Investigation into Macroeconomic Determinants of Gold Prices and Investment Potential of Gold – A study for India

Table of Contents

Chapter 1 - Introduction

1.1. About Gold[1]

Gold is a precious metal which has an extensive functionality and appeal. It is most commonly used for its ornamental value in the form of jewellery. However, it is also a significant investment tool prolifically traded in commodity exchanges, apart from having industrial uses as well. Historically, it has been treated as money, in the form of gold standard. Though gold standard does not exist anymore, gold still retains its power as an important monetary asset, being held by Central banks. Apart from this, in terms of employment generation, 100 million people depend on gold mining to earn a living. (World Gold Council). Hence it can be argued that gold holds the highest significance for global economy among all precious metals.

As stated above, gold had been playing an important role in economy since long. So it is important to get a historical perspective of gold. Its history as a monetary asset dates back to over two thousand years.

"Gold is the world's oldest international currency... Gold's scarcity, the fact that it does not corrode or tarnish, its malleability and status across civilisations have made it eminently suitable as a form of money." (World Gold Council, 2011) Also it has acted as a store of wealth, unit of value and medium of exchange akin to money. (Goodman (1956) & Solt & Swanson (1981))

Starting from the minting of the world's first gold coins in 564 BC in Lydia (Turkey) by King Croesus, it spread out to other parts of Europe, the Mediterranean and the Middle East. However, an important transition took place in the 17th and 18th centuries when 'specie money', (meaning, coin value based on the value of metal with which it is made) gave way to 'specie-backed money'. State issued bills of exchange, followed by token coinage came into circulation as a notional guarantee of exchange on demand for gold.

[1] Most of the facts and figures quoted in section 1.1 and 1.2 have been taken from different pages (specified) of the official website of 'World Gold Council', unless otherwise mentioned. The organization is a one-stop reliable source of latest information about gold. (http://www.gold.org/about_us/who_we_are/)

The era of gold standard started in Britain in 1717, and by 1900, all countries had adhered to this monetary system (except China and a few others). Despite the 'pros' like medium term price stability and large international foreign investment among countries in the era of gold standard (1870's to 1914 (World War 1)), its 'cons' like short-term economic instability when gold supply underwent variations weighed more. Mostly countries relinquished the system.

Prominently in US though, gold standard continued and remained at a dollar/gold parity of US$35 = one troy ounce under the Bretton Woods international monetary system (1934-1971). In the late sixties, due to high existing inflation and increased demand of gold for jewellery and investment, fixed convertibility between dollar and gold became untenable and finally ended in 1971. In 1978, role of gold in international monetary system finally ended. However, even in the present times, gold retains its significance in the form of reserves of Central Banks. (World Gold Council, 2011)

According to Table 1.1, the biggest gold holding by Central bank is of United States, who also happens to have the second highest percentage of foreign reserves in the form of gold (74.7%), followed by Germany. Portugal interestingly has the maximum percentage (84%) of its foreign reserves in the form of gold.

China is in the fifth position and India in the tenth position in terms of amount of Gold reserves (in tonnes) held in respective Central Banks[2].

Table 1.1: World Official Gold Holdings (International Financial Statistics, 2011)

2 This ranking is among countries, excluding IMF, which stands 3rd in the ranking after Germany, in terms of gold holdings.

Country	Tonnes	% of Reserves*
World	30,683.60	
USA	**8,133.50**	**74.70%**
Germany	3,401.00	71.70%
France	2,435.40	66.10%
China	1,054.10	1.60%
Russia	830.50	7.80%
India	**557.70**	**8.70%**
Portugal	382.50	**84.80%**
UK	310.30	16.50%

* The percentage share held in gold of total foreign reserves, according to calculations made by the World Gold Council

The world gold reserves by Central Banks and multinational organizations like the International Monetary Fund (around 30, 000 tonnes) account for around a fifth of global above-ground stocks of gold.

Source: (World Gold Council, 2011c)

Gold has always been considered an asset for safe investment, given its low correlation with other assets like equities, and resilience in crisis times. Specifically, it has been used as a hedge against economic and political crisis. In events like burgeoning national debt, equity market crash, serious inflation, internal or external aggression and the like, fiat currencies bear the brunt. In those events, gold is at its glittering best.

Gold is therefore considered an asset for portfolio diversification. (Carlson, 2010) Also it is highly liquid as an asset. Draper, Faff, & Hillier, (2006) et al pointed out that total annual production of gold is cleared by the London Bullion Market Association every 2.5 days.

Moreover the present condition of global economy and gold market makes gold more lucrative than before; specifically, growing demand of gold from India and China, increased money supply by Governments to stimulate their economies and rise of Exchange Traded Funds (ETFs) increases its appeal as an investment tool. (Carlson, 2010) The Y-O-Y growth in investment as in first quarter of 2011 has been a spectacular 26 percent. (World Gold Council, 2011d)

The third and the most obvious mode of use of this precious metal is jewellery. In recent years, jewellery has accounted for 55 – 60% or more of the global gold demand. This is followed by

around 30 percent demand for investment. The remaining demand is for industrial use. (World Gold Council, 2011g)

As for the supply aspect, 55-60 percent of the gold is produced from mines, around 35 percent is recycled (from existing products like jewellery, coin etc) and around 5-10 percent is contributed by net official sector sales (net selling by Central Bank from their reserves). The mine production has been stable over the years as new mines replace old ones. Also it has been price-inelastic since it takes many years for a mine to start regular production. The recent trend of gold selling by Central Banks has been largely from advanced countries, which typically hold a large percentage of foreign reserves as gold, (see Table 1.1) to emerging economies which have shown an increasing appetite for reserves. (World Gold Council, 2011g)

1.2. India – Demand hub of Gold

As far as demand for gold is concerned, specifically in the form of jewellery, India is a significant stake-holder. India and China accounted for 63 percent of demand of gold jewellery in the first quarter of 2011, which valued US$16 Bn. India emerged as the largest market for gold, specifically jewellery in the same period. (World Gold Council, 2011d) In India, gold jewellery has immense appeal, rooted in traditions (about 50 percent for weddings) and religion (festivals like Dhanteras, Onam, Pongal, Durga Puja and Akshaya Tritiya). The latter sometimes results in higher demand even at times of high prices. Of course, a dip in gold prices sees a surge in demand. (World Gold Council, 2011e)

Some other observations show the association of India with gold. (World Gold Council, 2011f)

- In the last decade, demand for gold in India has been growing at an average rate of 13 percent, which happens to be highest relative to growth of GDP, inflation and population growth.
- India has a high saving rate (estimated to be around 30 percent of income) which can potentially convert to a higher demand for gold.

Some unique selling propositions of gold responsible for high demand, especially in India are that it is considered a status symbol, it is liquid and can be converted to cash at times of

emergency, a good gift item, has perhaps the highest ornamental value among precious metals and can be transferred across generations.

The importance of gold for India has been discussed in further detail in the second chapter of 'Literature Survey'.

1.3. Factors affecting movement of gold prices

Having discussed the supply and demand of gold (latter specifically for India as well), the next logical economic concept is of price.

Here it is important to understand the mechanism of gold price-setting. The most common benchmark price for gold is the London gold fixing price. The gold prices are fixed in London market twice daily at 10am and 3pm. The 3 pm time is considered more important as it was introduced to coincide with the opening time of US markets by N.M. Rothschild in 1968. Historically, this process was established when the Bank of England in 1919 signed an agreement with seven South African mining houses to ship their gold to London for refining, which they did by selling all gold through the banking house N.M. Rothschild, with the price agreed upon by five members. (World Gold Council, 2011h)

The first gold fixing took place on the 12th September, 1919. The present five member banks are Barclays Capital, HSBC, Deutsche Bank AG London, The Bank of Nova Scotia - Scotia Mocatta, and Societe Generale Corporate & Investment Banking, all based in London. They set the price via a conference facility, twice a day as earlier mentioned. This price is used as a pricing medium by all stakeholders in gold, i.e. producers, consumers, investors and Central Banks. (London Gold Fixing, 2011) Gold price is quoted in dollars.

Gold prices are subjected to high short-run volatility, as is true for all assets. However, in the long-run, they have shown an upward trend. In the last decade, specifically between Dec 2000 and October 2010, the price of gold has seen a 394 percent increase. In 2010 alone, gold prices have reached a new high 35 times (World Gold Council) Hence the question that comes to mind is – What are the factors governing gold prices?

1.3.1 Gold price – How they are formed?

Broadly, the factors can be categorised as:

- Supply and demand
- Speculation in the trading market
- Macro-economic factors

While demand has a role to play in global markets, as is true for all commodities, gold supply does not affect the prices as much. As has been discussed, the annual production of gold through mining is stable and a small fraction of the overall above ground stock of gold (around 2 percent) and hence affects the price minimally. Another factor related to gold demand and supply, albeit on a broader perspective, is the variations in the reserves held by Central Banks. (Haubrich, 1998) Gold purchase by Central Banks leads to an increase in gold prices and vice-versa.

Since gold and gold funds are traded in commodity and stock exchanges respectively, the prices are bound to be affected by sentiments and speculation. Based on trading and the bench mark price (discussed above), the daily gold price is set.

This brings us to the third and arguably the most important category of determinants of gold prices, that is, macro-economic factors. The reasoning behind this presumption is as follows: Price of gold, like any macro-economic indicator, is inter-dependent. Change in one variable is bound to affect the other in some way or the other. Changes in domestic macro-economic indicators may occur due to geo-political events like internal strife, wars etc or economic events like the recent financial melt-down, inflation etc. In this era of globalization, vulnerability of macro-economy further increases as it is affected not only by domestic up-heavals but also from global events. Prices of all commodities and assets are impacted routinely and gold is no exception. Therefore it is very important to understand the causalities running between its price and several macro-economic factors, which are volatile like never before.

1.3.2 Macroeconomic Factors affecting gold prices

Among the factors which are likely to be significant determinants of gold prices are tightening of gold supply, inflation and interest rates, currency fluctuation, geo-political concerns, Central bank demand and weakness in financial markets. (Rediff news, 2009). Apart from gold supply variations and geo-political concerns, rest all can be clubbed as macroeconomic factors.

Gold prices have inverse relationship with interest rates, US Dollar and assets like equities, bond or real estate. High gold prices are seen during times of low interest rates. This can be understood as an increased investment interest in gold at times debt products are not yielding much. As far as dollar value is concerned, when the dollar comes under pressure, more dollars are required to buy the same amount of gold. Hence the gold price in dollar terms increase. Moreover, a weakened dollar means gold replacing dollar as a means of safe investment. In times of high inflation, as have been prevailing in the last two years in India, Gold prices have seen an upward trend. As Central Banks show increased appetite for gold reserves, the increased demand results in high prices.

Finally, whenever there is a crisis of any type, currencies, stocks, bonds and real estate which are inherently risky, lose investors. Flight of investment is directed towards gold, which is characterized by physical security and value retention in crisis situations, economic or geo-political.

1.4. Motivation of this study

The above discussion makes its amply clear that given the multiple functionality of gold, its demand is here to stay. In Indian perspective, it is more plausible due to the religious and cultural associations with this precious metal. Akin to other assets, its prices are also subject to fluctuations. In the globalized world that we live in, these factors are most likely macroeconomic in nature. This is because impact of macro-economic crisis (or any event) in one country is transmitted across the world almost instantly. Hence understanding of the bearing, macro-economic phenomena have on gold prices, is vital.

Several studies have been conducted for US and other countries over time, exploring links between macroeconomic factors like interest rates, inflation and exchange rate etc and gold prices. The results have not been unanimous.

