Stock Price Dependency in Indian Capital Market: An Explanation at Aggregated and Disaggregated Levels

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Several significant policy initiatives that have been initiated in recent years to refine the microstructure of the Indian capital market and modernize its operations with the intention of realizing informational efficiency helped to produce positive outcomes, at least up to a reasonable level. Still, several researchers and stock market analysts have argued that stock price movements in India does not obey random walk hypothesis, thereby questioning the capital market efficiency in Indian context. This supports the claim that extra normal return can be earned by trading on winner stocks selected with the help of suitable technical analysis tools. This argument of capital market efficiency, which has been a hot issue of debate among financial analysts and researchers for the past five decades, needs to be investigated.

The present paper is the outcome of an investigation made to see the empirical validity of random walk hypothesis in Indian stock market by using the most recent data. The paper is organised into five sections. The first section discusses the capital market efficiency and random walk hypotheses. The second part deals with the literature review. While the third section narrates the data and methodology aspects, the fourth throws light on results and discussion. The last and final section gives a conclusion.

1) THE CAPITAL MARKET EFFICIENCY AND RANDOM WALK HYPOTHESIS

The capital market efficiency, formally termed as the efficient market hypothesis (EMH), implies that security prices reflect all available information and that the prices adjust immediately to new information. Various capital market theories have been developed under the assumption that stock markets are efficient and information is available to all investors freely and instantaneously. The EMH has very strong implications in stock market analyses, especially in the technical analysis of security trading. Under EMH, all efforts to identify winners from a universe of stocks trading in a stock market with the objective of consistently making abnormal profits over a period becomes worthless.

The concept of EMH has historically been classified into three categories on the basis of the type of information set that it refers. If the information set considered refers to the historical prices of securities, it is called 'weak form of market efficiency', if it refers to all publicly available information, it is called 'semi-strong form of market efficiency' and finally if it refers to all information, both public and private, it is called 'strong form of market efficiency'. Of these, weak form of market efficiency is usually examined by testing the random walk hypothesis (RWH). Mathematically, a random walk refers to the path of a variable over time that exhibits no predicable pattern at all. Thus in a random walk model, the successive price changes are independent so that their changes cannot be predicted by analysing past price changes.

Researchers have applied several statistical tools for testing the validity of RWH. This includes the non-parametric Run Test, Bartlett's Z test for the significance of autocorrelation function, Ljung-Box test for testing the joint hypothesis that all autocorrelation coefficients are simultaneously zero, Dickey-Fuller Unit Root Test and the Variance Ratio Test. It has been proved that the 'Variance Ratio Test' of Lo and Mackinlay (1988) is more powerful than the other tests discussed (Lo and Mackinlay, 1989; Ayadi and Pyun, 1994). Also, the variance ratio test takes into account the possible hetroscedasticity in the disturbance term.

The objective of the present research is to examine the validity of RWH in India by using variance ratio test so that the influence of hetroscedasticity in the results of the empirical tests of RWH is distinguished. This has been done at the disaggregated level by using daily closing prices of a sample of individual securities and at the aggregated level by using closing price series of four popular stock market indices of national stock exchange (NSE).

2) EMPIRICAL EVIDENCE

Empirical results from the developed as well as developing markets have produced mixed results. Some of the important works that support RWH in developed capital markets include Kendall (1953), Moore (1964), Fama (1965), Jenson and Benington (1970), Dryden (1970) and Rosental (1983). While Kendall (1953) found that the theory of random walk is applicable in the British Stock Exchange based on the behaviour of prices of securities traded, Moore (1964), in his study on New York Stock Exchange, found that individual securities conformed to the theory of random walk but the index did not. He argued that since index is expected to reflect the overall changes in the economy non-randomness, it is not surprising but expected. Other studies also supported RWH.

Several departures from random walk have also been reported from these markets in the late 1980s. Rosenberg et al (1985)

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found serial dependence in the monthly returns in the common stocks of the US markets for the period between January 1973 and December 1980, and hence rejected RWH. DeBondt and Thaler (1985) introduced the concept of mean reversion, a phenomena of price reversal following an over reaction of the market to new information, which is against the random walk hypothesis. Lo and Mackinlay (1988) rejected random walk hypothesis based on weekly returns of NYSE stocks.

A study from Singapore stock market by Hong (1978) found that EMH is applicable there in its weak form. But Ghandi et al (1980) on Kuwait stock market, Wong and Kong (1984) on Hong Kong, Barnes (1986) on Kula Lumpur stock market and Butler and Malakah (1992) on Saudi Arabian stock market found evidence of inefficiency. Ayadi and Pyun (1994) showed the applicability of random walk model in Korean market. In the study made by Kok and Goh (1994) for the Malaysian stock market, it pointed out that random walk is followed there in the long run.

In India also the issue of efficient market hypothesis has been researched over a long period. Krishna Rao and Mukerjee (1971); Barua (1981); Ramachandran (1985); Gupta (1989); Vaidyanathan and Gali (1994) have reported strong supporting evidence that stock prices in India move like a random walk.

Barua and Raghunathan (1987) based on actual returns by following different strategies report that Indian capital market is inefficient in pricing its securities. Obaidullah (1992) examined whether the investment performance of securities in Indian capital market is related to their price-earning ratios. He concludes that the stock price adjustments to earnings information are biased and inaccurate, hence efficient market hypothesis is not valid in Indian capital market during the study period. Madhusoodanan (1995) examined the existence of winner-looser effect suggested by De Bondt and Thaler in Indian capital market and found that the strategy of purchasing looser shares and short selling winner shares can generate excess return in Indian capital market, and this is against the theory of market efficiency. Madhusoodanan (1998) using variance ratio test on weekly data of 120 stocks and two indices, BSE SENSEX and BSE National Index, argued that random walk hypothesis could not be accepted in India for the period January 1987 to December 1995.

