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Interaction among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India: A Time Series Analysis

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Abstract

The financial sector of a country plays a pivotal role in growth and structural transformation of its economy, i.e., in economic development. The real world situation is characterized by uncertainties, asymmetric information and so on. Under such circumstances, optimal allocation of resources and efficient decision making become difficult. The objective of our study is to find out whether there was any long-run equilibrium relationship among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India between the period January 1995 to December 2013 using monthly data. The variables representing the corresponding markets are Mumbai gold price, BSE SENSEX, transactions in Government securities, Indian Rupee / US Dollar exchange rate and call money rate (proxy for interest rate). By empirical Time Series Analysis, we have found out that there is a long-run equilibrium relationship among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India. This implies that there is an arbitrage opportunity (opportunity to buy an asset at a low price then immediately selling it on a different market for a higher price) for the investors, resulting in profits without any risk. Another objective of this study is to find out the degree of risk involved while investing on the three financial assets (Gold, Share and Government Securities). By looking at the Descriptive Statistics, we have found out that variance (risk) of gold > share > government securities. This implies that investing on gold is riskiest, followed by investing on shares and finally investing on government securities which is least risky.

Key words: Gold, Equity, Government Securities, Foreign Exchange, Money Markets, India

I. Introduction

Context of the Study

An investor will always like to invest in that market where probability of expected return is maximum. For this, we aim to study the interaction among five different markets in India -Gold, Equity, Government Securities, Foreign Exchange and Money, so as to look for a long-run equilibrium relationship among them. The inter-linkages among these markets would provide an arbitrage opportunity (opportunity to buy an asset at a low price and then immediately selling it in a different market for a higher price) for the investors, resulting in profits without any risk. The inter-linkages (if any) would confirm the view of law of one price which is based on the assumption that differences between prices are eliminated by market participants taking advantage of arbitrage opportunities. The law of one price exists due to arbitrage opportunities. If the price of a security, commodity or asset is different in two different markets, then an arbitrageur will purchase the asset in the cheaper market and sell it where prices are higher. Now, we will introduce all the five markets one by one.

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Gold Market

Gold is bought and sold in U.S. dollars, and so any decline (increase) in the value of the dollar causes the price of gold to rise (fall). It is an effective way to diversify our portfolio and protect the wealth created in the stock market simply because it is among the most negatively correlated asset compared with stocks. Demand for gold has exceeded the supply of gold from mines for a number of years. Some of this excess demand has been filled by recycled scrap but Central Bank gold has been the primary source of above-ground supply. Gold is regarded as a store of value. Indians have a huge fascination for the yellow metal. It plays an important role in the social, religious and cultural life of Indians. People invest both in gold bullion and gold jewellery.

Equity Market

The Equity or Stock market serves the company by providing it the finance for long term needs and for an investor an opportunity to park his savings in corporate world and in turn give their hand in Nation's development. Rising share prices is associated with increased business investment and vice versa. A stock exchange is a place to trade stocks. The purpose of a stock exchange is to facilitate the exchange of securities between buyers and sellers, thus providing a marketplace. So, a stock exchange has a vital role in a country's economic development. Any transaction done on Day 1 has to be settled on the Day 1 + 3 working days, when funds pay in or securities pay out takes place. The functions of the equity market in India are supervised by SEBI (Securities Exchange Board of India). Since we are dealing with BSE SENSEX, so here we will only discuss about it. The BSE (Bombay Stock Exchange) is the oldest stock exchange in India which was started in 1875. It is situated at Dalal Street in Mumbai. BSE has over 5000 companies that are listed in it. It was initially known as 'The Native Share& Stock Brokersô Association.' The BSE Index or the SENSEX (as it is popularly known) is the index of the performance of the 30 largest and most profitable and popular companies listed in it. Each company that is a part of the index has its own weightage in the value of the index. The values of all BSE indices are updated every 15 seconds during the market hours. So if SENSEX is up, we generally assume market to be up (which does not mean all shares are up) and vice versa.

Government Securities Market

The Government Securities market deals with tradeable debt instruments issued by the Government for meeting its financing requirements. Government securities, also called the gilt edged securities or G-secs, are not only free from default risk but also provide reasonable returns. The Government securities comprise of dated securities issued by the Government of India and State Governments and also Treasury Bills issued by the Government of India. In India, the Central Government issues both Treasury Bills and Bonds or dated securities while the State Governments issue only Bonds or dated securities, which are called the State Development Loans (SDLs).

Government securities are issued through auctions conducted by the RBI. Governments issue securities with maturities ranging from less than a year to a long-term stretching up to fifty years. Government paper with tenure beyond one year is known as dated security. State Government Securities are securities issued by the State Governments and are also known as the State Development Loans (SDLs). The issues are managed and serviced by the Reserve Bank of India. The tenure of State Government securities is normally ten years. Treasury Bills (T-bills) offer short-term investment opportunities, generally up to one year. They are thus useful in managing short-term liquidity. At present, the Government of India issues three types of treasury bills through auctions, namely, 91-days, 182-days and 364-days. There are no treasury bills issued by State Governments. While 91-days T-bills are auctioned every week on Wednesdays, 182-days and 364-days T-bills are auctioned every alternate week on Wednesdays.

Foreign Exchange Market

The Foreign Exchange Market is a global decentralized market for trading of currencies. It determines the relative values of different currencies. The U.S. Dollar is the worldôs reserve currency ï the primary medium for international transactions, the principal store of value for savings and the currency primarily held as reserves by the worldôs Central Banks. Till about 1992-93, the Government exercised absolute control on the exchange rate. After 1992, Government of India slowly started relaxing the control and exchange rate became more and more market determined. The gradual liberalization of Indian economy has resulted in a substantial inflow of foreign currency capital into India. Simultaneously, dismantling of trade barriers has facilitated the integration of domestic economy with the world economy.

Money Market

The Money market in India is a market for short-term and long-term funds with maturity ranging from overnight to one year. Here, we will be focusing only on the call money market. A market for extremely short-period is referred to as the call money market. The call money market for India was first recommended by the Sukhamoy Chakravarty Committee, which was set up in 1982 to review the working of the monetary system. Under this market, funds are transacted on overnight basis. The participants are mostly banks. Therefore, it is also called Inter-Bank Money Market. In this market, the rate at which funds are borrowed and lent is called the call money rate which is highly volatile.