Study by Feldstein (1980) and Geoffrey (1990) argued that gold prices did show a relationship with expected inflation. Ghosh, Levin, Macmillan, & Wright (2002) concluded that for US, gold acts a long-run inflation hedge. Tulley and Lucey (2007) observed that when dollar weakened in 2004 (and uncertain conditions in US prevailed), gold reached a 16-year high. Hence a

relationship between value of dollar and gold prices was suggested. On the other hand, studies like Mahdavi & Zhou (1997) pointed out that for US, gold prices are far too much volatile to be able to predict general price levels satisfactorily.

Moreover, despite the suggested linkages between macroeconomic factors and gold prices in foreign literature and the privileged position gold enjoys in India, there is hardly any literature in the Indian context.

In this backdrop, the current study is undertaken.

The objective of this study is to single out plausible macro-economic determinants of gold prices for India. This is done based on theoretical survey of existing literature for other countries and preliminary examination of relationship between the variables.

Specifically, the two objectives for conducting this study are as follows:

- Identification of macroeconomic determinants of gold prices in India; this is based on study of existing literature, followed by preliminary empirical analysis of probable relationships.
- Analysis of gold as an investment asset, based on existing works and findings of the current study

This is expected to provide a strong foundation for conducting a detailed econometric analysis on this topic of high significance, in future.

1.5. Organisation of this Dissertation

With this objective, the following dissertation has been conducted. The second chapter presents a survey of literature related to gold, its significance world-wide and in India, historical trend of its prices, and the exploration of mutual relationships between gold prices and different variables.

The third chapter discusses the Methodology and Data used to conduct the study. Results are presented and interpreted in the Fourth chapter. Final chapter comprises the Conclusion and Directions for further research.

Chapter 2 - Literature Survey

Gold enjoys arguably the most privileged status among metals, in the Indian society. Historically also, gold has been considered as a safe haven for investors. To add to the glitter is the remarkable upward trend that gold prices have followed in the recent years. Given its significance, the current study aims to understand the macroeconomic factors responsible for the price movement of gold. This would in turn, give a sound foundation for predicting the direction of gold prices.

The above quoted reasons have been responsible for researchers to be fascinated with this high return, low risk commodity as well. As a result, studies have been conducted to explore the interplay of factors with its price movement.

Discussion on significance of gold from a Global and Indian perspective forms the first segment of this chapter. In the second segment, its price movements – current price levels and trends are presented. Third segment has a discussion on the studies conducted so far to explore factors, specifically macroeconomic, affecting movement of gold prices. How the literature survey justifies the need to conduct the current study forms the subject matter of the last segment of this chapter.

2.1. Significance of Gold – Global and Indian perspective

Demand for gold is widely dispersed around the world. East Asia, the Indian sub-continent and the Middle East accounted for approximately 70% of world demand in 2009. India, Greater China (China and Hong Kong), US, Turkey and Saudi Arabia represented over half of world demand. (World Gold Council, 2011b)

Several studies have reported and discussed the significance of gold in the world economies. Its unique feature is that it is treated both as a commodity and monetary asset.

Goodman (1956) and Solt & Swanson (1981) report gold as a store of wealth, medium of exchange and a unit of value, akin to money.

The main demand for gold is for the following applications: jewellery, industrial use and investment & Government stocks. While the first two uses are as a commodity, the third application is as a financial and monetary asset.

To explore further the third application and the overall demand for gold, some reasons reported by Vuyyuri & Mani (n.d.) are as follows:

1. Gold has no credit risk as an asset, when retained by Central Banks.
2. Gold is a relatively liquid asset, with respect to other commodities, in crisis situations like "…high global inflation or political turbulence". (Vuyyuri & Mani, 2005) It can be readily bought or sold 24 hours a day, in large denominations and at narrow spreads. (Draper, Faff, & Hillier, 2006)
3. Gold is good diversification option for portfolio-building. "In the long run, the price of gold has shown a very low and even a negative correlation with the dollar and with US treasuries. Gold is not affected by the policy decisions of any individual country and cannot be frozen or repudiated as can be the case for foreign securities." (Vuyyuri & Mani, 2005)
4. Gold has been used as a security against loans when the Governments needed to make international borrowings.

From the Indian perspective, gold has an added significance.

Certain aspects of tradition, faith and attitude which cement the Indian society's bonding with gold (World Gold Council, 2011a) are as follows:

1. Gold is an important part of all wedding ceremonies. "With 50% of the Indian population under 25 and approximately 150 million weddings anticipated over the next decade, the World Gold Council estimates that wedding-related purchasing will drive approximately 500 tonnes a year" (World Gold Council, 2011a)
2. Gold is considered an auspicious metal and hence is a part of religious ceremonies.
3. Indians tend to be risk averse and hence value wealth preservation; and gold is arguably the best way to do it.

"Another reason for the economic significance of gold is the ease it offers in hoarding unaccounted wealth. Black money has been maintained in terms of gold bars, jewellery etc." (Vuyyuri & Mani, 2005)

Not surprisingly, India has a significant role to play in the gold bullion market.

Here are some statistical facts to illustrate the same. (World Gold Council, 2011a)

1. At more than 18,000 tonnes, Indian households hold the largest stock of gold in the world.
2. Gold purchases in India accounted for 32% of the global total in 2010
3. In 2010, total annual consumer demand in India reached 963.1 tonnes.
4. Indian gold demand has grown 25 percent despite 400 per cent price rise of the rupee, in the last decade.
5. The vast majority of the Indian population (70%) lives in villages, which have traditionally formed the source of more than two thirds of Indian gold demand.

   In terms of expectations,
6. This sector has been growing at less than 1% per annum but is projected by CMIE to grow in future at over 5% per annum, further fuelling gold demand.
7. By 2020, cumulative annual demand for gold in India will increase to excess of 1200 tonnes or approximately Rs. 2.5 trillion, at current price levels.
8. India's continued rapid growth which will have significant impact on income and savings, will increase gold purchasing by almost 3% per annum over the next decade.

This amply demonstrates that India's fascination with gold is here to stay.

2.2. Understanding Gold prices – Trends

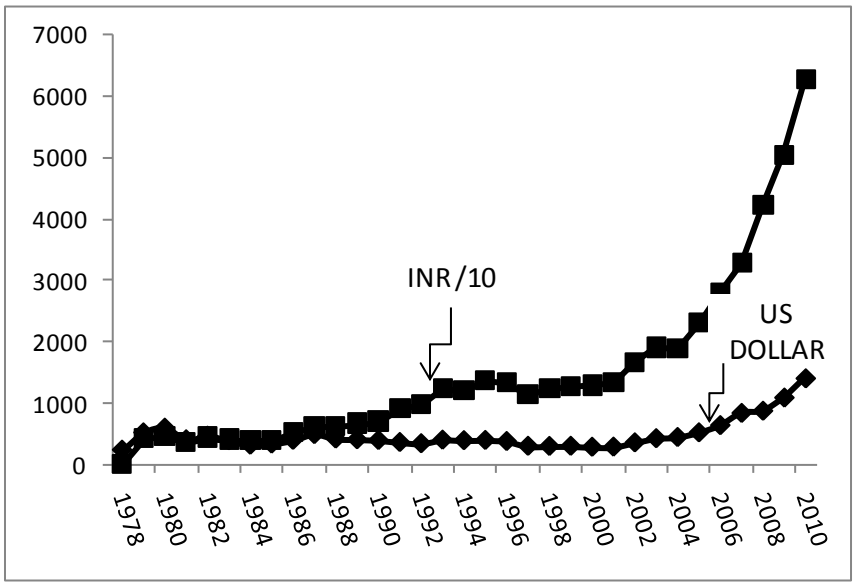
Gold prices, like all commodity prices, have seen a fair amount of volatility over the years. With respect to Indian rupee, gold prices have fluctuated, for instance, a 25 percent dip towards the end of 2008, however the overall movement has been in an upward direction in the period 1971 to 2006. 10-year and 5-Year Gold Price trends (till year 2010) in INR/oz reinforce the overall trend. In the last one year, the gold prices have seen a remarkable rise of 28 percent and in July,'11, they stood at around 71,000 INR/oz or about 25,000 INR/10 Grams. Movement of gold

prices vary in magnitude, when seen with respect to different world currencies. In terms of US Dollars, over the same period as above, the increase has been close to 34 percent, this year with prices close to 1600 USD/oz in July'11. These figures are the highest in at-least 30 years of recorded price history. (Goldprice.org, 2009) This also shows that gold reflects the relative strength of the currency in which it is quoted. (For instance, percentage increase in gold prices in terms of US Dollar is higher than in rupee terms over the last year may be due to the weakness of dollar vis-à-vis rupee in this period.)

Table 1 shows the trend of rising gold prices from 1978 onwards. This is also the period when gold was officially delinked from all currencies and hence entered a free market situation. As can be seen, the direction is mostly upwards though the slope is different for gold prices in terms of IND and US Dollar. While investors continue to reap rich dividends, a natural question that strikes the mind is – Which factors are driving this rally and to what point will it continue?

This justifies the need of the current study which focuses on exploring macroeconomic factors affecting gold price movements in India, the hub of gold demand.

Table 1: Trend of Gold prices expressed in National Currency Units (Here INR/10 and USD) per troy ounce for the period 1979 to 2010



Source: World Gold Council>Statistics (2011)[3]

2.3. Gold Prices in a Macroeconomic framework – Existing Literature

Analysis of fluctuation in gold prices, like for any traded commodity, is important because it affects the economic decisions made by governments, corporations and individuals. However, two important characteristics of gold that affect its price deserve mention. Firstly, gold behaves less like a commodity and more like long-lived assets as stocks or bonds. This is because its prices are not as much affected by its present supply but by its future demand and supply. Of the total world supply of 1, 25,000 metric tonnes of gold, annual production ranges around its 1/50 part. Hence the current year's gold production has little influence on gold prices. Also the interesting thing related to gold demand and supply is that while it is demanded for several uses, main being investment and jewellery, it survives much of its use and the world stock continues to grow, making its price resemble that of a long-lived asset. Secondly, gold is stocked by Central banks, as a tool of monetary policy. Expected or real sale/buying of gold by the banks lead to fall/rise of their prices. (Haubrich, 1998)

Hence it is plausible that certain macroeconomic factors (policies of Central Banks for instance) have a significant role to play in influencing gold prices. (Speculation and sentiments in the trading market also have a role to play given that gold is an important investment asset.)

Among the most critical factors affecting the movement of gold prices are inflation and interest rates, currency fluctuations, demand by Central Banks, weakness in financial markets (equity/bond/real estate), financial stress – stagnation, inflation, currency devaluation, and government deficits apart from the general mismatch between gold demand and supply and geo-political concerns, when gold emerges as the safest investment. (Rediff news, 2009)

2.3.1 Gold prices and Inflation

Gold is considered a hedge against inflation. When the expected inflation is high, gold demand as a hedge goes up and so does its price. In the words of Alan Greenspan[4], Gold is"…a store of

[3] 'Gold price in a range of currencies and frequencies since December 1978, both as period averages and end-of-period values' (http://www.gold.org/investment/statistics/prices/)

value measure which has shown a fairly consistent lead on inflation expectations and has been over the years a reasonable indicator."

A study by Feldstein (1980) mirrored the above argument through its findings that a rise in expected inflation will increase the relative price of gold.

Unanticipated components of the U.S. Money Supply and Producer Price Index (PPI) announcements were found to have significant impact on daily gold prices. (Tandon & Urich, 1987)

Another study was conducted focussing on co-movements of gold prices with US inflation. Geoffrey (1990) created a leading index of inflation using seven relevant components for instance degree of tightness in the labour market, credit market conditions etc. Each of these factors had led the turns in CPI inflation rate since 1948.