Pant and Bishoni (2001) examined weak form of EMH by using variance ratio test on Sensex, Nifty, S&P CNX 500, BSE-100 and BSE-200 for the period from 23, April 1996 to 7, June 2001 and rejected random walk hypothesis for both daily and weekly returns. Nath and Reddy (2002) show that there exists apparent trends in the movements of NSE Nifty during the period July 1990 to November 2001, which are against the efficient market hypothesis. Ahammed, Ashraf and Ahmed (2006) used daily return data on NSE Nifty and BSE Sensex for a period of 4 January, 1999 to 30 August, 2004 to examine the validity of random walk hypothesis. Applying various statistical tests such as unit root tests, Ljung-Box test, GARCH Model and the run test, they arrived at the rejection of the random walk hypothesis.

It is of interest to note that the recent studies have rejected the validity of RWH. What is more important is that these recent studies that had rejected RWH have used data on aggregate level market indices for their analysis. It is in this background, the present work is designed in such a way as to examine the validity of RWH both at the aggregate level as well as at the disaggregate level.

3) DATA AND METHODOLOGY

The data employed in the present study consists of daily closing prices of fifty sample companies and four market indices namely, CNX Nifty, Nifty Junior, CNX Midcap and CNX 500 for the period 1st January, 2001 to 23rd November, 2007. The fifty sample companies having continuous data points during the period of study, were selected from the CNX 500 list by using simple random sampling method. The CNX 500 list represents about 92.66 percent of the total market capitalization and about 86.44 percent of the total turnover in NSE. It contains 72 industries, including one category of diversified companies and one category of miscellaneous. The daily closing prices of the sample companies and the indices were taken from the official website of the national stock exchange (www.nseindia.com). The prices of the sample securities were adjusted for stock splits and bonus issues and then converted into return series by using the continuous compounding formula

$$R_t = \ln P_t - \ln P_{t-1} \tag{3.1}$$

where P_t denote the closing price for the day t.

The methodology used for the testing of RWH is the 'Variance Ratio Test' of Lo and Mackinlay. But, before conducting this specific test, first we compute the autocorrelation coefficients of the return series up to the lag 30 and examine their significance by using Bartlett's Z statistic[1] and Ljung-Box statistic[2]. This provides an idea of the serial dependence of the return series under the homoscedastic assumption. We then apply the variance ratio test under both the homoscedastic and hetroscedastic assumptions.

3.1 Variance Ratio Test

The variance ratio test for the random walk hypothesis developed by Lo and Mackinlay (1988) takes into account the possible hetroscedasticity in the disturbance terms. Let $\{Y_t\}$ denote a time series satisfying the following recursive relation

$$Y_t = \mu + Y_{t-1} + U_t \tag{3.2}$$

where μ is the arbitrary drift parameter and the random disturbance term U_t have mean zero, constant variance and non-auto correlated. Under the assumption that the increments are uncorrelated, (3.2) is a random walk with drift parameter m. Lo and Mackinlay (1988) stated that under random walk hypothesis, the variance of Y_t increments should grow linearly with the size of the interval. This means that under RWH the variance of (Y_t-Y_{t-q}) must be same as q times the variance of (Y_t-Y_{t-1}). Mathematically this relationship can be expressed by the following equation

$$\frac{V(Y_t - Y_{t-q})}{qV(Y_t - Y_{t-1})} = 1 \qquad (3.3)$$

As long as increments are uncorrelated, this relationship holds asymptotically even in the presence of hetroscedasticity. If Y_0, Y_1, Y_2, …, Y_{nq} denote the natural logarithm values of the stock prices of a stock for nq+1 periods, the q period variance ratio of the return series is defined as

$$VR(q) = \frac{\sigma^2(q)}{q\sigma^2(1)} \qquad (3.4)$$

where $\sigma^2(q)$ is the unbiased estimator of the variance of the q^{th} difference of the Y values and $\sigma^2(1)$ is an unbiased estimator of the variance of the 1^{st} difference of the Y values. Cochrane (1988) has shown that this variance ratio is asymptotically equivalent to

$$VR(q) = 1 + \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q} \right] \hat{\rho}_j \qquad (3.5)$$

where $\hat{\rho}_j$ is the estimator of the j^{th} autocorrelation coefficient of the return series.

Lo and Mackinlay proposed a standardized Z statistic for testing H_0: $VR(q) = 1$ under the assumption of homoscedasticity as given below

$$Z(q) = \frac{\sqrt{nq}\,[VR(q) - 1]}{\sqrt{\phi(q)}} \sim N(0,1) \qquad (3.6)$$

where

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q} \qquad (3.7)$$

They revised the test statistic for the test under hetroscedasticity as

$$Z^*(q) = \frac{\sqrt{nq}\,[VR(q) - 1]}{\sqrt{\phi^*(q)}} \sim N(0,1) \qquad (3.8)$$

where $\phi^*(q)$ is the asymptotic variance of the variance ratio that is consistent with the assumption of hetroscedasticity. A consistent estimate of $\phi^*(q)$ is given by

$$\phi^*(q) = \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q} \right]^2 \delta(j) \qquad (3.9)$$

where

$$\delta(j) = \frac{(nq) \sum_{t=j+1}^{nq} (Y_t - Y_{t-1} - \mu)^2 (Y_{t-j} - Y_{t-j-1} - \mu)^2}{\sum_{t=1}^{nq} (Y_t - Y_{t-1} - \mu)^2} \qquad (3.10)$$

These two test statistics, $Z(q)$ and $Z^*(q)$, are used to test the RWH under the assumption of homoscedasticity and hetroscedasticity respectively.

