data values have been analyzed in two stages: One by using simple linear regression model as an initial attempt to explore the impact of each of independent variables on the dependent variable separately, second by using the multiple linear regression model to examine the impact of selected set of independent variables on the dependent variable. The choice of variables for multiple linear regression model is based upon the impact these variables have shown in simple linear regression model.

## 6.1 Results of Simple Regression Analysis

The results of individual regressions of gold price on the chosen variables are given in Exhibit A and Exhibit B as shown below:

| Exhibit A – Summary Output | | | | | | |
|---|---|---|---|---|---|---|
| **Independent Variables** | **Intercept α** | **Slope Coefficient β** | **S.E.** | **Coefficient of Correlation** | **$R^2$** | **Adjusted $R^2$** |
| Exchange Rate | -21.905 | 0.755 | 0.104 | 0.824 | 0.678 | 0.665 |
| CPI | 13.057 | -6.817 | 63.607 | -0.021 | 0.000 | -0.040 |
| BSE Sensex | -8.586 | 10.297 | 0.992 | 0.901 | 0.812 | 0.804 |

| PDI | -19.588 | 9.608 | 0.931 | 0.900 | 0.810 | 0.802 |
| Interest Rate | 29.399 | -188.003 | 84.938 | -0.405 | 0.164 | 0.130 |
| Crude Oil Price | 0.659 | 0.503 | 0.055 | 0.878 | 0.771 | 0.761 |

**Exhibit B – Analysis of t-statistic and F-statistic**

| Independent Variables | Critical t-value = 2.056 at 0.05 level of significance | | Critical F-value = 4.242 at 0.05 level of significance | |
| --- | --- | --- | --- | --- |
| | Calculated t-value | Test of significance | Calculated F-value | Test of significance |
| Exchange Rate | 7.260 | Significant | 52.708 | Significant |
| CPI | -0.107 | Insignificant | 0.011 | Insignificant |
| BSE Sensex | 10.377 | Significant | 107.677 | Significant |
| PDI | 10.317 | Significant | 106.448 | Significant |
| Interest Rate | -2.213 | Significant | 4.899 | Significant |
| Crude Oil Price | 9.166 | Significant | 84.013 | Significant |

A perusal of the above findings reveals that:

**(a).**   Each of the variables: Exchange Rate, BSE Sensex, PDI and Crude prices are positively correlated with gold prices, as their respective coefficient of correlations are significantly high. Accordingly, the effect of these independent variables on gold prices has been examined individually using the simple regression model: $Y = \alpha + \beta X_i$. The adjusted $R^2$ for each of the simple regressions is found to be statistically significant as revealed by the F-test (Refer to Exhibit B). The calculated F-value lies between 52.708 to 107.677 against the critical F-value of 4.242, with (1,25) d.f., at 5% level of significance to indicate that each of these simple regression models has statistically significant explanatory power and therefore relevant.

The regression coefficient $\beta = 0.755$ in respect of exchange rate implies that an increase in **exchange rate** by ₹ 1 (due to depreciation of rupee against US dollar) results in an increase in gold price by ₹ 0.755 thousand. The findings as given in Exhibit B also reveal that the calculated t-value = 7.260 for β, with 26 d.f., exceeds the tabulated t-value of 2.056. Accordingly, the null hypothesis $H_0 : \beta=0$ stands rejected to suggest that the positive impact of exchange rate on gold prices is statistically significant at 5% level of significance.

The regression coefficient $\beta = 10.297$ in respect of BSE Sensex implies that an increase in **BSE Sensex** by 1% results in an increase in gold price by ₹ 10.297 thousand. The findings as given in Exhibit B also reveal that the calculated t-value = 10.377 for β, with 26 d.f., exceeds the tabulated t-value of 2.056. Accordingly, the null hypothesis $H_0 : \beta=0$ stands rejected to suggest that the positive impact of BSE Sensex on gold prices is statistically significant at 5% level of significance.