Structure of the Paper

In Section 2, we make an attempt to review the past literature. The next section deals with the motivation and objective behind this study, describes data and its base and also discusses the methodology used. In section 4, we analyse the empirical results obtained. Finally, section 5 contains concluding remarks.

II. Literature Review

Several works have been done by different authors over the years on our area of study. So here we will present a brief summary of the major findings of the papers that have contributed immensely for developing our present work.

Fox (1935) **e**xamined the relationships among gold prices, exchange rates and gold flows during the extremely unsettled period from January 1933 to July 1934 for three countries ï England, France and US, and concluded that gold will flow to the market in which the highest price can be obtained. Salant and Henderson (1978) analysed the effects of anticipations of Government sales policies on the real price of gold and concluded that announcements of a probable Government sales lead to a drop in the price of gold. Boyer (1978) emphasized that under certain circumstances, the particular exchange rate regime is irrelevant. In the long-run, the values of all real variables are independent of the exchange rate regime, and even in the short-run the same equilibrium can be attained by use of the policy instruments available under any regime. Caves and Feige (1980) concluded that money supply has no bearing on exchange rates for Canadian-US foreign exchange market but causality from exchange rates to the money supply is consistent with the hypothesis of Government intervention in the foreign exchange market.

Verghese (1985) found that exchange rates of all major currencies have undergone unprecedented magnitudes of volatility which offer opportunities for gains as much as they expose the parties to risks of potential losses. Hakkio (1986) explained changes in inflation and expected inflation to be the dominant factors causing high interest rates and a lower dollar in the 1970s and changes in real interest rates to be the dominant factor responsible for the positive correlation between interest rate and dollar in 1980s. His period of study was from 1974 to 1986.Jorion (1988) investigated the existence of discontinuities in the sample path of exchange rates and of a stock market index due to the arrival of news or by changes in monetary policies. Choi et al. (1998) used an unconditional and a conditional multi-factor asset pricing model to indicate that the exchange risk is generally priced in Japanese stock market, using monthly data from January 1974 to December 1995. Granger et al. (2000) found that in South Korea, exchange rates lead stock prices but on the other hand, in Philippines, stock prices lead exchange rates. They used daily data from January 3, 1986 to June 16, 1998.Nath and Samanta (2003) examined the dynamic linkages between foreign exchange of Indian Rupee and Indian stock index S&P CNX NIFTY using daily data for the period March 1993 to December 2002 and found that these two markets did not have any causal relationship. Canjels et al. (2004) assessed the degree of market integration in the dollar-sterling foreign exchange market from 1879 to 1913.

Mishra and Paul (2008) used monthly data from February 1995 to March 2005 and found that there is causality between Nifty and exchange rate but no causality between any other stock indices and exchange rate. Kannan and Dhal (2008) provided analytical and empirical perspectives on India's physical gold demand during the period 1980 to 2005. Empirical results revealed that gold demand is not only price sensitive, but also significantly influenced by macroeconomic and financial variables. Hammoudeh and Yuan (2008) examined the volatility behaviour of three commodities: gold, silver and copper in the presence of crude oil and interest rate shocks, using daily data during the period January 2, 1990 to May 1, 2006 and found that gold and silver have almost the same volatility persistence which is greater than that of copper. Sjaastad (2008) examined the theoretical and empirical relationships between the major exchange rates (between the US dollar, the UK pound sterling and the Japanese yen) and the price of gold from January 1991 to June 2004 using daily data. Sari et al. (2010) examined the co-movements and information transmission among the spot prices of four precious metals (gold, silver, platinum and palladium), oil price and the US Dollar/Euro exchange rate, using daily data during the period January 4, 1999 to October 19, 2007 and found no long-run equilibrium relationship among them. Zhang and Wei (2010) indicated positive correlation between crude oil price and gold price, using daily data for the period January 4, 2000 to March 31, 2008 and found long term equilibrium between the two markets. Hoang (2010) studied the return of investment in gold assets quoted at the Paris Stock Exchange from 1950 to 2003 and concluded that investing in gold is riskiest followed by stock and finally bond. Pukthuanthong and Roll (2011) used daily data from January 2, 1971 to December 10, 2009 and found that gold and the US dollar are negatively related. Joy (2011) found that increase in the price of gold is associated with decrease in the value of the US dollar for the period January 10, 1986 to August 29, 2008 using weekly data. Chang et al. (2013) examined the inter-relationships among gold prices in London, New York, Japan, Hong Kong and Taiwan for the period January 2, 2007 to December 31, 2010 using daily data and found bi-directional causality between London and New York gold markets and uni-directional causality from New York to the other markets. Wang and Chueh (2013) found long-run relationship between interest rate, US dollar and crude oil price for the period January 2, 1989 to December 20, 2007 using daily data. Jain and Ghosh (2013) examined cointegration among global oil prices, precious metal (gold, platinum and silver) prices and Indian Rupee-US dollar exchange rate from January 2, 2009 to December 30, 2011 using daily data and found them to be cointegrated. Smiech and Papiez (2013) investigated causality between fossil fuel prices, US dollar/Euro exchange rate and the German Stock Index (DAX) for the period October 5, 2001 to June 29, 2012 using weekly data and concluded that only crude oil price influenced the exchange rate. Ciner et al. (2013) investigated the dynamic correlations between oil, gold, currency, bond and stock markets for US and UK, covering the period between January 1990 and June 2010 using daily data and concluded that gold acts as a safe haven when exchange rates drop significantly in both the markets. Lili and Chengmei (2013) found that the effect of financial market indices and macroeconomic indicators to gold price is negative, while the effect of prices of energy product to gold price is positive for the period 1987 to 2005.

III. Objective, Data and Methodology

Motivation and Objective

From reviewing the past literature, it is found that no work has been done on the interaction among all the five markets (gold, equity, government securities, foreign exchange and money) taken together at a time. This work had not been done owing to the fact that all the markets did not develop properly in India, thus price mechanism was not discovered. The concept of inter-linkages among these markets has gained importance recently due to the scenario of highly volatile gold price, share price and exchange rate. So, we have decided to work in this area in the Indian perspective by means of time series technique.