A six month smoothed monthly growth rate of this index was used to signal inflation prospects. A -1 percent of annual growth rate was taken as the signal for downturn and +1 percent as upturn signal. As was observed, the average annual rate of increase in gold prices during the signalled upturns was 20.1 percent per year compared with 5.6 percent per year during the signaled downturns. The author also pointed out that an alternative to holding gold during downturns would be to hold US treasury bonds; as declining inflation leads to a decline in interest rates, price of long terms bond are raised. Taking these two results together, he argued that an investor can earn 18 percent by investing in gold during signalled upswings and in long term bonds in downswings.

Further, when downswings appear, a shift from gold to diversified stock portfolio (prices of which generally react favourably to decline in inflation) can be a useful strategy.

More specifically, gold prices showed a close relationship with inflation. (Haubrich, 1998) Gold prices with a one year lag moved closely with the US inflation (captured by CPI) in the period 1981-1997. However the direction of causality was not clear.

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[4] Greenspan Takes the Gold, (The Wall Street Journal, Feb, 28, 1994).

Ghosh, Levin, Macmillan, & Wright (2002) using monthly gold price data and cointegration regression techniques for the period 1976-1999 confirmed that gold can be regarded as a long-run inflation hedge in US perspective.

However, not all researches arrived at the same result. Aggarwal (1992) pointed out towards significant short-run price volatility in gold prices though gold may act as a long-run hedge against inflation.

Einhorn (1994) remarked that with the advent of financial futures, the role of gold as an inflation hedge has diminished.

Mahdavi & Zhou (1997) conducted a study for United States. They argued that gold prices have far too much short-term volatility to be able to predict general price level satisfactorily.

Another study by Kamery (2005) was conducted to understand the relationship between gold, inflation, and the Federal Reserve's economic policies, from a historical viewpoint. It scrutinized gold (and its prices) as one of the qualitative indicators for Fed's economic policies. Question asked was that – Can gold be considered a good qualitative indicator of inflation and economy as a whole, in the backdrop of existing models for predicting inflation. This was taken forward in the form of debate over advantages or otherwise of gold standard. Arguments favouring pegging of dollar to gold were in lines of stability it brought to the system and hence predictability. Counter arguments pointed to the restriction it imposed over the economy in terms of money expansion, hence justifying the severing of gold-dollar link by Nixon in 1971. At the end, conclusion drawn was that gold was not an accurate indicator of Fed's economic policies.

Though several studies have focused on the co-movement of these two variables, significance of causality is ambiguous.

2.3.2 Gold prices and Interest rates

Higher inflation is also related to lower interest rates. So as the rate at which deposits are held are low and these saving products are less lucrative, gold sticks out as a better investment option vis-à-vis debt products. As a result, its demand and price rises.

Among the earlier related studies were those by Diba & Grossman (1984) who found a close link between the time series properties of the relative price of gold and the real interest rates. More

specifically, study by Fortune (1987) pointed towards an inverse relationship between price of gold and expected interest rates.

A study was conducted by Thorbecke & Zhang (2009) to study the impact of Fed's monetary policies surprises on interest rates, term and forward and prices of daily traded commodity like gold. He pointed out the contrast in theories offered by different researchers on how federal rate increase affects expected inflation. According to Romer & Romer (2000), the fact that Federal Reserve is revealing private information about inflation by this move, may lead to a rise in expected inflation. On the other hand, Gu¨rkaynak, Sack, & Swanson (2005) showed through evidence that funds rate increases lowered long-term expected inflation. The finding of the study was that both arguments were correct to some extent depending on the time-period of study. The authors argued: "In the 1970s a funds rate increase, in addition to raising short-term real rates, might have increased expected inflation through the channel discussed by Romer and Romer (2000). In the 1990s and the first decade of the 21st century a funds rate increase, rather than leading investors to anticipate higher inflation, might have led them to believe that the Fed would be tougher on inflation" (in lines with the view of Bernanke & Mishkin (1997)). It could thus have lowered expected inflation. While in the 1970's, funds rate increases raised gold and silver prices, contrary to the popular belief, the impact was reversed after 1989. Similar contrarian impacts were observed for short-term interest rates and near-term forward rates. While for 1970's, findings of Romer and Romer (2000) are vindicated, results are consistent with findings of Gu¨rkaynak, Sack, & Swanson (2005) for recent years.

2.3.3 Gold Prices and US dollar (and other currencies)

Global gold prices are significantly affected by the fluctuation in valuation of European currencies. (Sjaastad & Scacciavillani, 1996) The authors further reported that floating exchange rates have a major role to play in gold price fluctuations.

However, dollar is arguably the currency affecting gold prices the most.

Sherman (1983) studied the relationship between gold prices and exchange rate. The results showed that the log of the gold price was inversely related to the US weighted exchange rate.

Baker & Van-Tassel (1985) conducted the study for US for the period 1973–1984. The findings clearly suggested that that changes in the price of gold showed dependence majorly on two variables, inflation (change in US prices) and changes in the value of the dollar.

In 2004, gold reached a 16-year high (compounded also by uncertain economic conditions, geopolitical tensions and producer de-hedging) when the dollar weakened. "Further dollar depreciation and a growing risk of dollar devaluation are likely to strengthen investor demand for gold." (Tully & Lucey, 2007)The reasoning behind this maybe that as dollar weakens, dollar-denominated gold becomes relatively cheaper to buy and hence can be invested in, leading to a rise in its demand and prices.

This again happened in the recent global financial melt-down; reason being dollar, which is the de-facto currency of exchange around the world, being, to some extent, substituted by gold as a safe haven for investments. This substitution further leads to Central Bank's increased demand for gold aggravating overall gold demand and hence prices.

2.3.4 Other works

Gold Demand and hence prices also rise when countries face tension, external or internal aggression and the like. Also it replaces other risky investments like stocks, bonds and real estate in times of weak financial market, leading to its price rise. (Rediff news, 2009)

Some significant work has been done regarding empirical investigation into the impact of macroeconomic factors, other than those discussed above, on gold prices. One of such works is by Koutsoyiannis (1983) who developed a dynamic model for the determination of the price of gold bullion in the very short-run period.

The main variables comprised US rate of inflation, US interest rates (real and expected), demand for substitutes like silver and stocks and strength of US dollar (vis-à-vis rupee) among other variables. He found the price of gold to be strongly related to the strength of the US dollar, among other variables like interest rates.

Kitchen (1996) analyzed domestic and international financial market responses to federal deficit announcements. He found that over the period 1981–1994, gold prices were affected positively and significantly.

Christie, Chaudhry, & Koch (2000) examined "whether gold and silver prices relate to economic fundamentals . . . assist market participants manage risk and help build diversified portfolios". The analysis was conducted on intra-day data from gold and silver futures markets for the period 1992-95. Results showed that the macro-economic news announcements that significantly affected gold prices were related to Consumer Price Index (CPI) followed by unemployment rate, GDP and Producer Price Index (PPI). However announcement on federal deficit announcements did not come out to be significant.

Study by Cai, Cheung, & Wong (2001) were on similar lines using similar data, as the above study. It looked into the impact of 23 macroeconomic announcements which are regularly released in the United States (also explored for daily and intra-day frequencies). The findings pointed out that only 4 of those included significantly affected gold price volatility. They were employment reports (most significant), GDP, Consumer Price Index (CPI) and personal income. This impact, they argued, was lesser than on the Treasury bond or foreign exchange markets. Further, using a high frequency dataset, the 25 largest 5 min absolute returns were found to attribute to almost all important factors like central bank sales, interest rates, oil prices, inflation rates, US unemployment rates, Asian financial crisis and other factors like concerns about consumer demand for gold and political tension in South Africa.

"The price of gold increased from Rs. 791 per 10 gms in 1978-79 to Rs. 1158 per 10 gms in 1979-80 during the second oil shock of November 1979." (Vuyyuri & Mani, 2005) This shows that as oil prices increase, the inflationary impact is passed on to the oil importers of the world, leading to an increase in gold demand and prices.

"When the economic environment becomes more uncertain, attention turns to investing in gold as a safe haven." (Smith, 2002) The FTSE All Share Index decreased by 9% whereas the London gold afternoon fixing price increased by 7.45% after the terrorist attack on US in 2001.

2.3.5 India Level

This sub-section discusses studies related to relationship of gold prices with different macroeconomic activities and phenomena, at the India level.

Vuyyuri & Mani (2005) conducted a qualitative and quantitative analysis of movement of gold prices in India. The study was conducted for the period 1978-2000. A multiple regression

analysis was conducted. Among the regressors were expected Inflation, interest rate, import demand for gold, Exchange Rate of US Dollar with Indian Rupee, stock market performance, and qualitative variables (removal of import restrictions on gold, FERA, FEMA, liberalization etc. taken as a dummy variable) . The data for the study was taken from the Handbook of Statistics on Indian Economy – 2000 (Reserve Bank of India), Website of Bombay Stock Exchange, and www.IeiCenter.com. The variables – lagged gold prices, expected interest rate, price of silver showed significance at 5% level of significance except the Sensex and foreign exchange rate, which came out to be significant at 10% level. Inflation Rate turned out to be insignificant. The sign of the coefficient of inflation was positive though meaning that inflation and gold prices shared a positive relationship but the relationship is low.

However the results of this analysis should be treated with caution. This is given the fact that the time-series of variables have not reportedly been checked for stationarity. In the event of non-stationarity, the relationships derived can be spurious.

2.4. Current Study

The above discussion has made it amply clear that gold possesses huge significance, both as a commodity and as a monetary asset; moreover, when seen from the Indian perspective, it has an added sheen. India and Gold have a strong mutual association, making India arguably the most influential stake-holder in Global Gold market.

Hence increased understanding of the movement of its price with respect to India can lead to informed spending/investment decisions at the level of individual/ society as a whole. Despite the high economic significance of this commodity in India, most studies have been conducted to explore its price dynamics in the macroeconomic domain are limited to US. Here too, the results are not unanimous.

In the current study, a theoretical survey of extant literature has been conducted in a detailed and focussed manner; This provides pointers towards probable macroeconomic determinants of gold prices in India. These selected variables are then subjected to preliminary statistical analysis. Together, the findings provide plausible inferences regarding macroeconomic influencers of gold

prices in India. Further, these findings are used to have a better understanding of gold as an investment asset. The methodology applied and data used forms the content of Chapter 3.

Chapter 3 - Research Methodology and Data

As discussed in the last chapter, several macroeconomic factors have come in the gamut of analysis regarding influence on gold prices. Most of these studies have been conducted in the context of US and other developed countries. However literature for India is scarce despite the fact that India is the demand hub of gold for reasons ranging from religion and culture to monetary considerations. To fill up this gap, this study has been undertaken. The approach is two-dimensional: Qualitative and Quantitative (discussed below). This exercise is conducted to fulfil the twin objectives of understanding dynamics of gold prices from the macroeconomic perspective and scrutinizing role of gold as an investment option.

3.1. Methodology

This section talk about the approaches used to fulfil the above stated objectives. In lines with the first approach, detailed theoretical survey is made based on which probable determinants of gold prices are singled out. Relationships of these variables with gold prices are then examined through a preliminary quantitative analysis, which is the second approach.

3.1.1 Qualitative Approach

In qualitative analysis, select studies pertinent to the objective of exploring macroeconomic factors impacting gold prices, are surveyed. The studies have been chosen mainly based on the significance of their findings and their econometric rigour. Results and conclusion are presented at the end of each study which point to the probable macroeconomic determinant(s) of gold prices in the Indian context. Further, the methodology and data are also detailed for each study. This is intended to be an econometric guide (albeit, limited in scope) for conducting an advanced econometric research on related topics.

It may be noted that so far, no significant work in the Indian context has been conducted. Hence literature in foreign context is used to draw parallels for India.

As mentioned above, based on the qualitative survey, certain variables are selected as probable influencers of gold price in India. This is followed by quantitative analysis.

3.1.2 Quantitative Approach

This analysis comprises understanding the nature of the gold prices and macroeconomic variables through 'Descriptive Statistics' and their mutual relationship through scatter plots and correlation. But firstly, the macroeconomic factors considered for this analysis are discussed.