The regression coefficient $\beta = 9.608$ in respect of **Personal Disposable Income (PDI)** implies that an increase in PDI by 1% results in an increase in gold price by ₹ 9.608 thousand. The findings as given in Exhibit B also reveal that the calculated t-value = 10.317 for β, with 26 d.f., exceeds the tabulated t-value of 2.056. Accordingly, the null hypothesis $H_0 : \beta=0$ stands rejected to suggest that the statistically significant positive impact of PDI on gold prices at 5% level of significance.

The regression coefficient $\beta = 0.503$ implies that an increase in **crude oil price** by ₹ 100 results in an increase in gold price by ₹ 0.503 thousand. The findings as given in Exhibit B also reveal that the calculated t-value = 9.166 for β, with 26 d.f., exceeds the tabulated t-value of 2.056. Accordingly, the null hypothesis $H_0 : \beta=0$ stands rejected to suggest that the positive impact of crude oil prices on gold prices is statistically significant at 5% level of significance.

**(b).**   The correlation coefficient between **Inflation (CPI)** on gold prices is very low. Further, the effect of inflation on gold prices on the basis of a simple regression analysis: $Y = \alpha + \beta (X_2)$ reveals that the $R^2 = 0.000$ (and adjusted $R^2 = - 0.04$ ) is almost zero and also statistically insignificant as revealed by the F-test (Refer to  Exhibit B). The calculated F-value 0.011 does not exceed the critical F-value of 4.242, with (1,25) d.f., at 5% level of significance, thereby indicating that the regression model is irrelevant. This implies that there is not effect of CPI on gold prices.

**(c).**   The correlation coefficient between Interest Rate and gold prices (as per Exhibit: A) reveals that gold prices are negatively correlated with interest rate, as their coefficient of correlation is -0.405, but not fairly high. The effect of interest rates on gold prices, on the basis of simple regression analysis: $Y = \alpha + \beta (X_5)$ reveals that the adjusted $R^2 = 0.130$ is statistically significant as per the F-test (Refer to Exhibit B). The calculated F-value 4.899 marginally exceeds the critical F-value of 4.242, with (1, 25) d.f., at 5% level of significance, thereby indicating that the regression model is somewhat relevant. The regression coefficient $\beta = - 188.003$ implies that an increase in interest rate by 1% results in a decrease in gold price by ₹ 188.003 thousand. The findings as given in Exhibit B also reveal that the calculated t-value = -2.213 for β, with 26 d.f., exceeds the tabulated t-value of 2.056. Accordingly, the null hypothesis $H_0 : \beta=0$ stands rejected to suggest that the negative impact of interest rates on gold prices is statistically significant at 5% level of significance.

On the basis of preliminary analysis of simple regression model as discussed above, a multiple regression analysis has been conducted, the details of which are as given below.

**6.2 Results of Multiple Regression Analysis**

A perusal of findings as given in Exhibit A reveals that gold prices are positively correlated with exchange rate, BSE Sensex, PDI and crude oil prices, as their coefficient of correlation is 0.824, 0.901, 0.900 and 0.878 respectively, which is fairly high. However, gold prices are negatively correlated with inflation and interest rates, as their coefficient of correlation is -0.021 and -0.405 respectively. Accordingly, the effect of this set of 6 variables, namely exchange rate, inflation, BSE Sensex, PDI, interest rates and crude oil prices on gold prices has been examined by performing a multiple regression analysis : $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6$ ; the results have been depicted below (Refer Exhibit C and Exhibit D)

| Exhibit C – Summary Output of Multiple Regression Model | | | | |
|---|---|---|---|---|
| $R^2$ | Adjusted $R^2$ | Calculated F-value | Critical F-value at 0.05 level of significance | Test of significance |
| 0.919 | 0.895 | 37.865 | 2.599 (6,20) d.f. | Significant |

| Exhibit D – Results of Multiple Regression Analysis | | | | | |
|---|---|---|---|---|---|
| Independent Variables | β | Standard Error | Critical t-value = 2.056 at 0.05 level of significance | | VIF |
| | | | Calculated t-value | Test of significance | |
| Exchange Rate | 0.620 | 0.227 | 2.737 | Significant | 15.093 |
| CPI | 47.624 | 30.082 | 1.583 | Insignificant | 2.211 |
| BSE Sensex | 5.303 | 3.229 | 1.642 | Insignificant | 19.729 |
| PDI | -3.412 | 5.488 | -0.622 | Insignificant | **65.301** |
| Interest Rate | 77.684 | 51.433 | 1.510 | Insignificant | 3.031 |
| Crude Oil Price | 0.197 | 0.095 | 2.805 | Significant | 6.758 |