4) RESULTS AND DISCUSSION

4.1 Results of the Aggregate level Tests

For the aggregate level study, the price movements of four market indices have been analyzed. We have calculated autocorrelations up to the lag 30 and examined their statistical significance by using Bartlett's Z test and Ljung- Box test. The results of these tests are presented in Table 1.

It can be seen that for all the indices, the autocorrelation function (ACF) of lag 1 is significantly positive and the ACF of lag 2 is significantly negative at five percent level. This can be considered as evidence in favour of the serial dependence of the price series and is against the RWH. The positive significance of ACF of lag 1 indicates that in general, a price increase/decrease on a particular day is followed by a price increase/ decrease in the following day. Similarly the negative ACF of lag 2 indicates that the price movements in a particular direction on a day produce a reversal after two days on an average. This can be interpreted as a result of the overreaction of the investors to the information and the corresponding reversal. Owing to the influence of the ACF of the first two lags, the Ljung- Box statistic were obtained as significant for all the lags. Hence, the primary evidence from the aggregate level analysis reveals that the price movements of the four major market indices are serially dependent and this is against the RWH.

Table 1
Auto Correlation and Ljung-Box LB Statistics

	NIFTY		NIFTY JUNIOR		CNX MIDCAP		CNX 500	
Lag	**ACF**	**LB**	**ACF**	**LB**	**ACF**	**LB**	**ACF**	**LB**
1	0.09*	14.60*	0.18*	56.03*	0.18*	58.58*	0.14*	33.75*
2	-0.09*	30.23*	-0.09*	70.57*	-0.09*	73.61*	-0.10*	49.79*
3	0.01	30.56*	0.02	71.54*	0.03	75.60*	0.01	50.08*
4	0.07*	39.63*	0.07*	79.32*	0.11*	95.50*	0.09*	64.06*
5	0.02	40.20*	0.03	80.49*	0.04	98.19*	0.03	65.17*
6	-0.05*	44.25*	-0.06*	86.13*	-0.03	100.01*	-0.04	68.19*
7	-0.04	46.64*	-0.04	88.92*	-0.04	102.53*	-0.02	69.17*
8	0.00	46.66*	-0.01	89.17*	-0.01	102.58*	-0.01	69.31*
9	0.04	49.24*	0.05*	94.19*	0.03	103.83*	0.03	71.04*
10	0.07*	57.35*	0.09*	109.91*	0.06*	111.10*	0.07*	79.00*
15	-0.02	74.43*	0.00	137.74*	0.01	138.06*	-0.02	99.97*
20	-0.06*	85.75*	-0.05*	147.29*	-0.06*	146.96*	-0.06*	111.69*
25	-0.01	91.93*	0.01	148.27*	0.00	148.04*	0.00	115.34*
30	-0.06*	102.80*	-0.05*	156.31*	-0.07*	160.00*	-0.06*	125.27*

*Significant at 5% level

The variance ratio tests were also conducted up to the lag 30 and the results are provided in Table 2. The table provides the values of the variance ratios and the values of the corresponding test statistics under the homoscedastic and hetroscedastic assumptions. For the most popular index Nifty, the variance ratio for lag 2 was found to be significantly different from one under the homoscedastic as well as hetroscedastic assumptions. The variance ratios for all the remaining higher lags of Nifty were not significantly different from one under both these assumptions. For the other three indices under the homoscedastic assumption, the test statistics were obtained as significant for all lags upto 30, and when the test statistic is adjusted for hetroscedasticity, it became insignificant at five percent level in all the cases except in the case of the variance ratio of lag 2 of CNX Midcap.

Table 2
Results of Variance Ratio Test (Aggregate Level)

q	NIFTY			NIFTY JUNIOR			CNX MIDCAP			CNX 500		
	V (q)	Z (q)	Z*(q)	V (q)	Z (q)	Z*(q)	V (q)	Z (q)	Z*(q)	V (q)	Z (q)	Z*(q)
2	1.09	3.818*	3.050*	1.18	7.479*	1.70	1.18	7.647*	2.327*	1.14	5.805*	1.32
3	1.07	1.84	1.47	1.19	5.316*	1.21	1.20	5.580*	1.70	1.13	3.583*	0.82
4	1.05	1.20	0.96	1.20	4.381*	1.00	1.21	4.663*	1.42	1.12	2.745*	0.63
5	1.08	1.44	1.15	1.23	4.333*	0.99	1.26	4.919*	1.50	1.16	2.974*	0.68
10	1.08	1.03	0.82	1.25	3.131*	0.71	1.35	4.355*	1.33	1.20	2.517*	0.57
15	1.14	1.38	1.10	1.35	3.466*	0.79	1.44	4.321*	1.32	1.28	2.756*	0.63
20	1.18	1.53	1.22	1.48	3.99*1	0.91	1.55	4.591*	1.40	1.35	2.884*	0.66
25	1.20	1.49	1.19	1.55	4.092*	0.93	1.61	4.503*	1.37	1.37	2.774*	0.63
30	1.20	1.37	1.09	1.58	3.889*	0.89	1.60	4.075*	1.24	1.39	2.593*	0.59

