A study of Market Efficiency In The stock market, Forex market and Bullion market In India

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Market efficiency is an important concern for optimal allocation of scarce resources to most productive purposes and thus contributes to economic growth of a country. The purpose of financial market is to transfer funds between lenders (savers) and borrowers (produces) efficiently. Both borrowers and lenders are better off if efficient marketing system is used to facilitate fund transfer. In an allocatively efficient market, savings are optimally allocated to productive investment in a way that benefits everyone (Ramasastri, 2001:885). Market efficiency is usually used to explain the relation between information and prices of the market (Poshakwale, 1996). In an informational efficient market all information are reflected in the current prices only. It implies that no investors can derive a trading rule based solely on past price pattern to earn abnormal returns. Then it is not possible to predict whether the prices or the market indices would be 'up' or 'down' in the next period, zero return being the best predictor. The term efficiency used in this paper refers to financial market efficiency in three markets - Stock, Forex and Bullion- where prices fully or instantaneously reflect all available relevant information. This means that when stocks/foreign currency /gold /silver are traded, prices are accurate signals for capital allocation (Ibid: 855).

There have been empirical evidences that efficient financial market significantly influences long-term per capita GDP growth of a country. To eliminate the structural weakness in the financial system, there has been rapid liberalization in this system in India since the early nineties. An important question that has been often raised is if these changes can improve market efficiency. The present study, thus, attempts to examine market efficiency of three markets - stock market, forex market and bullion market – in India during the last one-year starting on and from Oct 2003 to Sept 2004.

Policymakers and researchers have greater interest in studying market efficiency of the security market, forex market and bullion market because higher marketing efficiency are favorable for long term per capita GDP growth of a country. During the nineties, there had been several important developments in the Indian financial market. It seems to be useful to study the efficiency of different markets in order to compare the impact of developments on the efficiency of the respective markets. Similarly since the last decade, India has also gradually emerged as an important destination of global investors' investment in the emerging financial markets. But the highly fluctuating nature of such flows has been a matter of concern in Indian capital markets.

The study of market efficiency has been conducted in the past considering only capital market and the forex market. In such studies the bullion markets have been completely ignored.

The growing importance of bullion markets in India may be judged from the fact that RBI has plan to start Gold Exchange for trading in Gold based derivatives. According to Y.V.Reddy, the Deputy Governor of RBI, India imports around 800 tonnes of gold annually. Gold has a share of six percent in the country's total forex reserve of US $53 bullion (Damele et al, 2004:860). The selection of examining the market efficiency of three particular markets in Indian perspective is mainly due to some important factors: Firstly, the process of globalization has started to integrate the Indian capital markets with others financial markets both national and international. The foreign exchange market has taken a center stage with soaring high volume of trade. There is another set of liquid asset that has been popular traditionally apart from these two monetary assets, i.e. the investment in capital market or foreign exchange market. Gold, silver, bullion can also be considered as liquid assets. The bullion market is considered as an adjunct of the capital market and forex market since the funds flow from one market to another (Damele et al, 2004:859-860). Secondly, there has been close integration among these markets due to removal of entry restrictions to various participants during the nineties. Thirdly, the forex, bullion and stock markets are getting integrated because bank is one of the key players of these three markets. Moreover, the stock and forex markets are getting integrated because of the presence of the FIIs (foreign institutional investors) in the stock markets [(Ramasastri et al.2003: 29)]

Considerable research has been done in this area and several techniques have been developed to test market efficiency. For studying the market efficiency in stock market, forex market and call money markets in India one of the pioneering works was done by Ramasastri, Malathy and Sarma(2003). They used Run Tests and Variance Ratio (VR) Tests in order to examine the marketing efficiency in Indian Stock, Forex and Call money markets .It is worth mentioning that without examining the stationary a non- stationary of the time series data, they tested the market efficiency of the three markets. They stressed more on variance ratio tests instead of run tests because, according to them, the variance ratios capture the variation in permanent component of the series or a ratio of total variation and it can be interpreted as a summary statistic involving the autocorrelations up to a reasonably large lag instead of usual autocorrelations tests which consider the lag near zero (ibid: 32-34). They observe that the run tests, which are based on signs of the indices/ rates, do not reject efficient market hypotheses in all the three markets whereas VR Tests rejects the efficient market hypotheses in the case of forex and call money markets. Damale, Karmakar, and Kawadia (2004), based on the study of market integration in the Indian Stock, Bullion, and Forex markets, found some degree of price integration in the three markets. They used distributed lag model, estimates of compound growth rate and coefficient of variation and multiple regression estimates to study market integration between these three markets. But they did not use co- integration test in this regard. They are of the view that co- integration tests do not necessarily indicate market integration. Studies have found that market co-movement can also be

