

Stock Market Prices in India after Economic Liberalisation

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In 1984, the Rajiv Gandhi administration began a number of reforms that signified the beginning of India's prolonged movement towards market-oriented, liberalised, economic policies. In this article, we examine if and how these economic reforms have affected the behaviour of Indian stock prices. To address this issue we employ recently developed non-parametric variance ratio tests spanning a sample period of July 1957 to October 1996. Our study shows that from the mid-1980s, aggregate equity prices in India behaved like a random walk suggesting that Indian stock prices obeyed Fama's efficient market hypothesis after the beginning of the economic reforms. We also find that, to some extent, this progress towards efficiency was thwarted after the infamous scam of September 1991-May 1992.

I Introduction

IT is no secret that for its first 40 years of independence, India's economic system was characterised by heavy state involvement, a closed international sector, and relatively slow rates of economic growth. Indeed, over this period, it was not uncommon to hear musings about 'a Hindu rate of growth' – a slow rate of economic growth that India was seemingly predestined to enjoy due to its culture and heritage. Moreover, for an economist to suggest that the country should have more open trade was to do the unspeakable – threaten the country with recolonisation by multinationals.

In the middle of the 1980s, however, this character of the Indian economic system began to change as the Rajiv Gandhi administration began a number of economic reforms that signified the beginning of India's prolonged movement towards market-oriented, liberalised economic policies. Over the next decade, subsequent governments would continue to push through a number of economic reforms. On the domestic front, the long-held industrial licensing policy that forced firms to receive permission in order to start production was gradually removed. As a result, areas that were once closed to the private sector – electricity generation, petroleum, air transportation, telecommunications – were now opened to competition from the private sector. Domestic tax rates fell in this period; the top tax rate went from 56 per cent to 40 per cent and the corporation tax went down from 57.5 per cent to 46 per cent. The international sector also experienced large-scale reform: foreign investment, earlier only allowed in small amounts, was welcomed; the Indian rupee had most of its exchange controls removed and was made partially convertible; raw materials and capital goods were made freely importable and the maximum tariff on imports went from 400 per cent to 65 per cent.¹

Indeed, since the mid-1980s India has become a more open economy with the ratio of imports of goods and services to gross domestic product (GDP) reaching over 11 per cent in 1994. The results of the increase in openness can be seen in Figure 1.

The question that this article examines is how has the behaviour of Indian stock prices changed in the wake of this movement towards economic liberalisation? The efficient markets hypothesis in finance suggests that as markets are made more open to the public, prices should come to reflect the increased availability of information and be more efficiently priced. That is, as domestic and international investors have increased access to the market and the information surrounding the market, the current price should come to reflect all available information.² The implication of the efficient markets hypothesis on the time series behaviour of prices is that any future movements in the price are only the result of future random events which investors, of course, cannot accurately and consistently predict. In other words, since the current price reflects all available information, including information about the future, it is a very good predictor of the future price. The only difference between today's price and tomorrow's price are events that we cannot predict, i.e., random events. Hence, in an efficient market, stock prices should behave as a 'random walk' process when statistically tested. In this paper we examine whether this economic liberalisation, which has allowed domestic and international investors to be more involved in the stock market, has indeed caused Indian stock prices to behave as a random walk. If the theory is correct, we should see stock prices behaving as a random walk process during and after the liberalisation but not in the pre-liberalisation period.

The way our article differs from other examinations of the Indian stock market, most notably that by Thomas (1995), is that we attempt to examine the efficient markets

hypothesis on Indian stock markets by implementing a technique that is robust to time varying volatility.³ Most of the standard time series tests of a random walk assume the error term in the regression is of constant variance. However, there is a growing consensus among financial economists that the variance changes over time. We use a variance ratio test first devised by Lo and MacKinlay (1988) that allows us to test for a random walk in stock prices while being robust to this time-varying volatility.

Our article is presented as follows. First, by using the variance ratio methodology of Lo and MacKinlay and Chow and Denning (1993), we examine the behaviour of stock prices before and after the economic liberalisation reforms were put in place in India. We find the time series behaviour of stock prices has changed with the implementation of these liberal economic reforms. We show that before the intensive liberalisation period began, stock prices were associated with serial autocorrelation. After the liberalisation period began, though, we cannot reject the hypothesis that stock prices follow a random walk.

The rest of the article is organised as follows. Section II provides the methodology used in the empirical analysis. Section III describes the data and the empirical results. Section IV gives some concluding remarks.