The objective of our study is to find out whether there is any long-run equilibrium relationship among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India during the period January 1995 to December 2013 using monthly data. The variables representing the corresponding markets are Mumbai gold price, BSE SENSEX, transactions in Government Securities, Indian Rupee / US Dollar exchange rate and call money rate (proxy for interest rate). Another objective of this study is to find out the degree of risk involved while investing in the three financial assets (Gold, Share and Government Securities).

Database and Data description

Data is taken from *Handbook of Statistics on Indian Economy – Reserve Bank of India*. The period of our study is from January 1995 to December 2013, wherein we have used monthly data. The number of observations is 228.The variables that we have used for our study are described below:

mumgoldprice Ÿ monthly average price of gold in Mumbai (Rs. per 10 grams), shareprice Ÿ closing monthly average of BSE Sensitive Index (Base : 1978-79 = 100), govtsecurities Ÿ secondary market transactions in Government securities (Rs. billion) = outright transactions (Central Government securities + State Government securities + Treasury bills) + repo transactions (Central Government securities + State Government securities + Treasury bills), avgers_$Ÿ monthly average exchange rate of the Indian Rupee vis-à-vis the US Dollar (Rs. per unit of foreign currency), callmonrate Ÿ weighted average call money rates (% per annum)

The weight used for the call money rate is calculated as the share of the transaction in a given security in the aggregated value. The above five variables represent Gold, Equity, Government Securities, Foreign Exchange and Money markets in India respectively.

Methodology

For each variable, line diagram is plotted first. This is the most common method of representing statistical data, where data are shown in accordance with the time of occurrence. The line diagrams give the pictorial representation of the variables. From this, we can get an idea about the movement of the variables over the sampling period. Then, Descriptive Statistics are obtained for all of them. Descriptive Statistics give a brief summary of the nature of the variables under study. They are used to present quantitative descriptions in a manageable form. Descriptive Statistics are important because if we simply present our raw data, it would be hard to visualize what the data is showing. Next, by using the time series technique, Augmented Dickey-Fuller (ADF) Unit Root Test is carried out for checking stationarity of the variables, where the null hypothesis (H_0) supports the presence of unit root; i.e., it supports the view that the variables are non-stationary. After the test, it has been found that all the variables are non-stationary at level but stationary at first difference; i.e., all of them are I(1) variables, meaning they are integrated of order 1. Following this, all the I(1) variables are created and corresponding line diagrams are plotted. These line diagrams show how all the variables have become stationary at their first difference. Since all of them are integrated of the same order, we had a hunch that there might be a long-run equilibrium relationship among them. For this, Johansen Cointegration test is done. Finally, Vector Error Correction (VEC) model is executed which checks short-run adjustments with the possibility of convergence to long-run equilibrium. All the time series exercise (ADF Unit Root test, Johansen Cointegration test and VEC model) have been carried out with the help of EViews 7 software. Now, we will briefly explain the methodologies involved in the three above tests that we have carried out in our work.

Augmented Dickey-Fuller (ADF) Unit Root Test

A time series is said to be stationary if there is no systematic change in mean, variance and strictly periodic variations have been removed. A time series is strictly stationary if all the moments of its probability distribution are invariant over time. On the other hand, if a non-stationary time series has to be differenced "d" times to make it stationary, then the time series is said to be integrated of order "d". Mathematically, it is denoted as: $Y_t \sim I(d)$. The process Y_t is said to be integrated of order 1, denoted by I(1), if and only if, it satisfies the following recursive equation:

$$Y_t = Y_{t-1} + u_t \qquad (1)$$

where, u_t is a weak white noise. White noise process is a special case of stationary stochastic process. A stochastic process is said to be purely random or white noise if it has zero mean, constant variance and is serially uncorrelated. The unit root test is used to find out the order of integration in order to know whether a series is stationary or not. The variable Y_t may be tested for the presence of unit root as shown:

Let Y_t follows the following recursive equation:

$$Y_t = \rho Y_{t-1} + u_t \qquad (2)$$
$$\Rightarrow Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t$$
$$\Rightarrow \Delta Y_t = (\rho - 1) Y_{t-1} + u_t$$
where, $\Delta Y_t = Y_t - Y_{t-1}$
$$\Rightarrow \Delta Y_t = \delta Y_{t-1} + u_t \qquad (3)$$
where, $\delta = (\rho - 1)$

In order to test whether the time series is stationary or not, we need to test the null hypothesis, H_0: $\delta = 0$ against the alternative hypothesis, H_1: $\delta < 0$. The null hypothesis represents the presence of unit root in the series. Therefore, if $\delta = 0$, then, Y_t is non-stationary. On the other hand, if $\delta \neq 0$, or more specifically, if $\delta < 0$, then, Y_t is stationary. The usual t-test is inappropriate for testing null hypothesis of unit root because, the estimated coefficient of Y_{t-1} does not follow the t-distribution even in large samples. Dickey and Fuller (1979 and 1981) have proposed a test statistic that is different from the conventional t-statistic for testing the presence of unit root in univariate series. Dickey and Fuller have shown that, under the null hypothesis, H_0: $\delta = 0$, the estimated value of the coefficient of Y_{t-1} in equation (3) follows the standard normal distribution, and hence the τ(Tau) statistic. The test statistic is also known as Dickey-Fuller (DF) Test Statistic.

The DF test is estimated in three different forms:

$$\Delta Y_t = \delta Y_{t-1} + u_t \qquad (3)$$
$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t \qquad (4)$$
$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \qquad (5)$$

where, t represents the trend variable. Equation (3) is a pure random walk model. The inclusion of intercept in equation (4) allows for testing unit root along with the presence of drift. The inclusion of intercept and trend in the equation (5) gives the possibility of testing unit root along with the deterministic trend and drift. In all the above three models, the null hypothesis (H_0) is $\delta = 0$. That is, the time series is non-stationary. The critical values of τ statistic for each model are different.