the result of market contagion. 'In a world of asymmetric information about market prices, price changes in one market segment may depend on price changes in another segments through structural contagion coefficients' (Ibid: 861). A study made by Pethe and Karnik (2000) on Indian stock markets and macro-economic variables reveals that there is no long run, stable relationship between stock prices and variables like exchange rate. Ang and Ghallob (1976) found the stock prices to adjust rapidly exchange rate. In an empirical study of the Indian context Bhoj and Dhal (1998) provided reasonable evidence of integration between money market segments, the gilt market segments and exchange market segment. Thus different studies about the integration/market efficiency between different financial markets reflect divergent views on their interrelations in price movements.

The rest of the paper is organized as follows. Section 2 discusses in brief the significant development in three markets – stock, forex and bullion –during the nineties in India. Section 3 presents the data and methodology used in the study. The empirical analysis and the result are given in section 4. Section 5 provides the conclusions of the study.

2. **The Indian Perspective**.

2.1 **Stock Markets:**

The stock markets are the markets in which stock; shares and other long-term commitments are bought and sold. The Indian stock markets witnessed structural transformation during the nineties. To bring in orderliness into the markets, SEBI (Securities and Exchanges Board of India) .was vested with the necessary statuary power in1992. Through various measures, SEBI bought in the required discipline and transparency into the markets. Some of the important measures of them are: i) *Badla system* in Bombay Stock exchange was banned ii) FIIs were allowed to participate in the stock market. iii) Liberalized investment was granted to NRI's. NRI's and Overseas Corporate Bodies were permitted to buy shares and debentures of Indian companies. iv) On-line treading brought markets closer to participants. By the introduction of satellite communication, SEBI gave equal access to all to the trading members of the market. Technology also helped in setting up of depositors, which could reduce settlement lags and risks involved in delays of settlement. All these changes had the potential for influencing market efficiency of the stock markets.

2.2 **Forex market:** Forex markets are the markets in which foreign currency is traded and the exchange rate is determined. Consequent upon the collapse of Bretton Woods Agreement, forex markets started becoming active in the 1970 in the global perspective. Indeed, during the period 1975-1992, exchange rate regime in India was characterized by the daily announcement by the Reserve bank of India (RBI) of its buying and selling rates to the authorized dealers. Dual exchange rate system, which was initiated in March 1992, was in vogue during the transitional stage eventually leading to the ultimate convergence of dual exchange rate in 1993.Base on

demand and supply on the forex market, the unification bought in an era of market determined exchange rate which was also an important milestone in the progress towards current account convertibility that was finally achieved in Aug 1994. A number of measures like interest rate swaps and forward rate agreements have been introduced to facilitate hedging of interest rate risk and orderly development of fixed income derivatives based on the recommendation of the committee on Capital Account Convertibility.

2.3 **The Bullion market:** The bullion market represented by gold and silver has traditionally emerged as an important financial market in India. In keeping with this tradition, RBI closely monitors the global bullion market. As mentioned earlier, India imports around 800 tonnes of gold annually and gold has a share of 6 percent in the countries total forex reserve. The long-term focus of bullion market is on creating an environment conductive for more productive use of gold asset, RBI has also provided the necessary impetus for gold market reform in India by helping in evolving what may be termed as New Gold Policy. RBI's interest in gold may be judged by the fact that gold has characteristics of currency.