*Significant at 5% level

The significance of the variance ratio test statistic for lag 2 of the Nifty and CNX Midcap series under both the homoscedastic and hetroscedastic assumptions can be considered as a clear evidence of non-randomness in the movements of these indices. As this non-randomness disappears beyond lag 2 (for Nifty under both assumptions and for CNX Midcap under hetroscedasticity), the reason for this non-randomness may be the overreaction of the investors to new information. For the other indices, as the test statistic became insignificant at five percent level (when it is adjusted for hetroscedasticity), the observed non-random behaviour in the movements is to be interpreted as not because of genuine autocorrelation, but because of spurious correlation and the influence of hetroscedasticity of the disturbance term.

4.2 Results of the Disaggregate Level Tests

The procedure adopted for the aggregate level analysis is repeated at the disaggregated level on the sample companies. The results of the autocorrelation analysis done by using the Bartlett's test and Ljung- Box test are summarized in Table 3. The table provides a number of significant autocorrelation functions and the LB Statistics. Of the total 50 sample securities, 24 autocorrelations of lag 1 and 24 autocorrelations of lag 2 are found significant. The number of significant LB statistics lies between 24 and 35 (in the case of lag 1 and lag 2 respectively). Thus the analysis by using ACF indicates the existence of non-randomness in a large number of sample stocks. The phenomena of overreaction of the investors to information and the corresponding reversal observed in the aggregate analysis is not visible in the disaggregated analysis. Though it is observed that 42 securities bear the property that the ACF of lag 1 is positive and ACF of lag 2 is negative, only 12 of them have significant autocorrelation functions.

Table 3
Number of Significant Autocorrelation Functions and LB Statistics

Lag	ACF	LB statistics	Lag	ACF	LB statistics	Lag	ACF	LB statistics
1	24	24	**11**	6	30	**21**	1	27
2	24	35	**12**	8	30	**22**	2	30
3	3	31	**13**	5	27	**23**	1	30
4	8	32	**14**	9	33	**24**	4	31
5	5	30	**15**	4	31	**25**	2	29
6	6	30	**16**	7	31	**26**	3	28
7	6	30	**17**	6	31	**27**	4	29
8	8	30	**18**	4	32	**28**	6	27
9	2	29	**19**	3	29	**29**	7	27
10	12	31	**20**	6	29	**30**	7	29

The results of the variance ratio test conducted at the disaggregated level (Appendix 1) are summarized as follows. The sample companies are divided into three categories, companies exhibiting perfect random character (with insignificant test statistics for all the variance ratios), companies exhibiting the overreaction behaviour (with significant test statistic in the first case alone), and the rest. These statistics are provided in Table 4. From the table we can see that 44 per cent of the sample companies exhibit perfect random behaviour, 32 per cent exhibit non-random behaviour due to overreaction and remaining 24 percent non-random behaviour due to other reasons under the homoscedastic assumption. But, when the test statistic is adjusted for hetroscedasticity, 82 percent of the sample companies are found to be obeying RWH, the overreaction behaviour disappeared from the data and the remaining 18 per cent does not obey RWH.

Table 4
Significance of Variance Ratios

	As per Z (q)		As Per Z*(q)	
	Number	Percentage	Number	Percentage
All Insignificant	22	44	41	82
First Alone Significant	16	32	0	0
Rest	12	24	9	18

Thus, the results of the variance ratio tests at the disaggregate level support RWH in India during the period of study. Under homoscedastic assumption itself, 44 percent of the sample securities obey RWH and when the test statistic is adjusted for hetroscedasticity, the percentage of the sample companies obeying RWH increased to 82 percent. This leads to the conclusion that the observed non-randomness in the autocorrelation analysis cannot be considered as genuine, but it is there because of the influence of the hetroscedasticity present in the data.

The results of the present study seem to be different from the findings of previous Indian studies such as Madhusoodanan (1998) and Pant and Bishoni (2001). These two studies used data prior to 2001 and found variance ratios as significant under both homoscedastic and hetroscedastic assumptions, and hence, it is concluded that the RWH cannot be accepted under both these assumptions. The present study, by using daily data on both aggregate and disaggregate level for the period 2001 to 2007, found that the test statistics which were significant under homoscedastic assumptions became insignificant when adjusted for hetroscedasticity in a majority of the cases considered. This indicates that in India, the observed stock price dependency on the past price data is not because of the real autocorrelations but because of the spurious correlation and because of the presence of hetroscedasticity.

5) CONCLUSION

The results of aggregate level analysis obtained by applying the technique of variance ratios under the assumptions of homoscedasticity and hetroscedasticity indicate the existence of non-randomness in the movements of Nifty. As against this, the results of disaggregate level analysis is found to be supporting the existence of random walk hypothesis in India, when the test statistic is adjusted for hetroscedasticity. This indicates that the appearance of stock price dependency on the past price data in Indian bourses is not real as claimed by a section of analysts, but is present because of the presence of hetroscedasticity. The behaviour of the Nifty movements needs a special mention as it exhibits apparent non-randomness under both homoscedastic and hetroscedastic assumptions. Nifty being the most popular stock market index in India should reflect the overall changes in the economy. Borrowing the arguments of Moore (1964), it can be aptly remarked that "the non-randomness observed is not surprising but to be expected".