(1). Apply OLS to the most appropriate equation. (2). After estimating the coefficient corresponding to Y_{t-1}, divide it by its standard error to calculate τ statistic and compare with the DF table. (3). If calculated absolute value of τ, that is $|\tau|$, is greater than the critical value of DF statistic, then we reject H_0 and conclude that the time series is stationary and vice versa. One of the assumptions of DF test is that, the error term (u_t) is uncorrelated in equations (3), (4) and (5). But when this assumption is violated, it is appropriate to use another version of DF test, also known as Augmented Dickey-Fuller (ADF) test. The test is conducted by augmenting the previous three equations by adding the lag values of the dependent variable (ΔY_t), which is shown below:

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta Y_{t-i} + u_t \quad (6)$$

$$\Delta Y_t = \alpha_1 + \delta Y_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta Y_{t-i} + u_t \quad (7)$$

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta Y_{t-i} + u_t \quad (8)$$

where, u_t is white noise error term and $\Delta Y_{t-i} = Y_{t-i} - Y_{t-i-1}$. In ADF test also, the null hypothesis (H_0) is to test whether $\delta = 0$ against the alternative hypothesis (H_1): $\delta < 0$. The ADF test statistic follows the same asymptotic distribution as DF test statistic.

Cointegration

Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. For cointegration, all the variables are taken at their levels. If $x_t \sim I(1)$, $y_t \sim I(1)$ and $y_t - \beta x_t = \varepsilon_t \sim I(0)$, then the series y_t and x_t are said to be cointegrated in the sense of having a stable long-run relation. The existence of a long-run stable relation indicates that the short-run disturbances would eventually get corrected in this system. Hence, corresponding to any cointegration model, there will be an associated error correction model.

Vector Error Correction (VEC) Model

A Vector Error Correction (VEC) model is a restricted Vector Autoregression (VAR) designed for use with non-stationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the "error correction" term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. To take the simplest possible example, we consider a two variable system with one cointegrating equation and no lagged difference terms. The cointegrating equation is:

$$y_{2,t} = \beta\, y_{1,t}$$

The corresponding VEC model is:

$$\Delta y_{1,t} = \alpha_1 (y_{2,t-1} - \beta\, y_{1,t-1}) + \varepsilon_{1,t}$$

$$\Delta y_{2,t} = \alpha_2 (y_{2,t-1} - \beta\, y_{1,t-1}) + \varepsilon_{2,t}$$

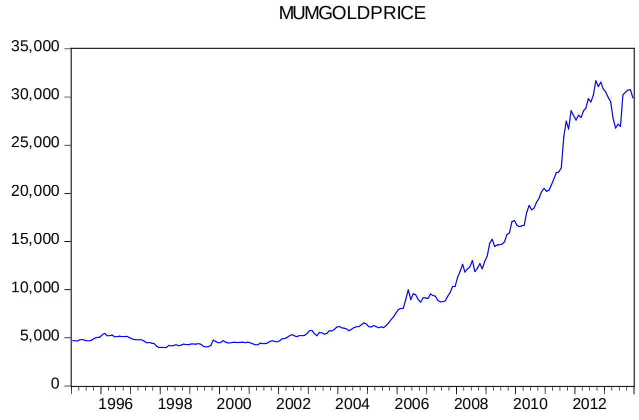
In this simple model, the only right-hand side variable is the error correction term. In long-run equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long-run equilibrium, the error correction term will be non-zero and each variable adjusts to partially restore the equilibrium relation. The coefficient α_i measures the speed of adjustment or magnitude of error correction of the i-th endogenous variable towards the equilibrium, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the white noise error terms.

IV. Empirical Results

We first plot line diagram for each variable at its level. Level means the variables are not differenced and are taken at their raw forms.

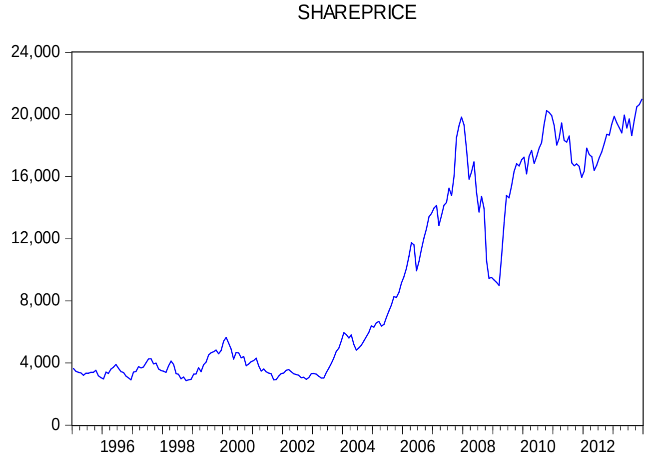
Line Diagrams at level

Figure 4.1: Line Diagram showing the movement of Mumbai Gold price at level



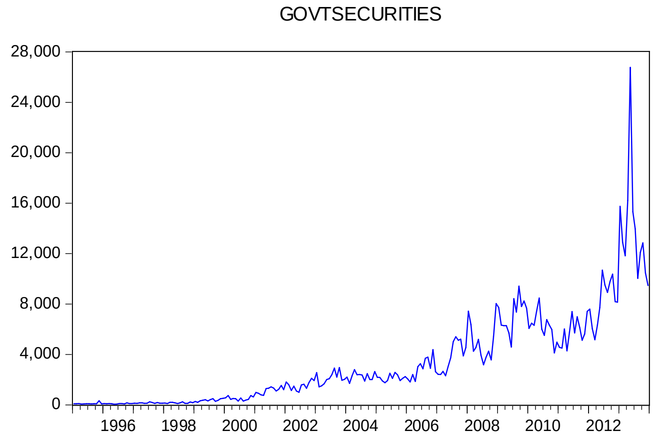
The above figure shows how Mumbai Gold price (termed as mumgoldprice) has overall increased during the sampling period.

Figure 4.2: Line Diagram showing the movement of BSE SENSEX at level



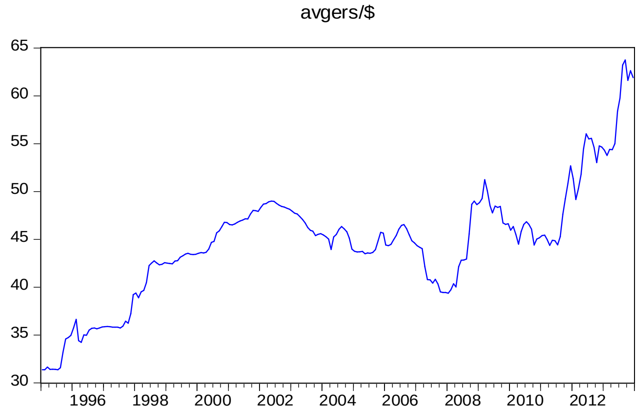
The above figure depicts how BSE SENSEX (termed as shareprice) has overall increased during the sampling period.