II Methodology: Variance Ratio Test

To examine the behaviour of Indian stock prices we used the Lo and MacKinlay (1988) variance ratio test.⁴ The reason why we chose this test is it uses a technique that is robust to changing time varying volatility. The basic rationale behind the variance ratio test is the following. Imagine that the log of Indian stock prices, denoted p_t is a pure random walk as in equation 1 below:

$$P_t = P_{t-1} + e_t \quad (1)$$

where e_t is a serially uncorrelated error term with constant variance. The significance of

this formulation is that the price today is equal to price yesterday plus some error that we cannot predict. In other words, the difference between today's price and yesterday's price is the random term, e_t , hence giving rise to the term 'a random walk'.

Because of the constant variance of e_t , we know that the variance of the q -differences of the random walk model in equation 1 grows linearly with the order of difference q . That is, the variance of $p_t - p_{t-2}$ will be exactly twice the variance of the $p_t - p_{t-1}$, the variance of $p_t - p_{t-12}$ will be exactly 12 times the difference of $p_t - p_{t-1}$. Thus, in very simple terms, what Lo and MacKinlay do is test the null hypothesis that a time series has the property that:

$$\frac{\text{Var}(p_t - p_{t-q})}{q^* (\text{Var}(p_t - p_{t-1}))} = 1 \quad (2)$$

If we cannot reject the null hypothesis that the 'variance ratio' is equal to 1, then we can say that the series follows a random walk. If we can reject the null, then we can reject the idea that the series is a random walk.

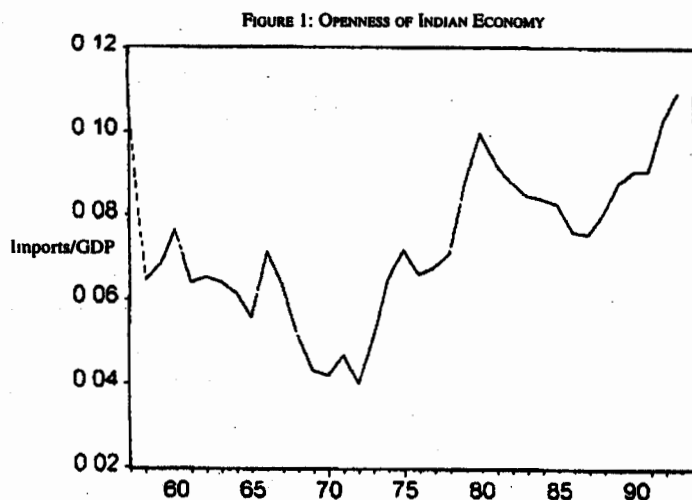
In Lo and MacKinlay's test the test statistic is robust to the changing error term problem that we discussed above.³ This is in contrast to conventional tests of random walks, such as the Dickey-Fuller unit root test, which are not robust to these changing variances and thus produce possibly incorrect results.

In the Lo and MacKinlay variance ratio test, the 5 per cent critical value for the test statistic of the variance ratio test is 1.96; a t -statistic value above 1.96 indicates a rejection of the null hypothesis of a random walk while a t -statistic below 1.96 indicates an acceptance of the null hypothesis. More recent research by Chow and Denning, however, provides a modification for testing multiple variance ratios across different values of q . In this test they use a different critical value that is given from Studentised Maximum Modulus (SMM) distribution. In this paper we also report the results using this version of the test; for our paper the 5 per cent SMM critical value corresponds to 2.49. So again, a t -statistic value above 2.49 indicates a rejection of the null of random walk and a value below this indicates an acceptance of the random walk hypothesis.

III

Data and Empirical Results

To examine the stock price behaviour of India we used the monthly all-India share index price data available from the International Financial Statistics (IFS). This index is a value weighted index in that stocks are not weighted equally within the index. The data spanned a period from July 1957 to October 1996. The data only include capital gains data and represent time averages of



daily or weekly index values. In all our calculations we examined the natural log of the stock price data. Figure 2 plots the log of the all-shares price index for the sample period.