The high VIF values of Exchange rate, BSE Sensex and PDI indicate the presence of multicollinearity. To address this situation, PDI has been removed from the set of independent variables. Accordingly, the multiple regression model is expressed as : $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_5X_5 + \beta_6X_6$ ; the results are as depicted below (Refer to Exhibit E and Exhibit F)

| Exhibit E- Results of Multiple Regression Analysis without PDI | | | | | |
|---|---|---|---|---|---|
| Independent Variables | β | Standard Error | Critical t-value = 2.056 at 0.05 level of significance | | VIF |
| | | | t-value | Significance | |
| Exchange Rate | 0.503 | 0.123 | 4.097 | **Significant** | 4.556 |
| CPI | 44.457 | 29.212 | 1.522 | Insignificant | 2.147 |
| BSE Sensex using $\log_e$ ) | 3.675 | 1.864 | 1.972 | Insignificant | 6.769 |
| Interest Rate | 91.311 | 45.845 | 1.992 | Insignificant | 2.481 |
| Crude Oil Price | 0.169 | 0.082 | 2.068 | **Significant** | 5.187 |

| Exhibit F | | | | |
|---|---|---|---|---|
| $R^2$ | Adjusted $R^2$ | Calculated F-value | Critical F-value at 0.05 level of significance | Test of significance |
| 0.918 | 0.898 | 46.726 | 2.685 (5,21) d.f. | Significant |

It may be observed that the variance inflation factors of the independent variables are below 10, thereby indicating that the effect of multicollinearity has been successfully reduced.

A perusal of Exhibit F shows that the adjusted $R^2 = 0.918$ is statistically significant as revealed by the F-test. The calculated F-value = 46.726 exceeds the critical F-value of 2.685, with (5, 21) d.f. at 5% level of significance, thereby indicating that the regression model is relevant. The findings as given in Exhibit G also reveal that the calculated t-value = 4.097 for $\beta_1$ and 2.068 for $\beta_6$, with 26 d.f. exceed the tabulated t-value of 1.706. Accordingly, the null hypotheses $H_0: \beta_1=0$ and $H_0: \beta_6=0$ stand rejected to suggest that the positive impact of exchange rate, BSE Sensex and crude oil prices on gold prices and the negative impact of interest rates on gold prices is statistically significant at 5% level of significance.

However, the findings as given in Exhibit F also reveal that the calculated t-value = 1.522 for $\beta_2$ , 1.972 for $\beta_3$ and 1.992 for $\beta_5$ with 26 d.f., do not exceed the tabulated t-value of 1.706. Accordingly, the null hypotheses $H_0: \beta_2=0$, $H_0: \beta_3=0$ and $H_0: \beta_5=0$ stand accepted to suggest that the positive impact of BSE Sensex on gold prices and the negative impact of inflation and interest rates on gold prices is statistically insignificant at 5% level of significance.

1. **Exchange Rate** and gold prices are positively correlated, as their coefficient of correlation is 0.824, which is fairly high. The regression coefficient β = 0.503 in respect of exchange rate implies that, holding other variables in the multiple regression model constant, an increase in exchange rate by ₹ 1 (due to depreciation of rupee against US dollar) results in an increase in gold price by ₹ 0.503 thousand. Further, on the basis of the results of the simple regression analysis, we have established that the

explanatory power of exchange rate is statistically significant at 5% level of significance. These findings are consistent with the views of Gireesh et al (2015), Subashini and Poornima (2014), Bhunia and Pakira (2014), Patel (2013), Apergis and Papoulakos (2013) and Sjaastad (2008). However, Ibrahim et al (2014) has argued that exchange rate negatively impacts gold prices. Arezki et al (2011) too has claimed in the context of South Africa, that the gold price fluctuation is less important to the South African Rand especially after the liberalization and their economy is less dependent on gold and its price variations.