3. Data and Methodology

3.1. **Data:** This study tests market efficiency on the basis of daily movement in the prices of stock market, forex market and bullion market during Oct.2003-Sept.2004. As far as stock markets are concerned, Bombay Stock Exchange sensitive index made up of 30 actively traded stocks, called the sensex is considered. Rupee-Dollar exchange rate is considered to see the movement in forex market. Daily prices of gold and silver were considered to represent the bullion market. Sensex, Rupee- Dollar, exchange rate, gold and silver are considered to play a very significant role in the stock, forex and bullion markets respectively in India. (Damele et al, 2004). It needs mentioning that there have been 242 trading days of sensex markets during the last one-year (i.e.Oct.2003-Sept.2004). Out of242 trading days we could collect data for 235 days. However, in keeping with the data for 235 days in the forex market we also consider data for 235 days each for other two markets-stock markets and bullion market. These data were collected from various issues of Economic Times based on the daily closing price data.

3.2. **Methodology:** Before proceeding with the estimation, the time series properties of the data need to be investigated. The basic question to be answered is whether the variables are stationary- a series is stationary if its mean, variance and covariance are independent of time- or non-stationary. The stationarity of the data is important since if non-stationeries characterize time series, the goodness of fit like t-test and F-test are inappropriate because the limiting distribution of the asymptotic variance of the parameter estimates is infinite (Fuller, 1985). For this reason we use both DF and ADF tests for unit root in our study following Fuller (1976).

Next, we attempt to examine market efficiency. Fema (1970) classifies market efficiency into three categories mainly weak form, semi strong form and strong form. A market is considered

weak form efficient if current prices fully reflect all information contained in historical prices. For testing semi strong form efficiency, all publicly available information, both prices and other relevant market information, are used. A market is strong form efficient if price reflect all types of information whether available publicly or privately. In this study we used random walk theory for testing weak form of efficiency. The random walk theory is used to refer to successive price changes, which are independent of each other. In other word, tomorrow's price change (and therefore tomorrow's price) cannot be predicted by looking at today's price change. The existing literature states that the random walk process consists of two implications: a unit root and uncorrelated increments. The unit root test for stationary is the Dicky- Fuller test. A time series that has a unit root is nonstationary and follows a random walk. Lo and Mackinlay (1988) states that one can test random walk hypothesis using a variance ratio test which is sensitive to correlated price changes but which is otherwise robust to may forms of heteroscedasticity and non normality; moreover, unlike unit root test the variance ratio test does not rely on nuisance parameters. Following Ramasastri et al (2003) in addition to Run test, a non-parametric test, and this paper also uses run test to test the market efficiency across the financial markets – stock, forex and bullion-of India considered for our study. A market is said to be efficient if successive price changes (or returns) are independent. Following Ramasastri et al, (2003), two methods-Run Test and Variance Ratio Test –are used to test the market efficiency across the financial markets –stock, forex and bullion- of India considered for our study.

Run Test - A run is defined as a sequence of changes of same sign, preceded and followed by changes of different signs or no sign at all. A run test is performed by comparing the actual number of runs with the expected number of runs on the assumption that successive price changes are independent. If the observed number of runs is not significantly different from the expected number of runs, then it can be inferred that successive price changes are independent. Under the null hypothesis that the series is random (or independent), mathematical expectation of the variable, number of runs, R is

$$\mathbf{E(R)= \{2mn/ (m+n)\} +1}, \ldots..(1)$$ where m=number of '+' signs

n=number of '-' signs.

$$\mathbf{Var(R),=\{2mn(2mn-m-n)\}/\{(m+n)^2 (m+n-1)\}}.....(2),$$ Where Var (R)=Variance of R.

For large m and n (greater than 10), the asymptotic distribution of the random variable, the number of runs, R, is normal and hence the test statistic is, $\mathbf{Z=\{R-E(R)\}/\sqrt{\{var(R)}}$.....(3). Using the standard normal deviate, critical region can be constructed at desired level of significance to test the randomness hypothesis.