Figure 4.3: Line Diagram showing the movement of transactions in Government Securities at level



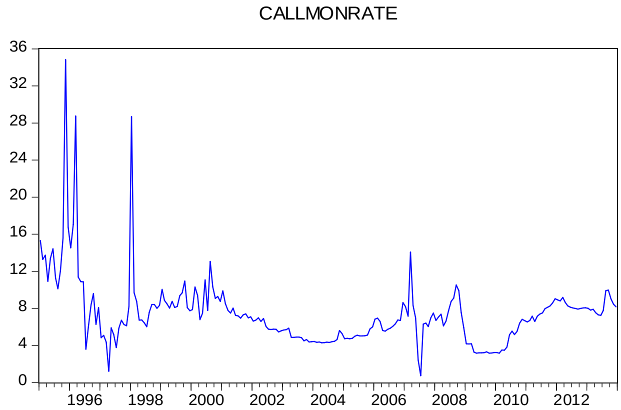
The above figure shows how transactions in Government Securities (termed as govtsecurities) have overall increased during the sampling period.

Figure 4.4: Line Diagram showing the movement of Indian Rupee-US Dollar exchange rate at level



The above figure depicts how Indian Rupee-US Dollar exchange rate (termed as avgers/$) has overall increased during the sampling period.

Figure 4.5: Line Diagram showing the movement of call money rate at level



The above figure shows how call money rate (termed as CALLMONRATE) has fluctuated during the sampling period.

Descriptive Statistics

After the line diagrams of the variables are plotted at their levels, Descriptive Statistics are obtained for all of them. Now, we show the result of the Descriptive Statistics of the studied variables.

Table 4.1: Descriptive Statistics

	Gold Price	Share Price	Govt. Securities	Exchange Rate	Call Money Rate
Mean	10635.49	9186.98	3349.95	44.64	7.43
Median	6058.84	5676.13	2104.43	45.07	6.95
Maximum	31672.83	20973.61	26769.27	63.75	34.83
Minimum	3995.00	2865.40	46.11	31.37	0.73
Std. Dev.	8406.52	6303.08	3774.10	6.09	3.80
Variance	70669578.51	39728817.49	14243830.81	37.09	14.44

One of the objectives of this study is to find out the degree of risk involved while investing in the three financial assets (Gold, Share and Government Securities). From the above table, if we consider the variance of the first three variables, which takes into account the degree of risk involved while investing on these financial assets, we find that the variance (risk) of Gold > Share > Government Securities. In other words, this implies that investing in Gold is the riskiest, followed by investing in shares and finally investing in Government Securities which is least risky. The implication behind this result is that only Gold is US dollar denominated, so any fluctuations in exchange rate will clearly have an effect on the gold price. Thus, it varies the most (having the maximum risk) compared with the other two financial assets - shares and Government Securities. Owning a share or stock presumes that we can find a buyer later who will pay us more when we sell it. Naturally, there is no guarantee that a future buyer will pay the premium that we expect. There lies the risk while investing in shares. Investment in gold has attended problems in regard to appraising its purity, valuation, safe custody, etc., while investing in Government securities has an advantage. Besides providing a return in the form of coupons (interest), Government securities offer the maximum safety as they carry the Sovereignôs commitment for payment of interest and repayment of principal. Hence, based on the above reasons, we can conclude that investing in gold is the riskiest, followed by investing in shares and finally investing in Government securities which is least risky.

Augmented Dickey-Fuller (ADF) Unit Root Test

After obtaining the result of the Descriptive Statistics, we have checked for the stationarity of the variables at level, using the Augmented Dickey-Fuller (ADF) Unit Root Test via the time series technique, where the null hypothesis (H_0) supports the presence of unit root; i.e., it supports the view that the variables are non-stationary at levels. For this, we have taken one variable at a time and checked for stationarity. First, we have gone for ñmumgoldpriceò at level. There are three alternatives under this: ñInterceptò, ñTrend and Interceptò and ñNoneò. We have to check for all of them. The underlying meaning of all these have been already discussed in section 3.3.1. From all the three alternatives under ñLevelò, we found the same result, showing ñmumgoldpriceò to be non-stationary at 1% level of significance. Then, we followed the same exercise at the first difference level of ñmumgoldpriceò. From all the three alternatives under ñFirst Differenceò, we found the same result, showing ñmumgoldpriceò to be stationary at 1% level of significance. Thus, we can conclude by saying that ñmumgoldpriceò is non-stationary at level but stationary at first difference at 1% level of significance; i.e., it is an I(1) variable, meaning integrated of order 1. Then, we created the corresponding first difference variable of ñmumgoldpriceò and named it ñmumgoldprice1ò. We used the following formula to create the new variable:

mumgoldprice1 = mumgoldprice ï mumgoldprice (-1)

Next, we checked for the stationarity of ñsharepriceò at level. From all the three alternatives under ñLevelò, we found the same result, showing ñsharepriceò to be non-stationary at 1% level of significance. Then, we followed the same exercise at the first difference level of ñsharepriceò. From all the three alternatives under ñFirst Differenceò, we found the same result, showing ñsharepriceò to be stationary at 1% level of significance. Thus, we can conclude by saying that ñsharepriceò is non-stationary at level but stationary at first difference at 1% level of significance; i.e. it is an I(1) variable, meaning integrated of order 1. Then, we created the corresponding first difference variable of ñsharepriceò and named it ñshareprice1ò. We used the following formula to create the new variable:

shareprice1 = shareprice ï shareprice (-1)