We conducted the variance ratio test on two sub-samples: pre-January 1985 and post-

January 1985. The rationale for using this date as a cut-off point was that the mid-1980s coincided with the time when major economic changes towards economic liberalisation were beginning to be made in India. For example, the process of reforming the important industrial licensing policy began

TABLE 1: VARIANCE RATIOS OF INDIAN STOCK PRICES, PRE-1985 AND POST-1985

Index	Sample Period	N	VR(q)			
			2	4	8	16
All-India share index	July 1957-Dec 1984	330 (4.10)	1.35** (3.16)	1.44** (2.08)	1.41* (1.54)	1.43
All-India share index	Jan 1985-Oct 1996	144 (2.31)	1.31* (1.87)	1.43 (1.56)	1.51 (1.04)	1.45

TABLE 2: VARIANCE RATIOS OF US STOCK PRICES JULY 1962-DECEMBER 1984, JANUARY 1985-DECEMBER 1994

Index	N	VR(q)			
		2	4	8	16
Value-weighted CRSP NYSE-AMEX					
July 1962-Dec 1984	270	1.05 (0.78)	1.05 (0.40)	1.16 (0.80)	1.04 (0.16)
Jan 1985-Dec 1994	120	1.05 (0.49)	0.95 (-0.27)	0.71 (-1.00)	0.55 (-1.09)

TABLE 3: VARIANCE RATIOS OF INDIAN STOCK PRICES WITH SCAM PERIOD EXCLUDED - SAMPLE PERIODS, JANUARY 1985-AUGUST 1991 AND JUNE 1992-OCTOBER 1996

Index	Sample Period	N	VR(q)			
			2	4	8	16
All-India share index (Pre-scam)	Jan 1985-Aug 1991	135	1.14 (0.92)	1.17 (0.66)	1.09 (0.27)	1.14 (0.28)
All-India share index (Post-scam)	June 1992-Oct 1996	53	1.38** (3.20)	1.79** (3.48)	2.19** (3.20)	2.02 (1.86)

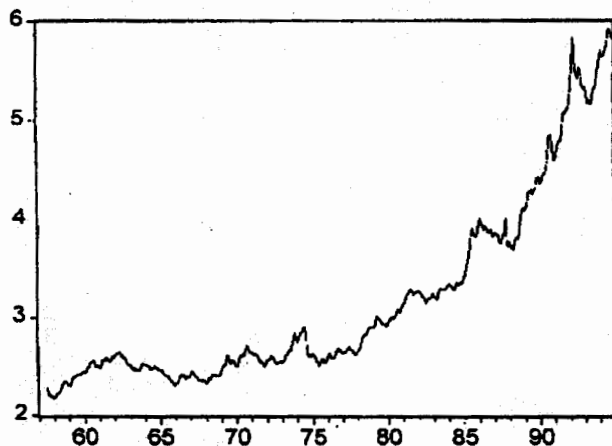
The variance ratio, $VR(q)$, is defined as $\sigma^2(q)/\sigma^2(1)$; where σ^2 is an unbiased estimator of $1/q$ of the variance of the q th difference of the real share price index and σ^2 is an unbiased estimator of the variance of the first difference of the real share price index. The data is all based on monthly observations. The heteroscedasticity-consistent test statistic $Z^*(q)$, which tests the null hypothesis that $VR(q)$ equals one, is given in the parenthesis immediately below each of the main row entries.

Notes: * indicates that the variance ratio is statistically different from one at the 5 per cent level (rejection of the random walk) using the conventional normal critical value of 1.96.

** Using a multiple comparison procedure for the five variance ratios, the corresponding variance ratios are statistically different from one at the 5 per cent level when compared with the SMM critical value of 2.49.

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FIGURE 2: LOG OF INDIAN STOCK PRICES (JULY 1957 TO OCTOBER 1996)



in 1984-85. Moreover, Thomas (1995) points out that because of the major economic changes in the economy beginning in 1984-85, the stock market underwent a regime change after 1985.⁶

One item that is important to note here is that what we are describing in January 1985 is not a structural break. Structural break tests are often used to show that a series, which is a random walk by conventional tests, is a trend stationary series once the structural break is accounted for. However, these tests are not appropriate in our situation, since what we are documenting is a change in the behaviour of the time series. That is, we document a change from serial correlation to random walk behaviour in the time series of the stock prices.

The results of the variance ratio test for the pre-1985 period are given in Table 1. The table shows the variance ratios for q values of 2, 4, 8, 16, and the associated Z' statistic.⁷ In general the results point to a strong rejection of the random walk: the random walk hypothesis is rejected at the 5 per cent level at values of q equal to 2, 4 and 8 when using the standard normal value 1.96 as the critical value, while when using the Chow and Denning multiple variance ratio test critical value of 2.49, we can reject at values of q equal to 2 and 4.