Variance Ratio Test- To test the bigness of random walks of GNP, variance ratio tests have been used recently. Variance ratio tests have also been used recently to test the efficiency of different financial markets in India (Ramasastri et al, 2003). Let y_t be a time series satisfying the

following recursive relation: $y_t = a + y_{t-1} + e_t$…..(4).Where a =an arbitrary drift parameter. e_t =random disturbance term(with zero mean, constant variance and zero auto covariance). Under this random walk hypothesis, the variance of y_t increments must grow linearly with the size of interval. That is, variance of $(y_t - y_{t-q}) = (q)$ times the variance of $(y_t - y_{t-1})$. This means that the ratio of (1/q) times the variance of $(y_t - y_{t-q})$ to variance of $(y_t - y_{t-1})$ must be equal to unity. Thus under H_0: variance ratio= 1 against H_1: variance ratio ≠ 1, (Ramasastri et al, 2003) estimates for the variances ratio as

$$\mathbf{VR\ (q) = 1 + \sum_{j=1}^{q-1} \{2\ (q-j)/q\}\ r\ (j)} \ldots\ldots(5).$$ where j = 1,……. ,q-1
r(j) = autocorrelation of order j

The test statistic is $\mathbf{Z} = \dfrac{\sqrt{(nq)}[VR(q) - 1]}{[f(q)]^{1/2}}$ **……(6)** , Where $\mathbf{f(q) = [2(2q-1)(q-1)] / 3q}$

To test the VR (q) =1, at desired level, we used standard normal tables.

Methods to compare degree of Efficiency

Test like runs and variance ratios help us in testing market efficiency but these are not helpful in comparing degree of efficiency of various market for comparing market efficiency in different financial markets average run length and variance ratio graphs are proposed (Lo, 1997, cited in Ramasastri et al, 2003: 32)

Average run length: The runs of longer length indicate a persisting pattern in the movements of the time series. In random series, such longer runs cannot be there very often. If there exists such longer runs, one can suspect that the series under consideration is not random reflecting that market with such price movement is not efficient. Average run length is obtained by dividing the number of observations by the number of runs. Besides the average run length obtained for all runs it would be useful to analyze average run length for only positive runs and negative runs in order to examine whether upward movements are followed by upward movements more frequency or downward movements are followed by downward movements.

Variance ratio graphs*:* variance ratios are calculated for different values of q ranging from 2 to 15. The maximum value of q depends on the type of data on which the ratios are calculated. Variance ratio tests, which take into account a reasonably large lag, are more powerful and hence the results for these tests can be more powerful. However, as there is no any fixed rule for the maximum value of q, this study estimates variance ratio for different values of q from 2 to 15. Using Z statistic their values are used for testing the equality of variance ratio (null hypothesis). It can happen that for some values of q the variance ratios are significantly different from unity whereas for certain other values they are not significantly different from unity. However, there is no summary statistic taking into account the variance ratios for different values of q..

4. Empirical analysis and Results:

4.1. **Result of descriptive statistic and unit root test:** The computed descriptive statistics such as mean, standard deviation, skewness, kurtosis, range and coefficient of variation 0f three markets during Oct 2003 – Sept 2004 shows that the movement of price of silver exhibits a high degree of volatility followed by sensex and gold whereas forex market exhibits a low degree of volatility (Table-1). In order to test stationarity of the given time series of individual price variables of three markets we consider unit root (Dickey Fuller) test in the level form (Table –2). The DF test statistic at the level form shows that the null hypothesis of existence of unit root are not rejected at 5% level of significance implying all series are non-stationary. The ADF test statistics at the level form (Table-3) shows that the null hypothesis of existence of unit root are not rejected at 5% level of significance implying all series are non-stationary. We find that in the level form all price series –sensex, forex, gold and silver- are non-stationary. We now seek to examine the order of stationary of the data; first we examine the first difference of price series in order to test whether the price series are 1(1). The results of first difference form are shown in Table-4 (DF test) and Table-5 (ADF test). Both DF and ADF tests show that the null hypothesis of the existence of unit root are rejected at 5% level of significance implying all price series (sensex, forex, gold and silver) are 1(1). The ADF test is performed against MacKinnon critical values. It needs mentioning that in our analysis we use Akaike Information Criterion (AIC) to determine the length of lag. The results show that the optimum lag length is equal to 2 in each case.