2.  **Inflation and** gold prices are negatively correlated as their coefficient of correlation is - 0.021, which is fairly low. The regression coefficient β = 44.457 in respect of inflation implies that, holding other variables in the multiple regression model as constant, an increase in inflation by 1% results in a decrease in gold price by ₹ 44.457 thousand. Also, the results of the simple regression analysis have established that the explanatory power of exchange rate is statistically insignificant at 5% level of significance. These findings are consistent with the observations of Guntur Archana Raju (2016) and Hoang et al. (2016) who, in their respective studies, have concluded that inflation and gold are correlated but only in the short-run. Rahul Bishnoi (2014) has opined that gold prices are negatively related to inflation. Tufail and Batool (2013) in their study have concluded that gold is a crucial determinant of inflation in Pakistan and not the other way round. In contrast, Dubey (2014) has claimed that there is a positive correlation between inflation and gold prices.

3.  **BSE Sensex** and gold prices are positively correlated as their coefficient of correlation is fairly high at 0.901. The regression coefficient β = 3.675 implies that, holding other variables in the multiple regression model as constant, an increase in BSE Sensex by 1% results in an increase in gold price by ₹ 3.675 thousand. The results of the simple regression analysis establish that the explanatory power of exchange rate is statistically significant at 5% level of significance. This view is in harmony with the observations of Mishra et al. (2012)[21] but the results of the multiple regression model indicate that the explanatory power BSE Sensex is statistically insignificant at 5% level of significance. These contrasting views have been observed in the numerous research studies. On the one hand, Mishra et al. (2012) and Le et al. (2012) confirmed that stock market drives gold prices and a similar conclusion was presented by Beckman et al (2014). However, Bhuyan, Dash (2018) have propounded that in short-run there is no causal relationship between gold price to stock price;  Srinivasan & Prakasam, (2015) and Narang and Singh (2013) and Kaliyamoorthy and Parithi (2012) have held similar views.

4.  **Interest Rates** and gold prices are negatively correlated as their coefficient of correlation is -0.405, which is a fairly high negative value. The regression coefficient β = 91.311 implies that, holding other variables in the multiple regression model as constant, an increase in interest rates by 1% results in an increase in gold price by ₹ 91.311 thousand. Further, on the basis of the results of the simple regression analysis, we have established that the negative impact of interest rates on gold prices is statistically significant at 5% level of significance. These findings are consistent with the views of Abdullah, Adam & Abu Bakar, Mohd Jaffri. (2015) in the context of gold prices and real interest rates. Wang and Chueh (2013) too held a similar position on the matter. The studies conducted Feldstein (1980) and Fortune (1987) and backed by Batten et al (2014) held mixed views as they found strong relationship between gold prices and CPI on account of interest rates which gradually weakened in the 1980s and 1990s. Similarly, Baur (2011) concluded that long-term interest rates impacted gold prices negatively but short-term interest rates impacted gold prices positively. However, Silva (2014) and Tully and Lucey (2007) held diametrically contrasting viewpoints as their respective case studies found no relationship between gold prices and interest rates.

5.  **Crude Oil Prices** and gold prices are positively correlated as their coefficient of correlation is 0.878, which is fairly high. The regression coefficient β = 0.169 in respect of crude oil prices implies that, holding other variables in the multiple regression model constant, an increase in crude oil price by ₹ 1 results in an increase in gold price by ₹ 0.169 thousand. Further, on the basis of the results of the simple regression analysis, we have established that the explanatory power of crude oil prices is statistically significant at 5% level of significance. These findings are consistent with the observations of Guntur Archana Raju (2016) and Bishnoi (2014). However, mixed views have been proffered in the studies conducted by Singh and Sharma (2017) and Kumar (2017).

## VII. CONCLUSION

In this research paper, we have tried to identify the various determinants of gold prices in India and empirically analyse and appraise the relevance and significance of these factors. The results of the econometric technique performed conclude that the individual impact of exchange rates, BSE Sensex, personal disposable income and crude oil prices on gold prices is positive and statistically significant, whereas the individual impact of inflation and interest rates on gold prices is negative and insignificant. Further, by eliminating the distorting effect of multicollinearity, the multiple regression analysis suggest that the exchange rate, crude prices and exert positive influence on gold prices, whereas the effect of  a combined impact of exchange rates, inflation, interest rates and crude oil prices is statistically significant.