To conclude, the results of the present study do not reject the scope for technical analysis in security trading as it has not investigated the existence of inefficiency in its other forms. Suitable technical tools will definitely help the traders to fetch extra normal return by exploiting the inefficiency, if it exists. However, a genuine investor, who is aiming at earning long-term capital gain, need not be much bothered about the technical analysis because the results of the study have shown that the Indian capital market is efficient at least in its weak form.

NOTES

1. Bartlett (1946) provided a simple Z statistic for testing the statistical significance of sample autocorrelation coefficient $\hat{\rho}_k$. According to him, for large samples, under the null hypothesis of serial independence

$$Z = \frac{\hat{\rho}_k}{1/\sqrt{n}}$$

where $\hat{\rho}_k$ denotes the sample autocorrelation coefficient of lag k and n the sample size, follows standard normal distribution. Hence, a significant Z value indicates the dependence of the underlying series.

2. Ljung-Box statistic of Ljung and Box (1978) tests whether a group of autocorrelation coefficients are simultaneously equal to zero. Hence the random walk hypothesis can be tested by computing autocorrelation function of the return series of different lags and then testing the joint hypothesis that all the auto correlation coefficients are simultaneously equal to zero up to a reasonable lag. The proposed test statistic is given by

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^{\,2}}{n-k}\right)$$

Under the null hypothesis, $H_0 : \rho_1 = \rho_2 = ... = \rho_m = 0$ the *LB* statistic asymptotically follows Chi square distribution with m degrees of freedom. A significant *LB* value leads to the rejection of the null hypothesis.

Appendix 1

Results of Variance Ratio Test (Disaggregate Level)

	q	2	3	4	5	10	15	20	25	30
ABB	V(q)	1.07	1.09	1.10	1.12	1.14	1.14	1.14	1.12	1.09
	Z(q)	2.80*	2.47*	2.21*	2.31*	1.70	1.41	1.14	0.89	0.60
	Z*(q)	2.04*	1.80	1.61	1.68	1.24	1.03	0.83	0.65	0.44
ACC	V(q)	1.00	0.94	0.91	0.91	0.93	0.94	0.94	0.93	0.99
	Z(q)	0.18	-1.63	-2.04*	-1.80	-0.88	-0.60	-0.47	-0.50	-0.09
	Z*(q)	0.10	-0.84	-1.05	-0.93	-0.45	-0.31	-0.24	-0.26	-0.05