4.2. Result for Run and variance ratio Test: Table-6 shows the Z – Values for Runs Tests on Sensex , Forex , and Bullion markets (Gold and Silver) for the period Oct 2003- Sep – 2004. Comparing the calculated Z values with the critical value of Z, we cannot reject the null hypothesis that Sencex,Forex,Gold and Silver prices of India were efficient. Variance ratio and Z-values for VR Tests on Sensex, Forex, and Bullion markets (Gold and Silver) for the period Oct 2003- Sep – 2004 are presented in Table-7. Autocorrelations of order q are calculated for values of q from 2to 15 are estimated using the equation (5). Variance ratios VR (q), for lag q ranging from 2 to 15 are estimated. Corresponding z-Values are also calculated. Table-7 gives the estimated value of VR for lags 2 to 15 along with calculated Z –Values. Comparing the calculated Z-Values with the critical value of Z, we can not reject the null hypothesis that Indian Stock markets, Forex markets; Silver markets were efficient in Oct 2003-Sept 2004. But, variance ratio does reject market efficiency in Indian Gold markets.

4.3.Average Run Length Analysis and Variance Ratio Graphs: Table-8 gives the average run length for all runs, positive runs and negative runs for Sensex, Forex, and Bullion markets (Gold and Silver) for the period Oct 2003- Sep – 2004. It can be inferred from Table-8 that

1) Average run length for all runs relating to the three markets ranges between 2.12 and 2.40. The highest average runs are occupied by Gold and lowest by Sensex.

2) Average run length for positive runs to the Gold (2.65) and Silver (2.64) markets are higher than the average run length for positive runs relating to other two markets.

3) Average run length for negative runs relating to the forex market at 2.11 is higher than the average run length for negative runs relating to other markets.

4) As regards average run length for all runs it can be said that as Gold exhibits longer run than the average run of other three markets. Gold can thus be considered to be less efficient. This is also true to the average run length for positive runs. On the other hand, sensex is observed to retain greater degree of efficiency compared to other markets.

The variances ratios graph (Figure-1) shows that the lines corresponding to stock markets, forex markets and silver markets run very close to the line corresponding to random series, which itself runs close to unity. The line corresponding to gold markets runs further away from the unity. The graph clearly brings out that that the silver markets have a greater degree of efficiency followed by sensex and forex. The line corresponding to Gold runs furthers away from unity. So Gold is observed to be the inefficient market compared with other markets under our study.

Conclusion:

Our study suggests that, run test, which are based on signs of indices / rates, do not reject efficient market hypothesis in the case of all the three markets, whereas VR tests, which capture the variation in permanent component of the series as a ratio to the total variation, reject the efficient market hypothesis in the case of the gold markets. Efficient market hypothesis in the case of Stock markets, Forex markets and Silver markets cannot be rejected based on VR tests. Since VR tests are more powerful than the run tests, it can be inferred that stock markets, forex markets and silver markets were efficient compared with gold markets during Oct 2003 - Sept. 2004.

Average run length analysis for all runs and positive runs indicate that the stock markets have a greater degree of efficiency than other markets. VR graph shows that the silver markets followed by stock markets and forex markets have greater degree of efficiency than gold market. Gold is observed to be the inefficient market compared with other market because the VR graph corresponding to gold markets runs further away from the unity.

The above findings have interesting implication for policy. Absence of a large number of participants to influence movement in the prices can be the reasons for lower degree of efficiency in the Gold market. This might play an adverse effect in promoting industrialization and growth in our country in the long run. Thus while formulating appropriate policies, it may be of concern to policy makers to improve the efficiency of gold market by increasing the number of participants.

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Table – 1 Descriptive Statistics of Stock, Forex and Bullion Markets during Oct 2003 – Sept 2004.

	Sensex	Forex	Gold	Silver
Mean	5302.50	45.46	5989.4	9838.03
S.D.	429.91	0.6309	192.70	1007.68
Skew ness	0.1704	-0.9031	-0.9167	0.084
Kurtosis	-1.1907	1.1611	2.4791	-0.479
Range	1740.87	2.93	1415	4295
Minimum	4453.24	43.54	4945	7975
Maximum	6194.11	46.47	6360	12270
Coefficient of variation	8.1076	1.3878	3.2175	10.24
Number	235	235	235	235

Table - 2: Unit root Test (D-F Test) in the level form:

	Sensex	Forex	Gold	Silver
DF Statistic a) (Intercept but not a trend)	-2.2172	-1.378	-4.173	-1.548
Critical value at 5%	-2.874	-2.874	-2.874	-2.874
b) Intercept and a linear trend	-2.2560	-1.776	-4.616	-1.616
Critical value at 5%	-3.4302	-3.430	-3.430	-3.430

Note: The DF test statistics shows that the null hypothesis of existence of unit root are not rejected at 5% level of significance implying all series are non-stationary.