The first factor is exchange rate, related to major currencies. It is arguably the most significant determinant pointed out by several studies in recent times (including the ones which are discussed in Chapter 4). This is followed by inflation. Relationship of this factor with gold prices is perhaps the most-analyzed in relevant literature. In view of the utility of gold as a portfolio diversification alternative, it is justified to explore relationship (if any) between movements of its price and the third factor, i.e. equity markets. Examining it in the Indian context becomes an interesting part of analysis, given that it has been explored in the foreign context in several studies. Lastly, silver prices are taken, choice being based on its intuitive relationship with price of gold. The intuition is based on the similarity between the two precious metals with respect to their role in economy, in general[5]. Hence it is justified to find out the commonality in their price movements (if any).

To begin with, *descriptive statistics* of all variables are analysed. The purpose is to better understand the variables in terms of their dispersion and distribution. The main parameters are mean, standard deviation (and variance), skewness and kurtosis (and their standard errors) and/or Jarque-Bera Statistics. Some of the statistical concepts are discussed in some detail below:

Skewness is an indicator used in distribution analysis as a sign of asymmetry and deviation from a normal distribution. A positive value of skewness would mean right skewed distribution, meaning most of the values are concentrated on the left of the mean. Interpretation of negative value is just the reverse of the former. Zero skewness would mean a normal distribution of the variable.

Kurtosis, on the other hand is the indicator used in distribution analysis as a sign of flattening or "peakedness" of a distribution. A kurtosis > 3 would mean a 'Leptokurtic' distribution. This indicates a sharper than a normal distribution, with values concentrated around the mean and

[5] Silver has cultural and traditional uses in India, apart from being an investment asset traded in exchanges. It also has a history as 'monetary asset' in the form of silver standard. Last but not the least, it has industrial demand.

thicker tails. This means high probability for extreme values. 'Platykurtic' distribution has kurtosis < 3 which indicates flatter than a normal distribution with a wider peak. The probability for extreme values is less than for a normal distribution, and the values are more spread around the mean than other distributions. A kurtosis equal to 3 (or excess kurtosis of 0) indicates 'Mesokurtic' distribution, which implies normal distribution. (Intercapital Invest, n.d.)

Further, Jarque-Bera normality test is performed. The null hypothesis of normality of sample distribution is tested here. The test statistic is derived from sample skewness and kurtosis. It is an asymptotic chi-squared distribution with two degrees of freedom. (Wikipedia, n.d.) This step is required to check the assumption of normality, for correlation coefficient 'r'.

To explore a possible relationship between gold prices and macroeconomic variables, scatter plots are constructed. These are used to ascertain the absence of outliers and clusters in data, which are two of the assumptions that need to be satisfied before use of results of Pearson's correlation coefficient 'r' results.

Among the other assumptions are linearity of relationship and normality of the residuals of the relationship. The former is taken care of by logarithmic transformation of the variables. The log transformation is done since "…it will squeeze together the values at one end of the range." (Statsoft, n.d.) The latter is checked subjectively using skewness and kurtosis values, or objectively using Jarque Bera test values as discussed above.

The methodology described above is applied to not only to the log values of the variables, but to the lagged log values and growth rates of variables, wherever required.

Macroeconomic variables showing higher values of 'r' vis-a-vis gold prices, with all assumptions satisfied become good candidates for being used in advanced econometric analysis.

3.2. Data

As mentioned above, analysis requires data of the following variables: Gold prices, exchange rate, inflation rate, stock prices and silver prices.

3.2.1 Variables Employed

For gold, two prices of Gold are taken up. One is quoted in Rupees per 10 gm of the metal, sourced by the Economic Times, Mumbai and another is in US Dollar per troy ounce, sourced by the London Bullion Market Association. As for silver, the prices used are quoted in Rupees per kg, sourced again by Economic Times, Mumbai.

For inflation, both monthly average of the Wholesale Price Index (WPI) and monthly values of Consumer Price Index (CPI) are analysed. The former takes prices of year 1993-94 as 100. The latter is quoted category-wise and is examined accordingly. The following are the sub-categories of CPI:

- Industrial Workers – General Index (Base year: 2001)[6]
- Industrial Workers – Food Group (Base year: 2001)
- Urban Non-Manual Employees (Base year: 1984-85)
- Agricultural Labourers (Base year: 1986-87)

Inflation rates for a particular month are calculated as a Y-o-Y change, expressed in percentage.

In exchange rates, US Dollar and Euro vis-a-vis Rupee are taken. The values are in the form of Rupees per unit foreign currency, averaged over the month.

To measure the probable impact of stock market on gold prices, monthly averages of the Bombay Stock Exchange (BSE)[7] and S & P CNX NIFTY[8] are used.

3.2.2 Frequency of data and period of study

The frequency of data is monthly. The reason behind this choice is that while a higher frequency data (daily or spot) is more capable of capturing volatility of variables like exchange rates, silver

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[66] Since all the sub-categories of CPI have been examined separately, the difference in base years is not a matter of concern.

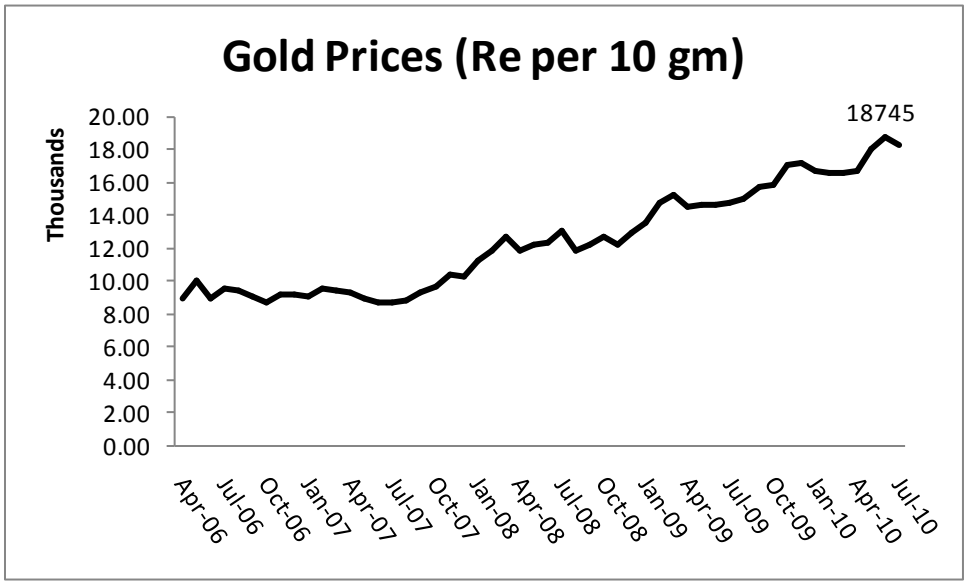
[7] Now known as BSE-100, this Index has a base year of 1983-84 and was launched in 1989. It has 100 stocks. BSE-100 was shifted to the globally accepted Free-Float methodology in 2004. The most prominent stock index of Bombay Stock Exchange (BSE) however is SENSEX (comprising 30 stocks and introduced in 1986). (http://www.bseindia.com/about/abindices/bse100.asp)

[8] S&P CNX Nifty is a 50 stock index, accounting for 24 sectors of the economy. It is owned and managed by India Index Services and Products Ltd. (IISL), which is a joint venture between National Stock Exchange (NSE) and Credit Rating Organisation, CRISIL.

prices and gold prices, it may be suitable only for a detailed time series analysis. As for the current analysis, the higher frequency would result in high noise in data, possibly obscuring the broader pattern of relationship. A lower frequency, on the other hand, will not be able to capture the dynamics of these variables.

The time period considered is between April '06 and June'10. This period has its own significance. Gold prices reached all time highs during this period as the recession engulfed the world. Recession gave way to recovery but the gold prices did not let go their upward trend, "...with prices roughly doubling since the global financial crisis began in mid-2007." (Oxford Economics, 2011) This is also evident in Chart 3.1

Chart 3.1: Gold price (Re per 10 gm in Mumbai) Trends in the study period (April '06 and July '10)



3.2.3 Data source

Data has been sourced from the latest edition of 'The Handbook of Indian Economy', published by the Reserve Bank of India.

3.3. Gold as an Investment Asset

As pointed out in the beginning of this chapter, the objective of this study is not only to pinpoint macroeconomic determinants of gold prices, but also to look closely into the role of gold as an investment asset. This is done as a separate section in Chapter 4. Based on facts and figures quoted in existing literature and findings of this study, the investment prospects of gold are discussed.

3.4. Concluding Remarks

The theoretical analysis and preliminary statistical analysis is conducted using the above methodology and data. The next chapter deals in presentation, analysis and interpretation of the results. The aim is to explore the plausible mutual relationships between the variables. Also the findings and existing literature are discussed from the perspective of gold being a lucrative investment option.

Chapter 4 - Results and Discussion

In this chapter, the results of qualitative and quantitative analyses are discussed at length. In the first segment, qualitative analysis is conducted which comprises a detailed survey of pertinent literature. Focus is on both the results and the methodology. The pointers provided in this section are quantitatively analysed in the next section. Correlations between gold prices and select macro-economic variables are analysed. The first objective is to figure out macro-economic determinants of gold prices with a reasonable level of conviction. This research can further, act as a foundation for detailed econometric analysis on the same. Finally, these research findings along with certain facts and figures are analyzed from the perspective of gold emerging as a lucrative investment option.

4.1. Qualitative Analysis – Detailed Survey

This section provides a detailed description of selected works from the gamut of relevant literature. The criteria of selection of the works as well as areas of focus within each study have been discussed in Chapter 3.

Selected studies can be clubbed into the following sub-categories: Studies exploring relationship between gold prices and multiple macro-economic determinants like oil prices, stock market, interest rates etc., between gold prices and exchange rate and finally between gold prices and Inflation.

Firstly papers exploring relationship of a gamut of macroeconomic factors and gold prices are discussed.

4.1.1 Gold Prices and Multiple Macro-economic Determinants

Oxford Economics (2011) explored the determinants of gold prices with special emphasis on price modelling and scenarios testing. The broader objective of the study was to test the resilience of gold as an asset in the face of crisis situations like high inflation, financial melt-down etc.

Hypothesis

- Gold is a good inflation hedge, and in inflationary times, demand of 'real assets' like gold go up and so does their price.
- As real interest goes down, the gold prices go up. The reason given was that in the absence of its own yield, lower interest rates decrease the opportunity cost of holding gold and vice-versa.
- A falling dollar increases the price of gold. Not only does it increase the purchasing power of non-dollar countries hence increasing their demand for gold, it leads to gold emerging as a credible alternative to dollar as a store of value.
- Financial stress results in an increase in gold demand and price. Reason suggested was that such conditions manifest as volatility and decline in the value of other financial assets and gold is relatively resilient. Moreover, if manifested as a potential collapse of banking system, it becomes a safer alternative to bonds and cash. Finally, it is liquid even in worst financial situations and its full value can be realized. This was backed up by statistics of historical stress periods (1971-2010), when price of gold rose at more than the average rate during this period.
- As in financial stress, also during political instability, demand for gold rises. It can be a 'currency of last resort'.
- Last but not the least, sale (or purchase) of gold by Central Banks decreases (or increases) the gold price. These banks held around 15 percent of the above-ground gold stock in 2010.

Methodology

An error-correction model (ECM) was constructed comprising a long-run element, where gold prices move in line with inflation (US general price level), and a short-run element containing the factors like current inflation rate (Annual CPI), World income (in terms of demand for jewellery and industrial uses), value of dollar, real interest rate, Gold's Beta[9] , financial stress measures (quantified as credit risk premium), Political instability and Official sector activity. All data corresponded to US.