	q	2	3	4	5	10	15	20	25	30
AMTEK	V(q)	1.02	1.01	1.01	1.02	1.03	1.06	1.09	1.10	1.11
	Z(q)	0.65	0.37	0.27	0.33	0.37	0.60	0.75	0.73	0.74
	Z*(q)	0.42	0.24	0.18	0.21	0.24	0.39	0.49	0.47	0.48
ASIAN PAINTS	V(q)	0.92	0.89	0.88	0.84	0.73	0.68	0.63	0.60	0.54
	Z(q)	-3.51*	-3.048	-2.66*	-2.97*	-3.28*	-3.09*	-3.07*	-2.96*	-3.10*
	Z*(q)	-3.50*	-3.03*	-2.66*	-2.96*	-3.27*	-3.08*	-3.06*	-2.95*	-3.09*
BAJAJ AUTO	V(q)	1.04	1.04	1.04	1.04	1.09	1.10	1.13	1.14	1.13
	Z(q)	1.79	1.10	0.84	0.68	1.05	1.02	1.07	1.06	0.91
	Z*(q)	1.61	0.99	0.76	0.61	0.95	0.92	0.97	0.96	0.82
BALRAMPUR	V(q)	1.03	1.00	0.98	0.98	1.04	1.12	1.19	1.21	1.20
	Z(q)	1.32	-0.13	-0.49	-0.32	0.53	1.19	1.55	1.59	1.37
	Z*(q)	2.33*	-0.22	-0.86	-0.56	0.93	2.09	2.73	2.79	2.41
BHEL	V(q)	1.03	0.98	0.96	0.96	0.91	0.90	0.89	0.87	0.82
	Z(q)	1.41	-0.50	-0.95	-0.84	-1.11	-0.99	-0.91	-0.95	-1.22
	Z*(q)	0.70	-0.25	-0.48	-0.42	-0.55	-0.50	-0.46	-0.47	-0.61
BPC	V(q)	1.03	1.05	1.06	1.06	1.02	0.98	0.97	0.96	0.88
	Z(q)	1.17	1.35	1.34	1.12	0.31	-0.20	-0.27	-0.28	-0.82
	Z*(q)	0.59	0.68	0.68	0.56	0.15	-0.10	-0.14	-0.14	-0.42
BRITANNIA	V(q)	0.95	0.96	0.96	0.98	1.04	1.08	1.15	1.22	1.14
	Z(q)	-2.18*	-1.21	-0.80	-0.36	0.49	0.79	1.30	1.61	0.94
	Z*(q)	-2.35*	-1.31	-0.86	-0.38	0.52	0.85	1.40	1.74	1.01
CIPLA	V(q)	1.07	1.05	1.04	1.04	0.95	0.90	0.88	0.88	0.94
	Z(q)	2.76*	1.35	0.83	0.69	-0.56	-0.97	-1.00	-0.88	-0.37
	Z*(q)	2.27*	1.11	0.68	0.57	-0.46	-0.79	-0.82	-0.72	-0.31
COLGATE	V(q)	0.99	0.95	0.93	0.92	0.89	0.89	0.91	0.92	0.88
	Z(q)	-0.56	-1.50	-1.63	-1.46	-1.36	-1.04	-0.77	-0.63	-0.83
	Z*(q)	-0.51	-1.36	-1.47	-1.32	-1.23	-0.94	-0.69	-0.56	-0.75
DCM	V(q)	1.01	1.00	1.00	0.99	0.92	0.90	0.91	0.89	0.88
	Z(q)	0.51	0.08	-0.05	-0.25	-1.01	-0.98	-0.75	-0.84	-0.83
	Z*(q)	0.37	0.06	-0.03	-0.18	-0.73	-0.71	-0.54	-0.61	-0.60
DENA BANK	V(q)	1.08	1.06	1.05	1.05	1.03	1.04	1.02	0.99	1.01
	(q)	3.16*	1.59	1.03	0.98	0.31	0.39	0.16	-0.09	0.08
	Z*(q)	1.37	0.69	0.45	0.42	0.13	0.17	0.07	-0.04	0.03
DR. REDDY	V(q)	1.02	0.98	0.96	0.96	0.87	0.83	0.84	0.87	0.92
	Z(q)	0.72	-0.51	-0.83	-0.84	-1.62	-1.63	-1.37	-0.99	-0.55
	Z*(q)	0.40	-0.28	-0.46	-0.47	-0.90	-0.91	-0.76	-0.55	-0.31
EIH LIMITED	V(q)	1.01	1.00	0.99	0.99	1.00	1.00	0.99	0.97	0.97
	Z(q)	0.32	-0.08	-0.19	-0.17	-0.03	0.01	-0.08	-0.20	-0.22
	Z*(q)	1.02	-0.26	-0.60	-0.56	-0.10	0.03	-0.26	-0.66	-0.71
FOSECO	V(q)	1.06	1.09	1.11	1.13	1.13	1.17	1.22	1.27	1.25
	Z(q)	2.53*	2.60*	2.48*	2.46*	1.63	1.66	1.84	2.01*	1.65
	Z*(q)	0.91	0.94	0.90	0.89	0.59	0.60	0.67	0.73	0.60
GAIL	V(q)	1.01	0.95	0.93	0.93	0.91	0.88	0.83	0.82	0.78
	Z(q)	0.30	-1.27	-1.58	-1.25	-1.11	-1.18	-1.43	-1.34	-1.46
	Z*(q)	0.08	-0.35	-0.44	-0.35	-0.31	-0.33	-0.40	-0.37	-0.41
GLAXO	V(q)	1.02	1.00	0.99	0.99	0.95	0.94	0.97	1.00	1.02
	Z(q)	0.80	0.00	-0.21	-0.17	-0.63	-0.62	-0.22	0.01	0.11
	Z*(q)	0.66	0.00	-0.17	-0.14	-0.52	-0.51	-0.18	0.01	0.09
GRASIM	V(q)	1.00	0.95	0.93	0.93	0.97	1.01	1.04	1.06	1.03
	Z(q)	-0.20	-1.35	-1.54	-1.29	-0.33	0.11	0.32	0.42	0.19
	Z*(q)	-0.08	-0.53	-0.60	-0.50	-0.13	0.04	0.13	0.17	0.07