Table - 3: Unit root Test (ADF Test) in the level form:

	Sensex	Forex	Gold	Silver
ADF Statistic a) (Intercept but not trend)				
ADF (1)	-2.085	-1.726	-2.735	-1.873
ADF (2)	-1.916	-1.794	-2.070	-1.776
ADF (3)	-1.963	-1.816	-1.855	-1.826
Critical value at 5%	-2.874	-2.874	-2.874	-2.874
b) Intercept and a linear trend				
ADF (1)	-2.129	-1.726	-2.964	-1.836
ADF (2)	-1.967	-1.794	-2.255	-1.671
ADF (3)	-2.008	-1.816	-2.028	-1.765
Critical value at 5%	-3.430	-3.430	-3.430	-3.430

Note: The ADF test statistics shows that the null hypothesis of existence of unit root are not rejected at 5% level of significance implying all series are non-stationary.

Table-4: DF Test for unit root in the first difference form

DF statistic	Sensex	Forex	Gold	Silver
(A) Intercept but not a trend (B)	-14.276	-14.484	-24.313	-4.128
Critical value	-2.8741	-2.8741	-2.8741	-2.8741
(B) Intercept and a linear trend	-14.265	-14.459	-24.261	-14.128
Critical value	-3.4304	-3.4304	-3.4304	-3.4304

Table-5: ADFTest for unit root in the first difference form

	Sensex	Forex	Gold	Silver
ADF Statistic a) (Intercept but not trend)				
ADF (1)	-12.189	-10.119	-16.996	-11.429
ADF (2)	-9.019	-8.348	-12.644	-8.634
ADF (3)	-6.638	-6.320	-10.040	-6.153
Critical value at 5%	-2.874	-2.874	-2.874	-2.874
b) Intercept and a linear trend				
ADF (1)	-12.192	-10.103	-16.959	-11.442
ADF (2)	-9.028	-8.335	-12.616	-8.654
ADF (3)	-6.6453	-6.306	-10.017	-6.174
Critical value at 5%	-3.430	-3.430	-3.430	-3.430

Table—6. Z – Values for Run Tests 0n Sensex , Forex, Gold and Silver for the period Oct 2003- Sep – 2004.

Market	Z-Value
Sensex	-0.726
Forex	0.469
Gold	-1.169
Silver	-0.583

Note : The critical value of Z at 95% confident is 1.96 .

Table –7 :Variance Ratios and Z –Values for stock , Forex and Bullion markets

	Sencex		Forex		Gold		Silver	
q	VR(q)	Z-Value	VR(q)	Z-Value	Var(q)	Z-Value	Var(q)	Z-Value
2	1.03	0.16	1.04	0.22	0.52	-2.62	1.06	0.33
3	0.85	-0.68	0.99	-0.05	1.18	0.81	0.88	-0.43
4	0.87	-0.54	0.98	-0.08	1.34	1.40	0.89	-0.46
5	0.94	-0.24	0.86	-0.55	1.48	1.89	0.97	-0.12
6	0.90	-0.38	1.07	0.27	1.58	2.23	1.06	0.23
7	0.92	-0.30	1.08	0.30	1.81	3.04	1.04	0.15
8	0.87	-0.48	1.03	0.11	1.71	2.63	1.00	0
9	0.86	-0.51	1.02	0.07	1.76	2.78	0.99	-0.04
10	0.85	-0.54	1.35	1.26	1.80	2.90	1.02	0.07
11	0.85	-0.54	1.20	0.72	1.86	3.10	1.02	-0.07
12	0.78	-0.79	1.04	0.14	1.86	3.08	0.87	-0.47
13	0.88	-0.43	1.02	0.07	1.88	3.13	0.82	-0.64
14	0.87	-0.46	1.01	0.04	1.86	3.05	.097	-0.11