[9] Gold's Beta was calculated as a moving average of the correlation between movements in the gold price and the Wilshire 5000 index. Gold can be a good diversification tool in investment if returns on holding gold are unrelated to the stock market) – a fall in this parameter will push gold prices up.

Data

The variables were taken over the period 1976-2010 on a quarterly frequency. Data was sourced from Oxford Economics / Haver Economics. UK data on real returns and volatility of different assets 1971 onwards was used for the optimization results. All variables were converted to their logarithmic form.

Results

Over the long-term, it was assumed that general price level and gold prices move in a one-to-one relationship, in lines with the existing literature. This formed the long-run component of the Error Correction model. In the short-term, main variables that came out to be significant, as determinants of gold prices were US CPI inflation, the effective dollar exchange rate, real US interest rates, the default premium (the spread between BBB and AAA-rated corporate bonds) and the US monetary base[10]. The most significant relationship was with the effective dollar exchange rate (Appreciation of 10% of the $US reduced gold price by 8.4%). Also gold prices showed relationship with their own past values. Specifically, a 10 percent rise in gold price in the previous two quarters was shown to increase the current gold price by 3.3%. Impact of real interest rates was on expected lines (reduction of 100 basis points resulted in initial 1.5 percent rise in price.) A 100 basis rise in the credit risk premium was found to increase the gold prices by 4.4% in the next quarter. Similarly a 10 % point increase in the growth rate of US monetary base increased gold price by 1.4 percent in the current period. Relationship with inflation was also significant. (An inflation of 10% was found to increase gold price by 0.04%) Also time dummies (representing political disturbances) were included. R-square value of the equation was reported as 0.54 and assumptions of normality of errors, heteroskedasticity and autocorrelation were satisfied.

The same equation was used to decompose the impact in two time periods. During 1979-1982, which was a time of political disturbances, important drivers of gold prices (which struck a new high) were reported as political risk (represented by time dummies), inflation, real interest rates, a weaker US Dollar and financial stress.

[10] This variable may capture the increased „tail risk" of high inflation as a result of quantitative easing.

The authors pointed out that in 2007-2010 (which saw gold reaching all time high); an important factor was Federal Reserve's quantitative easing policy, to combat recession. This fuelled inflationary fears and pushed up gold prices. Other factors were the weakened dollar and high financial stress. "The 150 basis point rise in the credit default premium in late 2008 can explain 6.4% points of the 13.1% rise in the price of gold in 2009 Q1 alone. Meanwhile, swings in the dollar explained a large share of the gold price rise in 2008 Q4 and 2010 Q1-Q2, and much of the decline in 2009 Q2-Q3."

The authors reasoned that a new long-run equilibrium at higher level for the metal's price is possible, going forward. This is on account of fading importance of dollar as the reserve currency, and rise in demand of gold in China and India, on account of increasing incomes and relatively high inflation (as compared to western countries). Another factor contributing to the same is the limiting supply of gold, due to increasing mining costs.

Results of scenario testing, being pertinent to the last section of the chapter, are presented there.

Conclusion

This study explores relationship of gold prices with a gamut of macro-economic variables. In the context of US and for the study period, most of them showed an impact on gold prices, in the expected direction. However, in terms of magnitude, the impact of change in exchange rate was the maximum on movement of gold prices. Other significant determinants were financial stress, interest rates, monetary base and political turmoil. Inflation proved to be a significant, yet low-impact variable.

Another study which made an empirically innovative investigation into the macro-economic factors affecting gold prices was conducted by **Tully & Lucey (2007)**. This study had a relatively shorter time period under study, data was used for both US and UK, variables were in different formulation and a different methodology was employed. This explains the difference in results between this study and the study discussed above.

Hypothesis

- Gold prices are inversely related to the dollar.
- They exhibit no relationship with the stock prices.

- They exhibit inverse relationship with the interest rates.
- Gold prices move in the same direction as inflation.

Methodology

An Asymmetric Power Generalized Auto-Regressive Conditional Heteroskedasticity Model (APGARCH model) was applied. ARCH Models are generally used to model variance over time in series exhibiting clustered volatility or heteroskedasticity, more commonly a case in financial time-series. A generalized formulation of the same is GARCH. A power GARCH Model allows for a power term which transforms data so as to capture volatility clustering. It is superior to inclusion of a squared term, especially in case of non-normal distributions. An Asymmetric Power GARCH model captures the difference in volatility response of the positive and negative returns in the market.

Several models are nested within APGARCH. Maximum likelihood test is used to determine the goodness of fit between the models.

Impact of the following macroeconomic variables were tested on the cash and futures price series of gold - dollar and the pound effective exchange rate, FTSE cash, oil prices, cash and futures form of equity indices, general price level of US and UK (CPI), unemployment, interest rates and industrial production indices.

Data

Data on gold prices and macro-economic variables were of a monthly frequency. Period of analysis was taken as 1983-2003 with special emphasis on periods around equity market crashes of 1987 and 2001. Data was sourced from DataStream. Gold was taken in two forms - spot prices in dollar per troy ounce and futures as COMEX gold futures 100 oz rate. FTSE cash was taken from FTSE 100 price index (in London Stock Exchange). S & P 500 and FTSE – 100 equity indices were used both in cash and continuous futures form. Oil prices were in the form of Brent crude oil price in $ per barrel. Interest rates were of T- Bills. All variables were introduced as monthly percentage changes in the analysis.

Results

Summary statistics revealed that all time-series exhibited a non-normal distribution (justifying the use of a power term instead of a squared term in the model, as discussed above). In terms of mean, the most unambiguous finding for the study period was that dollar had a significant, inverse relationship with the gold prices. Also its magnitude of influence was the highest among all other variables. All other variables did not show a significant relationship. In terms of stock prices, this finding was in lines of the hypothesis. In terms of variance of gold returns, none of the variables whatsoever, showed any significant impact.

Further, specifically two-year windows around the two crisis periods 1987 and 2001 were considered. In 1987, results remained more or less the same as for the overall period. In 2001, again dollar came significant, but for only the futures values of gold and with reduced significance. In terms of variance, none of the variables showed any significance.

Conclusion

Significance of this study lies in the application of a specialized model like APGARCH for investigating gold prices over a long-run. Many possible macroeconomic determinants are employed in the model, however only dollar exhibits a strong impact on the gold prices in the study period. Also gold prices are shown to exhibit endogenous adjustment over the long-run in terms of volatility.

4.1.2 Gold Prices and Exchange Rate

As have also been pointed out in the studies above, exchange rate related to major currencies has been an important determinant of gold prices. Exclusive analysis in this direction has been made by **Sjasstad & Scacciavillani (1996)**, hence justifying its inclusion in this sub-section. Specifically, this study pointed out the relationship between floating exchange rates and the gold prices.

Hypothesis

Changing exchange rate causes a change in gold prices not only in currencies constituting the exchange rate, but also in other currencies, directly or indirectly tied to former.

Methodology

The authors developed an international pricing model, which predicted that the change in major exchange rates would impact price of commodities[11] in several currencies.

The model was defined by two basic elements: Law of one price (across the world) and global clearing of markets. More generally, the price of a commodity was modelled in terms of price shocks, sum total of country-specific fundamentals and the constant term. The shock term comprised an interesting entity, θ which captured the relative 'market power' of a participant in the global market of commodity concerned. A country could be absolute 'price taker' (θ = 0) or 'price maker' (θ = 1) given its dominance in the market. In case of former, depreciation in its currency vis-a-vis other currency would impact commodity price only in the same currency. On the other hand, the impact will be felt on price of commodity in other currencies, in case of the latter. Specifically for gold, a dominant country could be one which had extremely elastic excess demand. (The producer countries may not be exhibiting dominance because the annual production is a miniscule proportion of the above ground stock of gold).

To calculate θ, the forecast errors of gold and exchange rates were used instead of the actual values to counter issues of stationarity of actual exchange rates.

Data

The period of analysis was January 1982 to December 1990[12]. Spot and forward data of daily frequency, were used for gold prices[13] and exchange rates[14].

Results

Using the above mentioned data and methodology, preliminary tests revealed that θ is approximately 0 for UK and all exchange rates and price of gold were thus quoted in pounds (taken as the reference currency). Econometric investigation revealed non-stationarity of actual data series of the variables; further hypothesis of 'no-cointegration' between exchange rates

[11] Commodities referred to here, are homogenous in nature which are traded in organized markets, including gold.

[12] The period taken for analysis is such that it excluded impact of other macroeconomic factors like political instability of the late seventies and had no significant central bank sales etc which could impact gold prices, so as to capture relationship of gold prices and exchange rates well.

[13] Spot gold prices were taken from the London gold market and forward gold prices were computed from 3 month COMEX contracts. Spot and forward Exchange rate data were taken from International Monetary Fund database.

[14] The exchange rates considered were US Dollar and Duetsche Mark (DM), Pounds and Japanese Yen.

(regressor) and gold prices (dependent variable) could not be rejected. But the time-series of forecast errors were found to be stationary (as was assumed). Hence they could be used to measure θ's of other currencies. However, market efficiency was empirically found out to be 'weak' for exchange rate and gold[15]. Taking all these findings into consideration, calculation of θ was done for DM, dollar and yen by Hansen-Hodrick Method. Results indicated the dominance of European bloc (high value of θ for DM) in the gold market, followed by dollar bloc[16].

Further the forecast error equation was augmented by world inflation (computed as a weighted average of European, US and Japanese price levels) to account for impact of change in fundamentals on gold prices. Results showed a significant but low value for inflation. Specifically, after introduction of lags in the forecast error equation to account for presence of autocorrelation (in data and residuals of forecast error equation), the results were the following:

The global gold market is dominated by the European currency bloc (value of θ for DM = 0.65, more than 4 times of dollar and yen individually) As a result, dollar price of gold is heavily impacted by the movements of exchange rates of European currencies against the US dollar. (10 percent appreciation in value of DM, against all other currencies results in 6.5% increase in dollar price of gold) The dollar price of gold has a weak endogenous adjustment. Also the authors concluded that in the study period, in terms of variance, the floating exchange rates among the major currencies resulted in almost half the variance in spot gold prices.

Conclusion

This paper, in clear terms, gave an empirical proof of the impact that fluctuation of exchange rates has on gold prices (in almost all currencies). It also gave more credit to European currencies than the dollar to impact gold prices in currencies other than themselves. This, they reasoned, was because of European bloc's dominance in world gold market, far greater than of the dollar bloc and the yen. Being 'price-makers', the change in the value of their currency would impact the value of gold in all currencies tied to them, directly or indirectly. Dollar bloc and yen have almost the same dominance in the market and hence accordingly impact the gold prices. Also by making comparisons between the pre- and post Bretton Woods regime (of fixed

[15] 'Semi-strong' market efficiency restriction could not be rejected for gold.

[16] θ of yen did not come out to be significant at 5 % level of significance.

exchange rates), they attributed a significant variability in gold prices to the floating exchange rates.

4.1.3 Gold Prices and Inflation

Inflation is arguably the most analyzed variable vis-a-vis price of gold. In the long-run, most studies agree that both the variables move together. Oxford Economics (2011) reported: "The strong performance of gold during the inflationary 1970s and early 1980s confirms its potential value in periods of rapid price rises" However, at other times, its movement was independent of inflation. "…in the early 1980s the real price of gold leapt to over three times its very long-run average, while the 1990s saw a lengthy bear market which saw the gold price fall well below its long-term average."

Specifically, linkages of gold prices with expected inflation have been explored, in a way that they can be the leading indicators of inflation.

Mahdavi & Zhou (1997) conducted a study on relationship between gold and commodity prices, and inflation. Though the study discussed commodity prices also, we have confined our discussion to gold.