* Significant at 5% level

	q	2	3	4	5	10	15	20	25	30
HCLTECH	V(q)	1.04	1.01	0.99	0.97	0.87	0.85	0.81	0.80	0.89
	Z(q)	1.87	0.29	-0.20	-0.48	-1.55	-1.50	-1.62	-1.50	-0.71
	Z*(q)	0.64	0.10	-0.07	-0.16	-0.53	-0.51	-0.55	-0.51	-0.24
HERO HONDA	V(q)	1.02	1.02	1.01	1.02	1.02	1.00	1.01	1.04	1.08
	Z(q)	0.93	0.47	0.31	0.31	0.21	-0.05	0.08	0.29	0.51
	Z*(q)	0.47	0.24	0.15	0.15	0.10	-0.02	0.04	0.15	0.26
HIND PETRO	V(q)	1.06	1.08	1.10	1.09	1.11	1.11	1.14	1.16	1.12
	Z(q)	2.48*	2.31*	2.13*	1.70	1.36	1.05	1.17	1.21	0.80
	Z*(q)	1.38	1.29	1.19	0.95	0.76	0.59	0.65	0.68	0.45
ICICI BANK	V(q)	1.09	1.06	1.04	1.03	0.95	0.90	0.88	0.86	0.87
	Z(q)	2.48*	2.31*	2.13*	1.70	1.36	1.05	1.17	1.21	0.80
	Z*(q)	1.38	1.29	1.19	0.95	0.76	0.59	0.65	0.68	0.45
INFOSYS	V(q)	0.97	0.92	0.89	0.87	0.75	0.77	0.77	0.74	0.85
	Z(q)	-1.28	-2.20*	-2.34*	-2.54*	-3.06*	-2.21*	-1.93	-1.90	-1.00
	Z*(q)	-0.54	-0.92	-0.98	-1.06	-1.28	-0.93	-0.81	-0.80	-0.42
INDIAN HOTELS	V(q)	1.05	1.06	1.06	1.08	1.11	1.14	1.21	1.22	1.20
	Z(q)	2.27*	1.61	1.34	1.55	1.37	1.39	1.72	1.63	1.35
	Z*(q)	1.35	0.96	0.80	0.92	0.82	0.83	1.03	0.97	0.81
INDUSIND BANK	V(q)	1.06	1.01	0.99	0.98	0.97	1.00	1.06	1.09	1.15
	Z(q)	2.34*	0.32	-0.26	-0.44	-0.40	-0.02	0.48	0.64	1.00
	Z*(q)	1.08	0.15	-0.12	-0.20	-0.18	-0.01	0.22	0.30	0.46
INGE-RAND	V(q)	1.05	1.00	0.97	0.96	0.92	0.90	0.91	0.90	0.88
	Z(q)	2.00*	-0.05	-0.59	-0.71	-0.94	-0.97	-0.77	-0.71	-0.80
	Z*(q)	1.19	-0.03	-0.35	-0.42	-0.56	-0.58	-0.46	-0.42	-0.47
IOB	V(q)	1.08	1.04	1.01	1.01	0.92	0.89	0.87	0.83	0.85
	Z(q)	3.41*	1.05	0.31	0.11	-1.03	-1.04	-1.09	-1.30	-1.02
	Z*(q)	1.67	0.51	0.15	0.05	-0.50	-0.51	-0.53	-0.64	-0.50
ITC LTD	V(q)	0.96	0.91	0.88	0.87	0.89	0.86	0.83	0.78	0.77
	Z(q)	-1.52	-2.63*	-2.75*	-2.39*	-1.38	-1.34	-1.46	-1.64	-1.53
	Z*(q)	-1.27	-2.20*	-2.30*	-2.00*	-1.15	-1.12	-1.22	-1.37	-1.28
KOPRAN	V(q)	1.06	1.02	1.01	1.02	1.03	1.07	1.10	1.09	1.04
	Z(q)	2.36&*	0.68	0.19	0.37	0.42	0.65	0.80	0.69	0.28
	Z*(q)	1.06	0.30	0.08	0.16	0.19	0.29	0.36	0.31	0.13
MTNL	V(q)	1.06	1.01	0.97	0.97	0.93	0.90	0.86	0.81	0.83
	Z(q)	2.69*	0.17	-0.56	-0.55	-0.86	-0.94	-1.15	-1.43	-1.12
	Z*(q)	0.86	0.05	-0.18	-0.18	-0.28	-0.30	-0.37	-0.46	-0.36
NALCO	V(q)	1.04	1.03	1.02	1.02	0.96	0.90	0.87	0.86	0.82
	Z(q)	1.74	0.80	0.50	0.39	-0.54	-0.94	-1.11	-1.08	-1.24
	Z*(q)	0.61	0.28	0.18	0.14	-0.19	-0.33	-0.39	-0.38	-0.43
NELCO LTD	V(q)	1.03	1.03	1.03	1.04	1.09	1.10	1.16	1.22	1.19
	Z(q)	1.36	0.92	0.77	0.80	1.06	1.00	1.36	1.62	1.28
	Z*(q)	1.24	0.83	0.70	0.72	0.96	0.91	1.24	1.47	1.16
ONGC	V(q)	1.10	1.06	1.04	1.05	1.04	1.06	1.07	1.07	1.09
	Z(q)	4.06*	1.73	0.97	0.98	0.52	0.59	0.57	0.55	0.59
	Z*(q)	2.43*	1.03	0.58	0.58	0.31	0.35	0.34	0.33	0.35
ORI BANK	V(q)	1.09	1.07	1.06	1.05	1.02	1.04	1.02	1.01	0.99
	Z(q)	3.68*	1.84	1.23	0.99	0.22	0.38	0.18	0.10	-0.09
	Z*(q)	1.30	0.65	0.43	0.35	0.08	0.13	0.07	0.04	-0.03
RALLIS	V(q)	1.04	1.02	1.01	1.01	1.08	1.15	1.20	1.21	1.19
	Z(q)	1.73	0.51	0.16	0.23	1.01	1.48	1.69	1.54	1.27
	Z*(q)	0.92	0.27	0.08	0.12	0.53	0.78	0.89	0.81	0.67