Next, we checked for the stationarity of ñgovtsecuritiesò at level. From all the three alternatives under ñLevelò, we found the same result, showing ñgovtsecuritiesò to be non-stationary at 1% level of significance. Then, we followed the same exercise at the first difference level of ñgovtsecuritiesò. From all the three alternatives under ñFirst Differenceò, we found the same result, showing ñgovtsecuritiesò to be stationary at 1% level of significance. Thus, we can conclude by saying that ñgovtsecuritiesò is non-stationary at level but stationary at first difference at 1% level of significance; i.e., it is an I(1) variable, meaning integrated of order 1. Then, we created the corresponding first difference variable of ñgovtsecuritiesò and named it ñgovtsecurities1ò. We used the following formula to create the new variable:

govtsecurities1 = govtsecurities ï govtsecurities (-1)

Next, we checked for the stationarity of ñavgers_$ò at level. From all the three alternatives under ñLevelò, we found the same result, showing ñavgers_$ò to be non-stationary at 1% level of significance. Then, we followed the same exercise at the first difference level of ñavgers_$ò. From all the three alternatives under ñFirst Differenceò, we found the same result, showing ñavgers_$ò to be stationary at 1% level of significance. Thus, we can conclude by saying that ñavgers_$ò is non-stationary at level but stationary at first difference at 1% level of significance; i.e., it is an I(1) variable, meaning integrated of order 1. Then, we created the corresponding first difference variable of ñavgers_$ò and named it ñavgers_$1ò. We used the following formula to create the new variable:

avgers_$1 = avgers_$ ï avgers_$ (-1)

Finally, we checked for the stationarity of ñcallmonrateò at level. The first two alternatives under ñLevelò are showing ñcallmonrateò to be stationary at level but the third alternative is showing it to be non-stationary at level. For accepting it to be stationary at any level, all the three alternatives have to be shown as stationary. So, here we cannot claim ñcallmonrateò to be stationary at level but non-stationary at 1% level of significance. Then, we followed the same exercise at the first difference level of ñcallmonrateò. From all the three alternatives under ñFirst Differenceò, we found the same result, showing ñcallmonrateò to be stationary at 1% level of significance. Thus, we can conclude by saying that ñcallmonrateò is non-stationary at level but stationary at first difference at 1% level of significance; i.e. it is an I(1) variable, meaning integrated of order 1. Then, we created the corresponding first difference variable of ñcallmonrateò and named it ñcallmonrate1ò. We used the following formula to create the new variable:

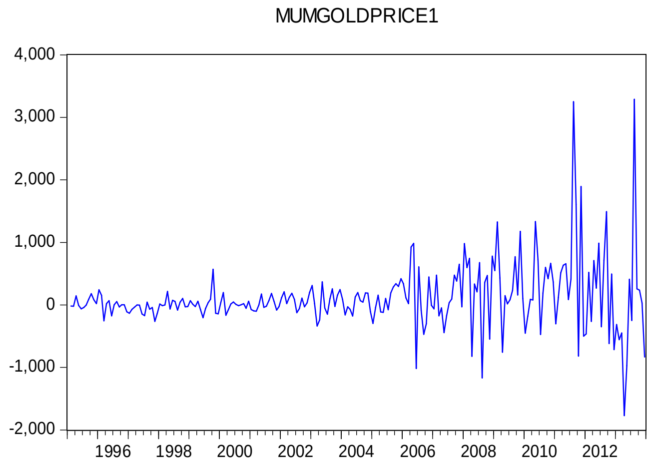
callmonrate1 = callmonrate ï callmonrate (-1)

Thus, by doing ADF Unit Root Test, it is found that all the variables (mumgoldprice, shareprice, govtsecurities, avgers_$ and callmonrate) under study are non-stationary at their levels but stationary at their first differences; i.e. all of them are I(1) variables at 1% level of significance.

Line Diagrams at first difference

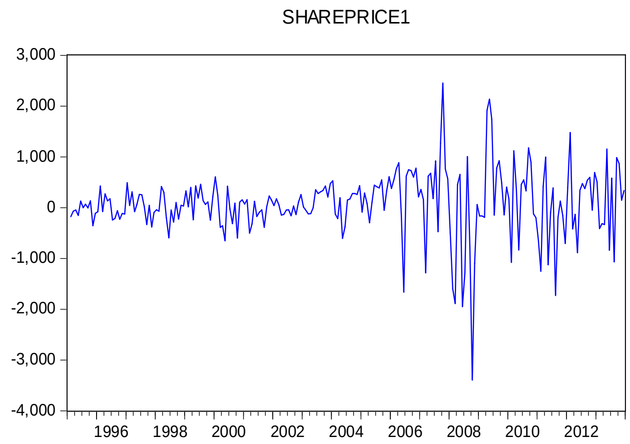
Following the ADF Unit Root Test, all the I(1) variables are created (mentioned in section 4.3) and corresponding line diagrams are plotted. These line diagrams show how all the variables have become stationary at their first differences.

Figure 4.6: Line Diagram showing the stationarity of Mumbai Gold price at first difference



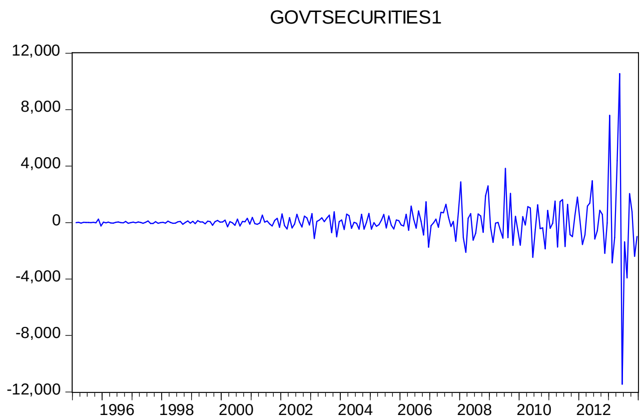
The above figure shows how Mumbai Gold price (termed as MUMGOLDPRICE1) has become stationary at first difference.