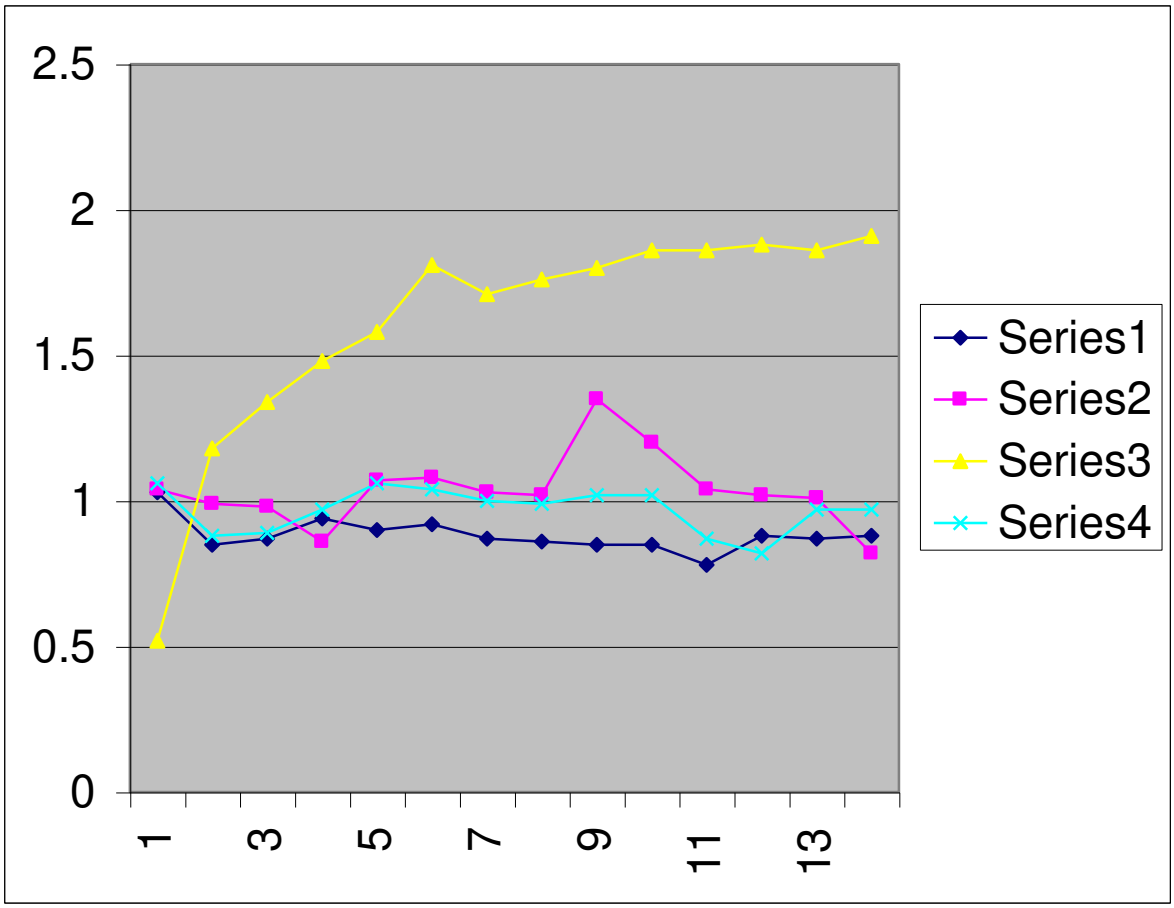
15	0.88	-0.42	0.82	-0.64	1.91	6.74	0.97	-0.11

Note :-- The critical value of Z at 95% confidence is 1.96 .

Table –8:--Average Run Lengths for four markets during Oct 2003- Sept-2004

Market	All runs	Positive runs	Negative runs
Sensex	2.12	2.38	1.86
Forex	2.20	1.85	2.11
Gold	2.40	2.65	1.84
Silver	2.26	2.64	1.69

Figure – 1: Variance Ratio Graph



Note: Series 1 = Sensex; Series 2 = Forex; Series 3 = Gold; Series 4 = Silver