Hypothesis

Gold and commodity prices are good leading indicators of inflation. The argument is that being determined by markets which are flexible with forward-looking expectations, they can absorb events and news more quickly while the goods and services which are a part of general price level are slow to react.

Methodology

Cointegration analysis was conducted to test for long-run relationships and Error-Correction Modelling (ECM) was performed for testing predictive performance. They reasoned that if the gold is cointegrated with Consumer Price Index (CPI), then the information contained in the cointegrating relationship can be incorporated into the dynamic inflation model via the EC term. This, therefore would improve the forecasting efficiency of the model.

Included in the model were gold prices (London closing price of gold), CPI, real gross domestic product to control for the state of the economy and the nominal Three -month Treasury Bill Rate, to represent the financial and monetary scenario.

Data

Data of prices of gold and other variables used in this analysis were of a quarterly frequency and for the period Q1 of 1970 to Q4 of 1994. Source of data was 'International Financial Statistics'[17]. All variables except the Treasury bill rate were transformed to their logarithmic form.

Results

As a first step of cointegration exercise, unit roots in variables were checked using three techniques – Augmented Dickey and Fuller tests, Philips and Perron test and KPSS Test. The latter test has a null hypothesis of stationarity contrary to the other two tests who have a null hypothesis of non-stationarity. All tests consistently revealed that all data series were integrated of order 1 ~ I(1). Also they were all found to be difference-stationary.

Cointegration among the variables was explored using the Johansen and Jeuslius Procedure. Using λ_{max} tests, the null hypothesis of 'no cointegrating vector' could not be rejected at 5 percent level of significance. Hence no cointegration between CPI and gold prices could be inferred. They moved ahead to improve the Inflation Forecast specifying ECM of CPI. In terms of root mean square error (RMSE) and Mean Square Error (MSE), the ECM of the CPI including commodity prices was found superior to the one created including gold. Moreover, it was concluded that the addition of Error-correction term had little contribution in improving the prediction accuracy of inflation rate.

Conclusion

[17] This dataset is published by International Monetary Fund (IMF).

Despite some historical trends of both variables moving together, empirically it could be proven that gold and inflation (CPI) displayed cointegrating or long-run relationship. Hence the investment application of gold as an inflation hedge could not be justified. The credit to this study is that it was empirically exhaustive and it contributed its perspective on the ongoing debate of gold prices being significantly related to inflation.

In general, one fact that has come to light in conclusive terms is that macroeconomic factors do have a significant role to play in determining gold prices. Also the factor endorsed by most of the studies discussed is the exchange rate (in terms of USD and Euro). This is followed by inflation and equity markets. These become the probable determinants to be analyzed in Indian context as well.

4.2. Quantitative Analysis

From the above discussion, certain macroeconomic factors are singled out as probable determinants of gold prices in India.

The preliminary statistical analysis thus can be grouped in four categories – Gold prices and Exchange Rates, Gold prices and Inflation, Gold prices and Stock market and Gold prices and Silver prices.

Under each category, firstly the descriptive statistics are presented and discussed. This is followed by presenting the results of correlation. However, at this stage, it is ascertained whether all the assumptions of Pearson's correlation coefficient are satisfied (as discussed in Chapter 3). This is done by means of skewness, kurtosis, Jarque's Bera statistic and scatter plots.

Finally, results are interpreted so as to draw plausible inferences regarding macroeconomic determinants of gold prices in India.

4.2.1 Gold price and Exchange Rate

It has been reported by studies for US and other countries that gold price is inversely related to US Dollar. Also it is reported to exhibit relationship with the Euro (as in the study discussed above). To test this hypothesis in Indian perspective, similar analysis is conducted.

Descriptive statistics reveal that average of gold prices in the study period has been ` 12,429 per 10 gm while the maximum has been ` 18,745 per 10 gm of gold (in June 2010 which is also the end point of the upward trend in data under study, see Chart 3.1). Also while USD stayed on ` 44.8 on an average, Euro remained at ` 61.5 in the study period. The range of variability was approximately ` 10 for USD and ` 15 for Euro. (Table 4.1)

Table 4.1: Descriptive statistics of Gold prices and Exchange Rates (US Dollar and Euro vis-a-vis `)

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	USD in Rupee terms	Euro in Rupee terms
Mean	12429	850	44.83	61.55
Median	12143	849	45.48	59.71
Maximum	18745	1233	51.23	70.46
Minimum	8695	586	39.37	54.71
Skewness	0.39	0.34	-0.22	0.28
Standard Error Skewness	0.33	0.33	0.33	0.33
Excess Kurtosis	-1.16	-0.94	-0.99	-1.32
Standard Error Kurtosis	0.65	0.65	0.65	0.65
Jarque-Bera	4.28	2.99	2.63	4.40
Probability	0.12	0.22	0.27	0.11
Observations	52	52	52	52

Euro data series has a 'Platykurtic' distribution as indicated by significant and negative excess kurtosis. However, since the data has more than 50 observations, normality may not be a big issue. (Statsoft, n.d.) Other variables show a normal distribution. Scatter plots of USD and gold prices show presence of clusters in the data. Hence correlation results of USD vis-a-vis ` cannot be relied upon. As far as scatter plot of Euro exchange rates is concerned, it shows a linear relationship and absence of clusters. So correlation results are reliable. However it also shows 3 outliers, which when removed, increase the magnitude of correlation. (Scatter plots of USD and Euro and correlation results of USD in Appendix 1.1)

Following observations can be made regarding correlation of gold prices and Euro (Table 4.2):

The gold prices (in Re and Dollar terms) show significant and positive correlation (0.67 and 0.58, respectively) with the value of Euro. All assumptions except absence of outliers are satisfied. With the 3 outliers removed, the correlation increases to 0.85 and 0.74, respectively... This shows that as Euro appreciates the dollar as well as rupee price of gold increases as well. These results are in line with those reported by Sjasstad & Scacciavillani (1996).

As far as correlation between gold prices and USD is concerned, it is possible that there exists a significant non-linear relationship in the Indian context as well; hence there is scope for further exploration through other econometric techniques.

Table 4.2: Correlation matrix of gold prices and Euro

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Euro in Rupee terms
Gold Price (Re per 10 gm) in Mumbai	1.00		
Gold Price (USD per troy ounce in London)	0.96	1.00	
Euro in Rupee terms	**0.85**	**0.74**	1.00

All correlations are significant at 1 percent level of significance.

To further explore this relationship, both in terms of Euro and USD, correlations are also tested between the growth rates of gold prices and exchange rates. Apart from the outlier assumption, all are satisfied in both cases. So outliers were removed and the results obtained thereafter, are presented in Table 4.3 for Euro and 4.4 for USD. (Scatter plots of growth rates vis-a-vis Euro and USD in Appendix 1.2.) Growth rates of gold and Euro also show a linear relationship with a positive, significant though low correlation (0.38 and 0.24 which improves to 0.43 and 0.34 with respect to rupee and dollar value respectively after removal of 3 outliers).

Table 4.3: Correlation matrix of growth rates of gold prices and of Euro

	Growth rate of gold price (Re per 10 gm)	Growth rate of gold price (USD per troy ounce)	Growth rate of Euro
Growth rate of gold price (Re per 10 gm)	1.00		
Growth rate of gold price (USD per troy ounce)	0.89	1.00	
Growth rate of Euro	**0.43**	**0.3447***	1.00

All correlations are significant at 1 percent level of significance except for the starred entry (significant at 5%).

Growth rate of US Dollar, on the other hand, show a negative and significant correlation, though of a low magnitude (-0.3) with gold prices in Dollar per troy ounce (after removal of outliers). (Table 4.4) The inverse movement of gold prices with respect to USD is in lines with the established observation and reasoning of gold prices being 'anti-dollar'.

Table 4.4: Correlation matrix of growth rates of gold prices and of USD

	Growth rate of gold price (Re per 10 gm)	Growth rate of gold price (USD per troy ounce)	Growth rate of USD
Growth rate of gold price (Re per 10 gm)	1.00		
Growth rate of gold price (USD per troy ounce)	0.87	1.00	
Growth rate of USD	**-0.30***	**0.21**	1.00

All correlations are significant at 1 percent level of significance except for the starred entry (significant at 5%)

This is followed by examination of next set of relationship – Gold prices and Inflation.

4.2.2 Gold prices and Inflation

Inflation in India is measured in terms of two measures – Wholesale Price index (WPI) and Consumer Price Index (CPI). Inflation rates are calculated from these measures. Also data on the latter is available category-wise (and not aggregated as the former), so it is analysed accordingly (as discussed in Chapter 3).

Table 4.5 gives the descriptive statistics of the data set corresponding to Gold prices and WPI Inflation.

Table 4.5: Descriptive statistics of Gold prices and WPI Inflation

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	WPI Inflation (%)
Mean	12429	850	6.3%
Median	12143	849	5.5%
Maximum	18745	1233	12.8%
Minimum	8695	586	0.2%
Skewness	0.39	0.34	0.09
Standard Error Skewness	0.33	0.33	0.38
Excess Kurtosis	-1.16	-0.94	-1.28
Standard Error Kurtosis	0.65	0.65	0.73
Jarque-Bera	4.28	2.99	2.75
Probability	0.12	0.22	0.25
Observations	52	52	40*

* indicates that values of WPI inflation is lesser because the inflation is calculated year on year, hence values are included from 13th observation of WPI (First 12 are used only to calculate inflation rate).

The data series for all variables follow close to a normal distribution. This can be deduced from the observation that mean and median are not very much different from each other, and skewness & kurtosis[18] are not statistically significant. In terms of Jarque-Bera statistic, the null hypothesis of normality cannot be rejected at 5% level of significance. (Probability or p-values are much above 0.05). WPI Inflation has hovered around 5.5% on an average with the maximum of 12.8% (in August 2007 after an increasing trend in the earlier months of the year).

[18] Significance of skewness and kurtosis can be judged with the help of Standard error values. If the absolute value of the statistic (excess kurtosis for kurtosis) is greater than twice the standard error, then we can safely significant skewness and/or kurtosis. For more on this thumb rule, please visit (University of New England, 2000)

Next step is to test understand the general nature of relationship between the two variables.

This is done with the help of Pearson's Correlation coefficient or 'r'. However the results show no significant correlation between the variables. (Scatter plots and correlation matrix between log of gold prices and WPI Inflation in Appendix 2.1) Going further, log of gold prices lagged by a year are analyzed vis-a-vis log of WPI Inflation, but it too do not show significant correlation. Next, growth rates of gold prices are analyzed vis-a-vis WPI Inflation. Though correlation matrix showed a negative and significant relationship between growth rates of gold price in $ per troy ounce and WPI Inflation, a closer look at the scatter plot reveals presence of outlier without which correlation comes out to be insignificant. (Results in Appendix 2.2 and 2.3)

Since inflation is a probable determinant of gold price and is also measured in CPI terms, therefore relationship with respect to CPI is analysed. Table 4.6 gives the descriptive statistics of the data set corresponding to Gold prices and CPI Inflation. CPI is calculated and reported separately for four categories - Industrial Workers – General Index, Industrial Workers – Food Group, Urban Non-Manual Employees and Agricultural Labourers having an average of 9.5 %, 12.1%, 9.7% and 10.8% respectively in the study period.