	q	2	3	4	5	10	15	20	25	30
RANBAXY	V(q)	1.06	1.06	1.07	1.07	1.06	1.07	1.07	1.09	1.11
	Z(q)	2.45*	1.79	1.48	1.28	0.77	0.72	0.54	0.68	0.72
	Z*(q)	1.26	0.92	0.76	0.66	0.40	0.37	0.28	0.35	0.37
RELIANCE	V(q)	0.97	0.96	0.96	0.96	0.93	0.93	0.93	0.91	0.93
	Z(q)	-1.32	-1.07	-0.94	-0.81	-0.86	-0.68	-0.61	-0.65	-0.49
	Z*(q)	-0.84	-0.69	-0.60	-0.52	-0.55	-0.44	-0.39	-0.42	-0.31
SAIL	V(q)	1.06	1.02	1.00	1.01	1.06	1.14	1.21	1.23	1.24
	Z(q)	2.57*	0.54	-0.04	0.11	0.77	1.41	1.73	1.73	1.62
	Z*(q)	0.84	0.18	-0.01	0.04	0.25	0.46	0.56	0.56	0.53
SBI	V(q)	0.66	0.53	0.47	0.42	0.33	0.31	0.30	0.30	0.34
	Z(q)	-14.24*	-13.12*	-11.90*	-10.95*	-8.29*	-6.80*	-5.87*	-5.19*	-4.48*
	Z*(q)	-3.05*	-2.81*	-2.55*	-2.35*	-1.78	-1.46	-1.26	-1.11	-0.96
SCI	V(q)	1.06	1.06	1.06	1.07	1.09	1.12	1.12	1.12	1.18
	Z(q)	2.66*	1.73	1.31	1.27	1.11	1.13	0.97	0.87	1.24
	Z*(q)	1.16	0.75	0.57	0.55	0.48	0.49	0.42	0.38	0.54
SIEMENS	V(q)	1.06	1.08	1.08	1.09	1.09	1.16	1.26	1.29	1.29
	Z(q)	2.68*	2.12*	1.85	1.76	1.07	1.60	2.15	2.19	1.94
	Z*(q)	1.63	1.29	1.12	1.07	0.65	0.97	1.31	1.33	1.18
SUN PHARMA	V(q)	0.97	0.95	0.94	0.93	0.93	0.90	0.86	0.84	0.78
	Z(q)	-1.21	-1.48	-1.42	-1.29	-0.89	-0.95	-1.17	-1.18	-1.47
	Z*(q)	-1.02	-1.25	-1.20	-1.09	-0.75	-0.81	-0.99	-1.00	-1.25
TATA CHE	V(q)	1.06	1.04	1.04	1.04	1.06	1.01	0.98	0.92	0.87
	Z(q)	2.49*	1.25	0.83	0.71	0.71	0.05	-0.17	-0.61	-0.91
	Z*(q)	1.34	0.67	0.45	0.38	0.38	0.03	-0.09	-0.33	-0.49
TATA POWER	V(q)	1.09	1.01	0.96	0.96	1.00	1.05	1.09	1.10	1.17
	Z(q)	3.91*	0.17	-0.87	-0.73	0.00	0.48	0.78	0.76	1.12
	Z*(q)	1.42	0.06	-0.32	-0.26	0.00	0.18	0.28	0.28	0.41
TATA TEA	V(q)	1.12	1.09	1.07	1.08	1.09	1.10	1.11	1.11	1.21
	Z(q)	5.00*	2.45*	1.55	1.50	1.07	1.01	0.89	0.85	1.40
	Z*(q)	3.03*	1.49	0.94	0.91	0.65	0.61	0.54	0.52	0.85
TNPL	V(q)	1.03	1.00	0.99	0.98	0.93	0.91	0.89	0.88	0.85
	Z(q)	1.35	0.12	-0.19	-0.33	-0.87	-0.86	-0.89	-0.87	-1.05
	Z*(q)	0.75	0.06	-0.11	-0.19	-0.48	-0.48	-0.50	-0.49	-0.58
VSNL	V(q)	1.04	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04
	Z(q)	1.86	0.90	0.58	0.53	0.49	0.27	0.22	0.25	0.24
	Z*(q)	1.04	0.50	0.33	0.30	0.27	0.15	0.12	0.14	0.13
WIPRO	V(q)	1.01	0.97	0.95	0.94	0.89	0.95	0.97	0.99	1.06
	Z(q)	0.51	-0.83	-1.15	-1.08	-1.35	-0.48	-0.27	-0.10	0.39
	Z*(q)	0.18	-0.30	-0.41	-0.38	-0.48	-0.17	-0.10	-0.04	0.14
ZEEL	V(q)	1.03	1.01	1.00	0.98	0.91	0.90	0.89	0.85	0.86
	Z(q)	1.23	0.24	-0.06	-0.34	-1.16	-0.99	-0.93	-1.14	-0.92
	Z*(q)	0.45	0.09	-0.02	-0.12	-0.42	-0.36	-0.34	-0.41	-0.33

* Significant at 5% level

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regulatory measures to restrict the use of derivatives. Derivatives-related disasters, such as the Orange County bankruptcy and the collapse of Barings have led to questions about the ability of individual derivatives participants to internally manage their trading operations. In addition, concerns have surfaced about the regulators' ability to detect and control potential derivatives losses.

But regulatory and legislative restrictions on derivatives activities are not the answer, primarily because standardized rules most likely would only impair one's ability to manage risk effectively. A better answer lies in greater reliance on market forces to control derivatives-related risk taking, together with more emphasis on government supervision, as opposed to regulation. The best regulations are those that guard against the misuse of derivatives, as opposed to those that severely restrict, or even ban, their use. Derivatives-related losses can typically be traced to one or more of the following causes: an overly speculative investment strategy, a misunderstanding of how derivatives reallocate risk, an ineffective internal risk-management audit function, and the absence of systems that simulate adverse market movements and help develop contingency solutions. To address those concerns, supervisory reforms should focus on increasing disclosure of derivatives holdings and the strategies underlying their use, appropriate capital adequacy standards, and sound risk-management guidelines.

For the most part, however, policymakers should leave derivatives alone. The development of derivatives was brought about by a need to isolate and hedge against specific risks. Derivatives offer a proven method of breaking risk into component pieces and managing those components independently. Almost every investor has a unique risk profile inherent in his investment portfolio and marketplace that can be better managed through derivatives trading. The freedom to manage risks effectively must not be taken away.

Ultimately, financial derivatives should be considered part of any investor's risk-management strategy to ensure that value-enhancing investment opportunities are pursued. Derivatives allow for the efficient transfer of financial risks and can help to ensure that value-enhancing opportunities will not be ignored. It is important that derivatives players fully understand the complexity of financial derivatives contracts and the accompanying risks. Users should be certain that they do not take unnecessary risks.

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