Figure 4.7: Line Diagram showing the stationarity of BSE SENSEX at first difference



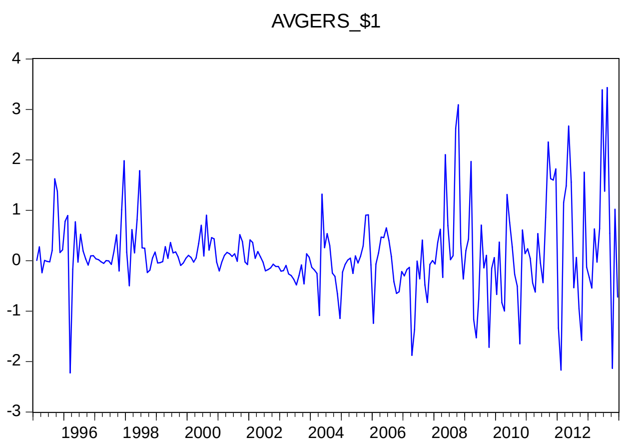
The above figure shows how BSE SENSEX (termed as SHAREPRICE1) has become stationary at first difference.

Figure 4.8: Line Diagram showing the stationarity of transactions in Government Securities at first difference



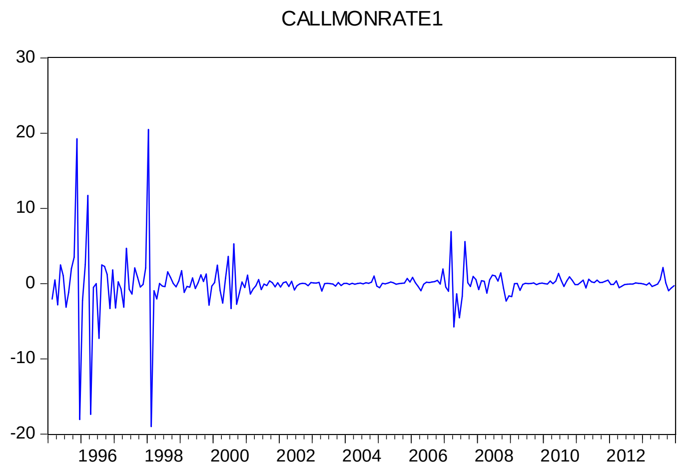
The above figure shows how transactions in Government Securities (termed as govtsecurities1) have become stationary at first difference.

Figure 4.9: Line Diagram showing the stationarity of Indian Rupee-US Dollar exchange rate at first difference



The above figure shows how Indian Rupee-US Dollar exchange rate (termed as AVGERS_$1) has become stationary at first difference.

Figure 4.10: Line Diagram showing the stationarity of Call Money Rate at first difference



The above figure shows how Call Money Rate (termed as CALLMONRATE1) has become stationary at first difference.

Johansen Cointegration Test

Since all the variables are integrated of the same order, i.e. I(1), we had a hunch that there might be a long-run equilibrium relationship among them. For this, Johansen Cointegration test is done. For cointegration, all the variables are taken at their levels. The result of the cointegration test is shown below:

Table 4.2: Unrestricted Cointegration Rank Test (Maximum Eigen Value)

Hypothesized Number of Cointegrating Equation(s)	Eigen Value	Max-Eigen Statistic	0.01 Critical Value	Prob. **
None *	0.1824	45.3211	39.3701	0.0014
At most 1	0.1221	29.3105	32.7153	0.0297
At most 2	0.0588	13.6483	25.8612	0.3946
At most 3	0.0453	10.4382	18.5200	0.1847
At most 4	0.0158	3.5962	6.6349	0.0579

Maximum Eigen Value test indicates 1 cointegrating equation at the 0.01 level.
* denotes rejection of the hypothesis at the 0.01 level.
** MacKinnon-Haug-Michelis (1999) p-values.

Here, from the obtained result, we find that for ñNoneò, p-value = 0.0014 < 0.01. Thus, we reject the null hypothesis (for ñNoneò) which states the presence of no cointegrating equation, at 1% level of significance (strongest level) and we accept the presence of ñAt most 1ò cointegrating equation at 1% level of significance, since here p-value = 0.0297> 0.01. This indicates that there is 1 cointegrating equation among Mumbai Gold price, BSE SENSEX, transactions in Government Securities, Indian Rupee-US Dollar exchange rate and Call Money Rate at 1% level of significance. In other words, all the markets (Gold, Equity, Government Securities, Foreign Exchange and Money) are cointegrated in India.

Now, we write the Normalized cointegrating equation obtained from the result as:
e ï 3.7818 c ï 0.0134 g + 0.0023 m + 0.0038 s = 0
=>e= 3.7818 c + 0.0134 g - 0.0023 m - 0.0038 s
(3.6224 ***) (6.5199 ***) (2.2929 **) (3.4189 ***)

where e Ÿ monthly average exchange rate of the Indian Rupee vis-à-vis the US Dollar (Rs. per unit of foreign currency), c Ÿ weighted average call money rates (% per annum), g Ÿ secondary market transactions in Government securities (Rs. billion) = outright transactions (Central Government securities + State Government securities + Treasury bills) + repo transactions (Central Government securities + State Government securities + Treasury bills), m Ÿ monthly average price of gold in Mumbai (Rs. per 10 grams), s Ÿ closing monthly average of BSE Sensitive Index (Base : 1978-79 = 100). Note that the figures within the parentheses indicate modulus value of the t-statistics. *** and ** indicate significance at 1% and 5% levels respectively.

We will now explain the Normalized cointegrating equation. From the equation, we can comment that given ceteris paribus, if call money rate increases (decreases) by 1 unit, exchange rate increases (decreases) by 3.7818 units. This implies that they are positively related and the coefficient is significant at 1% level. The implication behind this is that given Indian Rupee-US Dollar exchange rate, if the value of Rupee rises (i.e. exchange rate appreciates), capital inflow will take place in the economy which implies that the supply of funds in the financial market rises, economy then remains cool, leading to a fall in the call money rate. Thus, exchange rate and call money rate are positively related.

Next, from the equation, we can comment that given ceteris paribus, if transactions in Government securities increase (decrease) by 1 unit, exchange rate increases (decreases) by 0.0134 units. This implies that they are positively related and the coefficient is significant at 1% level. The implication is that given Indian Rupee-US Dollar exchange rate, if the value of Rupee falls (i.e. exchange rate depreciates), people like to invest on the safest assets which are Government securities, thereby leading to an increase in their transactions. Thus, exchange rate and transactions in Government securities are positively related.