**Note:** In an effort to eliminate the effect of multicollinearity between BSE Sensex and PDI, we have had to remove PDI from the multiple regression analysis. However, these two factors also serve as important determinants of gold prices in India and can be studied further.

REFERENCES

[1] Ancient Gold Mining Activities in India – An Overview; by A.K. Grover and M.K. Pandit
https://www.researchgate.net/publication/301294492_Ancient_Gold_Mining_Activities_in_India_-_An_Overview
[2] A Brief History of Gold
http://onlygold.com/Info/History-Of-Gold.asp
[3] Top 10 Countries with Largest Gold Reserves
http://www.usfunds.com/investor-library/frank-talk/top-10-countries-with-largest-gold-reserves/#.W-zxyXczZsM
[4] The Precious Metal Gold
https://www.minerals.net/gemstone/gold_gemstone.aspx
[5] How Gold Affects Currencies
https://www.investopedia.com/articles/forex/11/golds-effect-currencies.asp
[6] The Classical Gold Standard
https://www.gold.org/about-gold/history-of-gold/the-gold-standard
[7] The Bretton Woods System
https://www.gold.org/about-gold/history-of-gold/bretton-woods-system
[8] Factors that affect Gold Price
https://economictimes.indiatimes.com/wealth/invest/factors-that-affect-gold-price/articleshow/64464960.cms
[9] Reasons to invest in Gold
https://economictimes.indiatimes.com/wealth/invest/reasons-to-invest-in-gold/articleshow/64589106.cms
[10] 7 Reasons why Indians love gold
https://www.moneycontrol.com/news/business/personal-finance/-1830717.html
[11] The Relationship between Gold and the US Dollar
https://www.thebalance.com/the-relationship-between-gold-and-the-u-s-dollar-808978
[12] Safe Haven
https://www.investopedia.com/terms/s/safe-haven.asp
[13] Interest Rates and Real Interest Rates
https://www.sunshineprofits.com/gold-silver/dictionary/gold-interest-rates/
https://www.sunshineprofits.com/gold-silver/dictionary/gold-real-interest-rates/
[14] Oil and Gas Industry in India
https://www.ibef.org/industry/oil-gas-india.aspx
[15] Oil Prices can help Predict Movements in Gold Prices
https://www.commoditytrademantra.com/crude-oil-trading/oil-prices-can-help-predict-movements-in-gold-prices/
[16] Do Oil Prices affect Gold Prices?
https://www.americanbullion.com/do-oil-prices-affect-gold-prices/
[17] Cointegrating Relation Between Exchange Rate and Gold Price by Ranjusha N., Dr. Devasia M. D, Nandakumar. V. T.
http://oaji.net/articles/2017/1330-1510299345.pdf
[18] Impact of Inflation in India, China and USA on the Gold Prices by Prof. Guntur Anjana Raju, Shripad Marathe
http://irgu.unigoa.ac.in/drs/bitstream/handle/unigoa/4671/Splint_Int_J_Professionals_3%2810%29_2016_7-12.pdf?sequence=1&isAllowed=y
[19] Gold and Inflation(s) – A Time-Varying Relationship by Brian M. Lucey, Susan Sunila Sharma, Samuel A. Vigne
https://pure.qub.ac.uk/portal/files/120196463/gold_inflation_s.pdf
[20] An Analysis of the Relationship between Inflation and Gold Prices: Evidence from Pakistan by Saira Tufail and Sadia Batool
http://www.lahoreschoolofeconomics.edu.pk/EconomicsJournal/Journals/Volume%2018/Issue%202/Tufail%20and%20Batool.pdf
[21] Is it true that Indian gold prices are influenced by Indian Stock Market reaction? By Somnath Mukhuti and Amalendu Bhunia
http://www.e3journals.org/cms/articles/1376064880_Somnath%20and%20Amalendu.pdf
[22] Causal Relationship between Gold Price and Sensex: A Study in Indian Context by SP Narang and Dr. Raman Preet Singh
https://www.researchgate.net/publication/287196336_Causal_Relationship_between_Gold_Price_and_Sensex_A_Study_in_Indian_Context
[23] Does Gold act as a Hedge or a Safe Haven for Stocks? A Smooth transition approach by Beckmann, Joscha; Berger, Theo; Czudaj, Robert
https://www.econstor.eu/bitstream/10419/103324/1/796232105.pdf
[24] Gold Price, Stock Price and Exchange Rate Nexus: The Case of India by Srinivasan Palamalai and Karthigai Prakasam
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2556151
[25] A dynamic causality analysis between gold price movements and stock market returns : Evidence from India by Anil Kumar Bhuyan, Ajit Kumar Dash
https://www.innovativepublication.com/journal-article-file/6929
https://webcache.googleusercontent.com/search?q=cache:_7nHHQrqe9QJ:https://www.innovativepublication.com/journal-article-file/6929+&cd=5&hl=en&ct=clnk&gl=in
[26] Income and Price Elasticity of Gold Import Demand in India : Empirical Evidence from Threshold and ARDL bounds test co-integration by Kakali Kanjilal and Sajal Ghosh
https://www.researchgate.net/publication/262417157_Income_and_Price_Elasticity_of_Gold_Import_Demand_in_India_Empirical_Evidence_from_Threshold_and_ARDL_Bounds_Test_Cointegration
[27] Saving and Investment Factors Literature Review
http://shodhganga.inflibnet.ac.in/bitstream/10603/131003/7/07_chapter%202.pdf