Table 4.6: Descriptive statistics of Gold prices and CPI Inflation

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	CPI Inflation Industrial Workers General Index (%)	CPI Inflation Industrial Workers Food Group (%)	CPI Inflation Urban Non Manual Employees (%)	CPI Inflation Agril Labourers (%)
Mean	13288	910	9.5%	12.1%	9.7%	10.8%
Median	12923	910	9.0%	11.7%	9.5%	10.5%
Maximum	18745	1233	16.2%	21.3%	16.9%	17.6%
Minimum	8707	655	5.5%	6.2%	4.8%	5.6%
Skewness	0.04	0.20	0.46	0.46	0.40	0.44
Standard Error Skewness	0.37	0.37	0.38	0.38	0.38	0.37
Excess Kurtosis	-1.09	-0.75	-0.83	0.20	-1.02	-0.47
Standard Error Kurtosis	0.72	0.72	0.74	0.74	0.74	0.73
Jarque-Bera	2.10	1.37	2.63	1.36	2.80	1.81
Probability	0.35	0.50	0.27	0.51	0.25	0.40
Observations	41	41	39	39	39	40

Again all the variables follow a more or less normal distribution (in terms of skewness, Kurtosis/Jarque-Bera statistic). Also scatter plot reveal no outliers or clusters in data. Relationship is clearly linear and hence all assumptions are satisfied. (Appendix 2.4)

Correlation matrix shows significant and positive relationship between gold prices and all categories of CPI. It is in the range of 0.75 to 0.86 for the categories with ` value of gold. Correlation with $ value is relatively less (0.59 to 0.76); However it is also at 1% level of significance. (Table 4.7)

Table 4.7: Correlation matrix of gold prices and CPI Inflation

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Industrial Workers – General Index	Industrial Workers – Food Group	Urban Non-Manual Employees	Agricultural Labourers
Gold Price (Re per 10 gm) in Mumbai	1.00					
Gold Price (USD per troy ounce in London)	0.94	1.00				
Industrial Workers – General Index	0.86	0.76	1.00			
Industrial Workers – Food Group	0.73	0.59	0.94	1.00		
Urban Non-Manual Employees	0.84	0.71	0.98	0.95	1.00	
Agricultural Labourers	0.78	0.66	0.97	0.97	0.98	1.00

All correlations are significant at 1 percent level of significance.

The other half has mirroring values (Same for all correlation matrices presented in this Chapter)

The lagged values of gold prices show an even higher level of significant and positive correlation with CPI Inflation in terms of Dollar value of gold (0.70 to 0.83). (Table 4.8) Again all assumptions are satisfied. (Scatter plots in Appendix 2.5)

This indicates that while gold prices may lead inflation or in other words, gold prices move with expected inflation, (as showed by correlation between lagged gold prices and CPI inflation) they also have a contemporaneous relationship with CPI inflation in the Indian context. This is indicated by results of correlation between gold prices and CPI Inflation. However the finding needs to be put to further econometric scrutiny.

Table 4.8: Correlation matrix of lagged gold prices and CPI Inflation

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Industrial Workers – General Index	Industrial Workers – Food Group	Urban Non-Manual Employees	Agricultural Labourers
Gold Price (Re per 10 gm) in Mumbai	1.00					
Gold Price (USD per troy ounce in London)	0.91	1.00				
Industrial Workers – General Index	0.83	0.79	1.00			
Industrial Workers – Food Group	0.71	0.70	0.94	1.00		
Urban Non-Manual Employees	0.86	0.83	0.98	0.95	1.00	
Agricultural Labourers	0.80	0.74	0.97	0.97	0.98	1.00

All correlations are significant at 1 percent level of significance.

Next relationship between gold prices and stock price index is analyzed.

4.2.3 Gold prices and Stock Price Index

A lack of correlation between these two variables may be taken as a vindication of gold's applicability as a diversifier in investment portfolio. However, if significant and high values of correlation are shown, then adding gold to portfolio of equity investments may not help much in terms of risk management.

Firstly, descriptive statistics of this dataset are presented. (Table 4.9) While the S & P CNX Nifty remained at a level of 4200 on an average in the study period, BSE National Index hovered around an average level of 7500. They hit a minimum around January, 2009 after a fall from January, 2008 onwards, i.e. start of the Recent Financial Meltdown. (Chart 4.2 in next section on "Gold for Investment") Also all series show a normal distribution in the study period. In terms of scatter plots, no prominent clusters or outliers are observed. However relationship is not clearly linear and hence results may be treated with caution. (Scatter plots in Appendix 3.1)

Table 4.9: Descriptive statistics of Gold prices and Stock Price Indices (S & P CNX Nifty and BSE National Index Monthly Averages)

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Nifty Monthly Average	BSE Monthly Average
Mean	12315	843	4266	7484
Median	12143	839	4301	7595
Maximum	18745	1233	5964	10795
Minimum	8695	586	2802	4569
Skewness	0.40	0.35	-0.09	-0.07
Std. Error of Skewness	0.33	0.33	0.33	0.33
Kurtosis	-1.14	-0.89	-0.88	-0.82
Std. Error of Kurtosis	0.66	0.66	0.66	0.66
Jarque-Bera	4.18	2.81	1.85	1.60
Probability	0.12	0.25	0.40	0.45
Observations	51	51	51	51

The results shows a significant and positive, yet low magnitude of correlation between stock price indices and gold prices. Correlation of gold price in $US per troy ounce with BSE National Index is 0.45. Similarly, its correlation with S & P CNX NIFTY is again positive and significant (0.48). Interestingly, correlation of stock market with dollar value of gold is higher than with the rupee value of gold. It points to the fact that there is there are one or more common factors affecting the dollar price of gold as well as the stock indices. (Table 4.10)

Growth rates of the share price indices however showed no significant correlation with growth rate of gold prices. (Correlation matrices in Appendix 3.2)

These findings do not support the hypothesis in clear terms that gold prices and stock market are uncorrelated. Hence investment in gold may not fully provide investors a fool-proof cushion

against stock market risks. However it needs to be further assessed if this moderate correlation is an indication of long-run relationship or not.

Table 4.10: Correlation Matrix of Gold prices and Stock Price Indices (BSE National Index and S & P CNX Nifty Monthly Averages)

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	BSE National IndexMonthly Average	S & P CNX Nifty Monthly Average
Gold Price (Re per 10 gm) in Mumbai	1.00			
Gold Price (USD per troy ounce in London)	0.96	1.00		
BSE National IndexMonthly Average	**0.23**	**0.45**	1.00	
S & P CNX Nifty Monthly Average	**0.25**	**0.48**	0.96	1.00

The last relationship examined is between gold prices and silver prices.

4.2.4 Gold Prices and Silver Prices

With regard to this relationship, it has been mentioned in Chapter 3 that if it exists, it is based on the similarity of roles, the two metals play in the global economy in general and domestic economy in particular.

Descriptive statistics are presented in Table 4.11.

Table 4.11: Descriptive statistics of Gold Prices and Silver Prices

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Silver Prices (Re per Kg)
Mean	12429	850	21870
Median	12143	849	20365
Maximum	18745	1233	29821
Minimum	8695	586	16752
Skewness	0.39	0.34	0.65
Std. Error of Skewness	0.33	0.33	0.33
Excess Kurtosis	-1.16	-0.94	-0.79
Std. Error of Kurtosis	0.65	0.65	0.65
Jarque-Bera	4.28	2.99	5.15
Probability	0.12	0.22	0.08
Observations	52	52	52

Silver prices are very volatile in nature, even more than gold as can be judged from the range of price movement (` 13, 000 per kg) in the study period. Jarque-Bera statistic indicates non-normality (positive skewness in the silver price data). However again since number of observations are greater than 50, it may not pose a serious issue. Other assumptions are also satisfied. (Scatter plots in appendix 4.1)

With regard to the correlation, as expected, the correlation is high, positive and significant between the two variables. (Table 4.12)

Table 4.12: Correlation Matrix of Gold prices and Silver Prices

	Gold Price (Re per 10 gm) in Mumbai	Gold Price (USD per troy ounce in London)	Silver Prices (Re per Kg)
Gold Price (Re per 10 gm) in Mumbai	1.00		
Gold Price (USD per troy ounce in London)	0.96	1.00	
Silver Prices (Re per Kg)	**0.85**	**0.89**	1.00

This high correlation can be put to advanced econometric tests to understand their mutual dynamics. Here, it may be a similar set of factors that may be resulting in high correlation. Causality of relationship, if it exists, remains unanswered.

As can be inferred with these findings, macroeconomic factors do seem to have a role to play in determining prices. In Indian context, variables like CPI Inflation, Euro exchange rate vis-a-vis ` and silver prices show strong correlation with the gold prices. The direction of correlation is also on expected lines. However, to be able to conclusively prove causal relationships between the variables in the Indian context, further empirical work would be required. That would be in lines of cointegration tests for exploring long-run relationships, Error Correction Modelling to be able to predict gold prices based on macroeconomic determinants and Granger causality tests to understand the dynamics of the mutual relationships. This is beyond the scope of current research.

4.3. Gold for Investment

As discussed earlier in this study, one of the most important functionality of gold in modern times is as an asset for investment.

Demand for the metal has been on the surge, due to increase in personal savings in countries like India and China and due to the weakening of dollar's monopoly as the world's reserve currency. Moreover trading in gold has become more convenient than before due to the rise of ETFs thereby increasing demand for the metal. (Carlson, 2010)

ETFs or Exchange traded funds is an investment tool. Other ways of investment in gold are discussed in the next sub-section.

4.3.1 Ways of investing in gold

In modern times, investment in gold can be done in the form of physical exposure or exposure to gold price movements. For relatively smaller investments, 'gold coins and small bars' are good options. If physical possession of gold is not required, then ETFs or Exchange Traded Commodities (ETCs) are good alternatives. Most of these products are backed by gold held in secure vaults. This is how these products are different from derivative products. Many other tools of investment in gold exist like futures and options (derivatives), warrants, gold certificates,

Gold mining stocks, Gold accounts, Gold oriented funds and structured products. (World Gold Council, 2011i)

4.3.2 Why invest in gold?

Various factors have been pointed out which increase gold's appeal as an asset for investment. First is its property of *high liquidity and wealth preservation*. It means that it has the ability to redeem its value quickly as well as completely. It is not vulnerable to consequences like being frozen or devalued, as are equities and fiat currency in financial crisis situations. (Vuyyuri & Mani, 2005) This is because it is a 'real' asset like commodities.

Second is its role in *stabilizing of portfolio*. This is further attributed to its low correlation with industrial demand, which manifests as its resilience in recessionary, inflationary or any similar crisis situations. Hence when most assets including commodities lose value, gold is not or relatively lesser affected. Also further as gold emerges as a safe alternative to financial assets, its demand goes up, pushing its price as well. This has been the recent trend as well with gold prices doubling in the recessionary period of 2007-2010. (Oxford Economics, 2011)

The best asset is one which can offer the maximum returns at minimum risk. Gold apparently seems to be the most appropriate fit in this frame.