Again, from the equation, we can comment that given ceteris paribus, if gold price increases (decreases) by 1 unit, exchange rate decreases (increases) by 0.0023 units. This implies that they are negatively related and the coefficient is significant at 5% level. The implication is that given Indian Rupee-US Dollar exchange rate, if the value of Rupee rises (i.e., exchange rate appreciates), value of Dollar relatively falls. Since gold is US Dollar denominated, fall in the value of dollar will lead to an increase in the demand for gold, thereby increasing its price. Thus, exchange rate and gold price are negatively related.

Finally, from the equation we can also comment that given ceteris paribus, if BSE SENSEX increases (decreases) by 1 unit, exchange rate decreases (increases) by 0.0038 units. This implies that they are negatively related and the coefficient is significant at 1% level. The implication is that given Indian Rupee-US Dollar exchange rate, if the value of Rupee rises (i.e., exchange rate appreciates), investors will be attracted to it and they will try to invest in the share market in anticipation of getting a higher return, leading to an increase in the demand for shares and thereby increasing its price. Increase in share price will be represented by the upward movement of the index. Thus, BSE SENSEX (in our case) will rise. Hence, exchange rate and BSE SENSEX are negatively related.

Vector Error Correction (VEC) Model

After Johansen Cointegration Test, Vector Error Correction (VEC) model is executed which checks for short-run adjustments with the possibility of convergence to long-run equilibrium. The existence of a long-run stable relation indicates that the short-run disturbances would eventually get corrected in this system. Hence, corresponding to any cointegration model, there will be an associated error correction model. The variables used are described as follows:

φe_t Ÿ change in monthly average exchange rate of the Indian Rupee vis-à-vis the US Dollar (Rs. per unit of foreign currency) at time period t,φc_tŸ change in weighted average call money rates (% per annum) at time period t, φg_t Ÿ change in secondary market transactions in Government securities

(Rs. billion) at time period t = outright transactions (Central Government securities + State Government securities + Treasury bills) + repo transactions (Central Government securities + State Government securities + Treasury bills), ϕm_t Ÿ change in monthly average price of gold in Mumbai (Rs. per 10 grams) at time period t, ϕs_t Ÿ change in closing monthly average of BSE Sensitive Index (Base : 1978-79 = 100) at time period t

ϕe_{t-1} Ÿ change in monthly average exchange rate of the Indian Rupee vis-à-vis the US Dollar (Rs. per unit of foreign currency) at time period (t-1), ϕc_{t-1}Ÿ change in weighted average call money rates (% per annum) at time period (t-1), ϕg_{t-1} Ÿ change in secondary market transactions in Government securities (Rs. billion) at time period (t-1) = outright transactions (Central Government securities + State Government securities + Treasury bills) + repo transactions (Central Government securities + State Government securities + Treasury bills), ϕm_{t-1} Ÿ change in monthly average price of gold in Mumbai (Rs. per 10 grams) at time period (t-1), ϕs_{t-1} Ÿ change in closing monthly average of BSE Sensitive Index (Base : 1978-79 = 100) at time period (t-1)

The result of the VEC model is shown below considering one month lag:

Table 4.3: Vector Error Correction Estimates

	ϕe_t	ϕc_t	ϕg_t	ϕm_t	ϕs_t
CointEq1	-0.0055 (2.2021**)	0.0297 (3.3115***)	19.9516 (4.7278***)	0.0036 (0.0022)	-1.6310 (0.8182)
ϕe_{t-1}	0.3224 (3.9474***)	1.1675 (4.0203***)	-18.0426 (0.1321)	-45.8074 (0.8616)	-53.0575 (0.8226)
ϕc_{t-1}	-0.0413 (2.1570**)	-0.3936 (5.7772***)	14.6679 (0.4579)	-12.7505 (1.0223)	3.0789 (0.2035)
ϕg_{t-1}	-1.85E-05 (0.4368)	0.0002 (1.2390)	-0.1649 (2.3250**)	-0.0094 (0.3398)	-0.0536 (1.6016*)
ϕm_{t-1}	1.82E-05 (0.1644)	-0.0001 (0.3625)	-0.5918 (3.1950***)	0.0961 (1.3326*)	0.0046 (0.0523)
ϕs_{t-1}	8.89E-06 (0.0894)	0.0009 (2.6110***)	-0.3198 (1.9241**)	0.0537 (0.8302)	0.2533 (3.2264***)

Note that for each differenced variable, the first figure indicates the value of the coefficient and the figures within the parentheses indicate modulus value of the t-statistics. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.

For short-run adjustments with the possibility of convergence to long-run equilibrium, the coefficients of VEC model must be negative and statistically significant. For interpreting the VEC model, we first see the modulus value of the t-statistics of ñCointEq1ò (Cointegrating Equation 1) for each differenced variable (denoted by ϕ) at time period t and check whether it is significant or not. Only if it is significant, we see the sign and value of the coefficient. From the above table, we find that only for exchange rate, 0.0055% of the short-run fluctuations get autocorrected in the long-run (since the value of the coefficient has a negative sign) and also the coefficient is significant at 5% level. For all other variables, no short-run fluctuations are getting autocorrected in the long-run.

V. Conclusion

The objective of our study is to find out whether there is any long-run equilibrium relationship among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India during the period January 1995 to December 2013 using monthly data. The variables representing the corresponding markets are Mumbai gold price, BSE SENSEX, transactions in

Government securities, Indian Rupee / US Dollar exchange rate and call money rate (proxy for interest rate). By empirical Time Series analysis, we have found out that there is a long-run equilibrium relationship among Gold, Equity, Government Securities, Foreign Exchange and Money Markets in India. The inter-linkages among these markets provide an arbitrage opportunity (opportunity to buy an asset at a low price and then immediately selling it in a different market for a higher price) for the investors, resulting in profits without any risk. The inter-linkages confirm the view of law of one price which is based on the assumption that differences between prices are eliminated by market participants taking advantage of arbitrage opportunities. The law of one price exists due to arbitrage opportunities. If the price of a security, commodity or asset is different in two different markets, then an arbitrageur will purchase the asset in the cheaper market and sell it where prices are higher. Another objective of this study is to find out the degree of risk involved while investing on the three financial assets (Gold, Share and Government Securities). By looking at the Descriptive Statistics, we have found out that the variance (risk) of gold > share > Government securities. This implies that investing on gold is riskiest, followed by investing on shares and finally investing in Government securities which is least risky.

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