**[28]** Gold Monetization in India as a Transformative Policy : A Mixed Method Analysis by Priya Narayanan, Balagopal Gopalakrishnan and Arvind Sahay

https://web.iima.ac.in/assets/snippets/workingpaperpdf/1743454792017-01-02.pdf

**[29]** The Application of Gold Price, Interest Rates and Inflation Expectations in Capital Markets by Adam Abdullah and Mohd. Jaffri Abu Bakar

https://www.researchgate.net/publication/276320062_The_Application_of_Gold_Price_Interest_Rates_and_Inflation_Expectations_in_Capital_Markets

**[30]** Short-term and long-term relationships between gold prices and precious metal (palladium, silver and platinum) and energy (crude oil and gasoline) prices by Mehmet Eryiğit

https://pdfs.semanticscholar.org/1fab/d8571d38fd5d10258f7abc64cbf0cdb8dbb0.pdf

**[31]** The Financial Economies of Gold – A Survey by Fergal A. O'Connor, Brian M. Lucey, Jonathan A. Batten and Dirk G. Baur

https://brianmlucey.files.wordpress.com/2011/05/1-s2-0-s1057521915001325-main.pdf

**[32]** Linkage between Gold and Crude Oil Spot Markets in India – A Co-integration and Causality Analysis by Narinder Pal Singh and Sugandha Sharma

http://www.ijetmas.com/admin/resources/project/paper/f201706121497273753.pdf

**[33]** The Relationship between Gold Price, Euro, US Dollar, Oil Price and Stock Market by Phuong Tang

https://www.theseus.fi/bitstream/handle/10024/136901/Phuong%20Tang%20thesis1.pdf?sequence=1

**[34]** Impact of Crude Oil Prices in India, China and USA on the Gold Prices by Prof. Guntur Anjana Raju, Shripad Marathe

http://indianaccounting.org/downloads/08%20%20%20Prof.%20Guntur%20Anjana%20Raju%20and%20Shripad.pdf

**[35]** An Empirical Analysis of Factors Affecting Gold Prices by Rahul Bishnoi

http://www.ijhpdindia.com/upload/article/PDF000012.pdf

**[36]** RBI Handbook of Statistics on Indian Economy

https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy

**[37]** Labour Bureau Government of India

http://labourbureaunew.gov.in/LBO_indexes.htm

**[38]** Crude Oil (Petroleum) Monthly Price – Indian Rupee per Barrel

https://www.indexmundi.com/commodities/?commodity=crude-oil&months=360&currency=inr