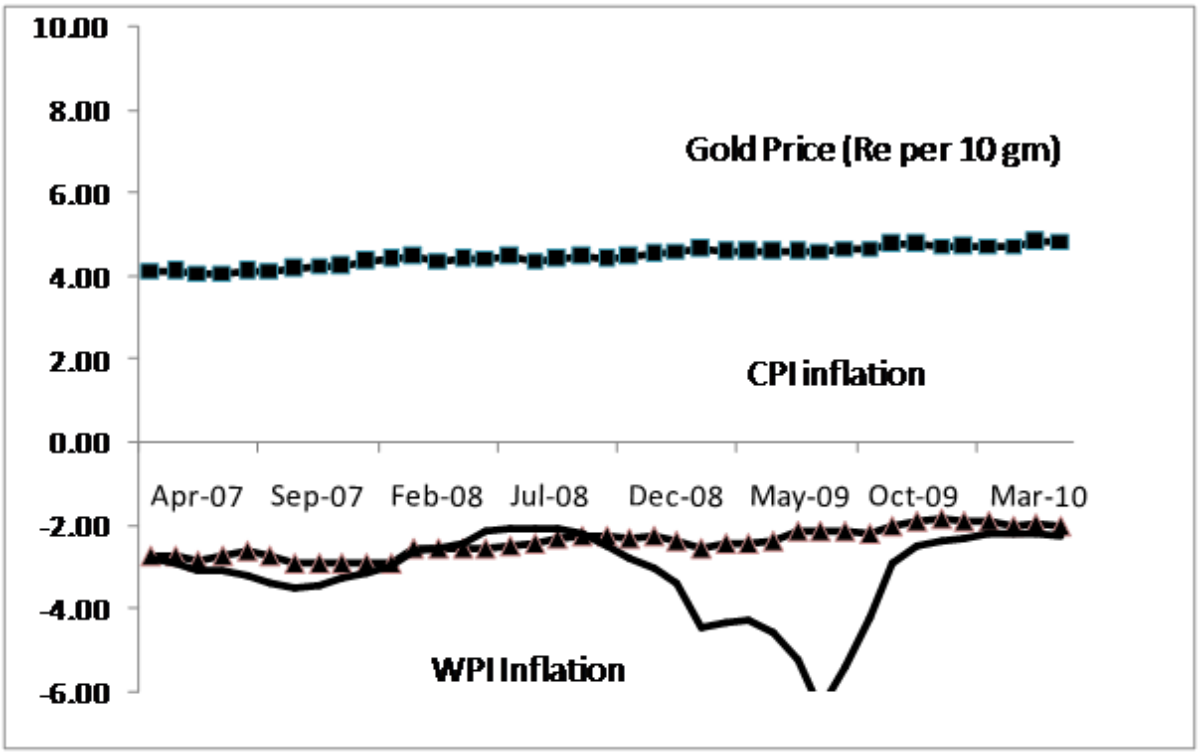
It is beyond doubt that structurally gold retains its value in crisis times and that is fully liquid; other argument like its price movements are independent or inversely related to those of other assets is a subject of investigation.

4.3.3 Gold – An attractive investment alternative?

In this sub-section, certain results inferred in the section 4.2 in the Indian context are used to answer the above question. Relationship between gold prices and US Dollar, inflation and stock prices are pertinent in deciding whether gold should be a part of investment portfolio, in present times.

To summarize the key findings of the previous section again, CPI Inflation displayed a strong and significant positive correlation with gold prices. However correlation with WPI Inflation did not come out to be significant. Hence in at-least one formulation, the co-movement of inflation and gold prices could be established. (Chart 4.1)

Chart 4.1: Trends of Gold prices and WPI Inflation and CPI Inflation (divided into sub-categories) in the period Apr '06 to Jun '10



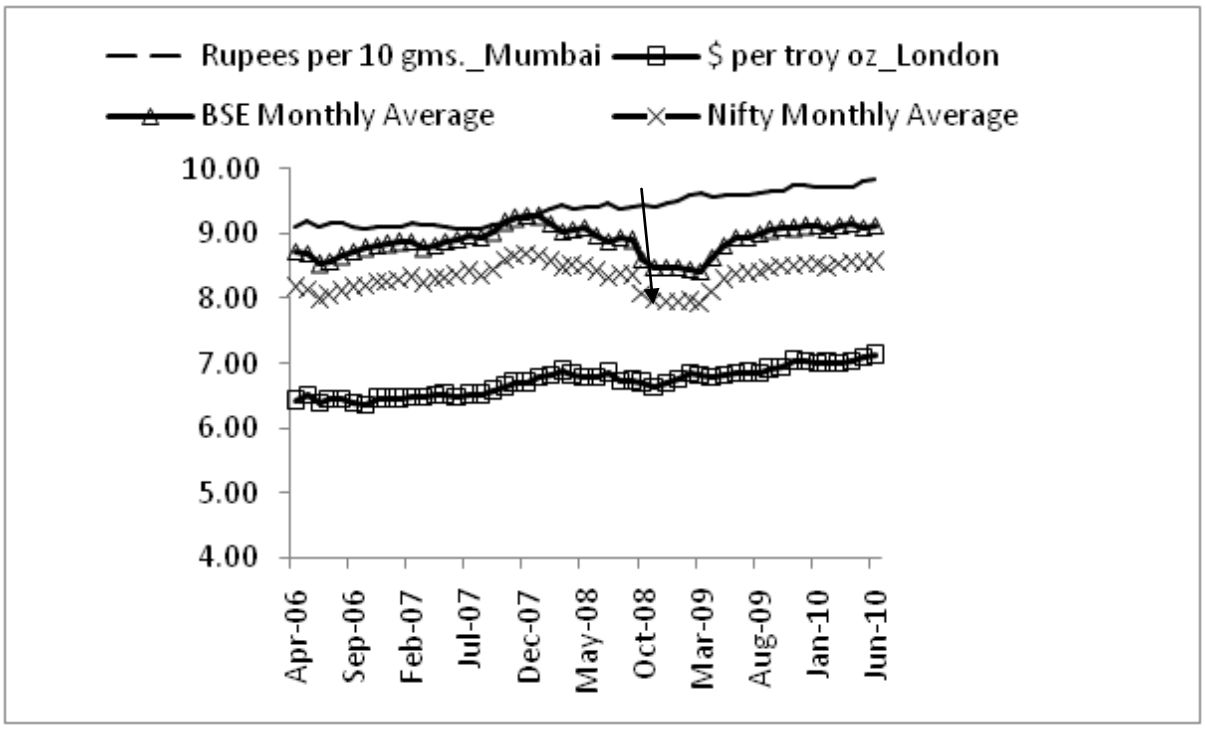
Values are in ln form; the gold price series is ln (Gold Price)-5 to be able to get all series in the same frame.

In terms of dollar, again relationship could not be firmly established as correlation assumptions were not satisfied by the data. However growth rate of dollar did show a low but significant negative correlation with the growth rates of gold prices. This can be interpreted as a vindication, albeit weak, of the inverse relationship that gold prices are hypothesized to have with US Dollar. (Chart 4.2)

In terms of stock market, though, the results were not as hypothesized. This is because gold prices did show a significant positive correlation with the two indices, BSE National Index, S & P CNX NIFTY. This could be interpreted (although with caution since correlation is not very strong) as rejection of hypothesis that 'Movement of gold prices and stock prices are unrelated'. (Chart 4.2)

Hence at-least with respect to Indian equity markets taken in the analysis, gold has not emerged as a perfect alternative.

Chart 4.2: Trends of Gold prices and BSE National Index, S & P CNX NIFTY and gold prices in the period Apr '06 to Jun '10



Values are in ln form.

Apart from the findings of the current study, discussion of another study, although in UK perspective (Oxford Economics, 2011) suggest gold's resilience in times of financial stress caused by inflationary or deflationary conditions. This justifies investment in gold for the purpose of hedging against such crisis conditions.

As has been discussed in detail in Section 4.1, in this study, an Error correction model of gold prices was developed based on macroeconomic factors. Further this equation was used as a basis to predict the possible behaviour of gold in different scenarios of economic conditions.

Specifically, the scenarios tested were the following:

The Oxford Economics baseline scenario - positive and improving conditions in terms of growth and inflation; deflation scenario – recession and falling prices; stagflation scenario - higher

inflation and low growth; high inflation scenario – double digit inflation due to monetary policy laxness and wage-price spiral which gives way to tightening of monetary policy and then recession.

Results showed that gold fared the best as compared to equities, bonds, cash and house prices in a high inflation scenario and better than real estate and equities in the deflationary scenario.

Gold as a tradable commodity has certain unique features like high liquidity and redemption of full value; it also has shown co-movements with CPI Inflation and an inverse relationship with dollar (although weakly vindicated) in the Indian context. Historically and more evidently in the last four years or so, gold has shown resilience in the face of financial crisis. Specifically, downgrading of US credit ranking by Credit agency, Standard and Poor in August 2011 saw gold touching another all time high (MarketWatch , 2011). As a whole, it may be inferred that in the present times, gold deserves a share in the investment portfolio.

4.4. Concluding remarks

On the basis of detailed theoretical discussion and empirical findings, it is amply clear that gold prices are significantly affected by macroeconomic determinants. Same applies to India as well. Variables like CPI Inflation, Euro and silver prices have exhibited strong correlation with gold price. Further, gold's potential as a lucrative investment has been explored on the basis of above findings and some other studies. It can be argued that gold looks attractive at present in global as well as Indian context.

Chapter 5 - Conclusion

Gold is a precious metal having multiple functionalities. Not only is it valued in the form of ornaments, it is also a significant investment tool prolifically traded in commodity exchanges, apart from having industrial uses as well. Historically, it has been treated as money, in the form of gold standard. Even now it forms a part of Central banks' reserves. It has also generated significant employment in its mining operations. Hence it is arguably the most significant of all precious metals for global economy.

India is a major stakeholder as far as demand for gold is concerned, specifically in the form of jewellery. Gold is a part of tradition, faith and attitude, which cements its bonding with the Indian society. As far as gold prices are concerned, it has been a trend of rising gold prices from 1978 onwards.

Broadly, price determinants can be categorised into Supply and demand factors; Speculation in the trading market and Macro-economic factors.

Related literature is scarce for India and hence this study is undertaken. The twin objectives are identification of macroeconomic determinants of gold prices in India and analysis of gold as an investment asset, based on existing works and findings of the current study

Both Qualitative and Quantitative approaches are applied. In qualitative analysis, select studies pertinent to the objective of exploring macroeconomic factors impacting gold prices, are surveyed. Results and conclusion are presented at the end of each study which point to the probable macroeconomic determinant(s) of gold prices in the Indian context. The quantitative analysis comprises understanding the nature of the gold prices and macroeconomic variables through 'Descriptive Statistics' and their mutual relationship through scatter plots and correlation.

As a result of qualitative analysis, one fact that has come to light in conclusive terms is that macroeconomic factors do have a significant role to play in determining gold prices. Also the factor endorsed by most of the studies discussed is the exchange rate (in terms of USD and

Euro). This is followed by inflation and equity markets. These become the probable determinants to be analyzed in Indian context as well.

Variables pin-pointed by qualitative study and analyzed quantitatively vis-a-vis gold prices are exchange rate, inflation rate, stock prices and silver prices.

The frequency of data is taken as monthly. The time period considered is between April '06 and June'10.

The gold prices show significant and positive correlation with the value of Euro. However correlation results with respect to USD are not found to be reliable. Further, significant and positive correlation is exhibited between gold prices & lagged gold prices and all categories of CPI. Hence gold prices are found to have a relationship with expected as well as contemporaneous inflation (subject to further scrutiny). However, no such relationship is evident in terms of WPI Inflation. The results shows a significant and positive, yet low magnitude of correlation between stock price indices and gold prices. Hence investment in gold may not fully provide investors a fool-proof cushion against stock market risks. With regard to the correlation with silver prices, as expected, the correlation is high, positive and significant between the two variables. However, to be able to conclusively prove causal relationships between the variables in the Indian context, further empirical work would be required, which is beyond the scope of current research.

Further, the financial aspect of gold is discussed in the last section. Various factors have been pointed out which increase gold's appeal as an asset for investment. Significant among them are *high liquidity and wealth preservation* properties. Further its role in *stabilizing of portfolio* is worth mention due to its low correlation with industrial demand and hence all other assets.

The findings of the current study and some other works are discussed in this perspective. Finally it is concluded that in present times, gold deserve a place in the investment portfolio.

Limitations and Scope of Further Research

Given that a vast range of econometric techniques have already been applied to analyzing the impact of vast range of the factors on gold prices, it felt pertinent to first have a broad outlook of the existing literature and present it as a detailed theoretical survey for further reference. Due to

focus in this direction, only preliminary statistical analysis could be done to explore the probable relationships between gold prices and macroeconomic factors.

As a direction for further research, further econometric tests can be done. They constitute cointegration tests for exploring long-run relationships, Error Correction Modelling to be able to predict gold prices based on macroeconomic determinants and Granger causality tests to understand the dynamics of the mutual relationships.

Also several factors, which have shown significance in foreign context but were not included in the current study, can be analyzed for India.