Table 1 also presents the post-January 1985 variance ratio results. Here, we cannot reject the random walk for all values of q when using the SMM critical value and we only reject the random walk at a q value of 2 when using the standard normal critical value.⁸ Thus, it would seem that there is evidence from these results that the price behaviour of the Indian stock market has changed as the economic liberalisation plans were implemented.⁹

Two questions that naturally arise with these results are:

- (1) is the pattern that we see in these

emerging market returns – rejection of the random walk and serial correlation in the pre-1985 period and inability to reject the random walk hypothesis in the post-January 1985 period – just an artefact of all stock markets, emerging and developed? and, (2) given that the Indian stock exchange scam of September 1991-May 1992 affected the stock returns [Thomas 1995], are we still able to accept the random walk hypothesis for the post-1985 period even if we exclude the scam period from our variance ratio test?

To answer the first question we examined the variance ratio results for the US market. To do this we used the monthly Chicago Research on Security Prices (CRSP) value-weighted returns to assess what occurred in the US market. We examined this index since: (1) a number of recent papers on the efficiency of the US market has used this index, i.e., Lo and MacKinlay, Poterba and Summers (1988), and Chow and Denning; and (2) because the value-weighted index would be most similar to the all-India share index. As with the Indian stock prices, the variance ratios tests are applied to two different samples: July 1962 (the beginning of the sample) to December 1984, and January 1985 to December 1994. The results, in

Table 2, show that we cannot reject the random walk for either of the two sub-periods. The fact that these results are quite different from the India results lends support to the suggestion that economic liberalisation affected the serial correlation property of Indian stock prices and is not just an artefact of all markets including developed markets.

For the second question on the Indian scam, we broke the post-1985 sample period into two sub-samples: pre-scam (January 1985-August 1991) and post-scam (June 1992-October 1996). We then analysed the variance ratios for these two periods. The results for the scam excluded variance ratio tests are shown in Table 3. For the pre-scam period our findings are similar to those for the full post-1985 period (i.e., January 1985 – October 1996). That is, across all values of q , the variance ratio test cannot reject the null hypothesis of a random walk. However, for the post-scam period, there is a relatively strong rejection of the random walk.

This failure of the random walk hypothesis in the post-scam period has to be interpreted with caution. It appears from the test results that the scam had an adverse impact on the efficient market performance. However, this was based upon only a relatively small sample of 53 observations. Also, it is difficult to tell whether the scam effect is limited to September 1991-May 1992. Whether the scam gave rise to a change in stock price behaviour is difficult to evaluate without having a sufficient number of observations of the post-scam period. This suggests that only time will tell whether the scam impaired the stock market efficiency.

IV Conclusion

Our empirical analysis of Indian stock prices suggests that, in the wake of economic liberalisation in the mid-1980s, Indian stock prices showed signs of greater efficiency. Our variance ratio tests, which are robust to time varying volatilities, strongly suggest that stock prices behaved like a random walk beginning in the mid-1980s, the period when Rajiv Gandhi initiated market-oriented

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reforms. It is, of course, true that the brunt of liberalisation measures came much later the mid-1980s; however, interestingly enough, the financial markets anticipated these reforms quite in advance.

Our study complements Thomas' (1995) finding of a mid-1980s regime shift in that we find that following this regime shift the financial market actually became more efficient. Moreover, it turns out that this change in serial correlation property of stock returns is not a unique occurrence for India. It has happened in several emerging market economies including Mexico, the Philippines and Thailand, and over the same time period as in India. In a separate paper, Basu and Morey (1997) report these cross-country findings and develop a theoretical hypothesis using an open economy asset pricing model.

Notes

- 1 See *The Economist*, January 21, 1995, pp ss10-ss15, for a survey of India's economic reforms.
- 2 See Fama (1991) for a survey on the efficient markets literature.
- 3 In an important paper Thomas (1995) uses Bombay Sensex index returns to show that there was a clear regime shift in the stock return behaviour starting from March 1985.
- 4 For more information on the variance ratio test see Campbell, Lo and MacKinlay (1997) and Basu and Morey (1997).
- 5 The specific formulations for this test statistic are available in Campbell, Lo and MacKinlay (1997).
- 6 See Thomas (1995), p 12.
- 7 We did not use larger variance ratios ($q = 24, 32, \text{etc}$) since they would probably yield spurious results due to the changing nature of the Indian stock market and the relatively small sample sizes that were chosen. Urrutia (1995) also makes this point in a variance ratio analysis of nominal Latin American stock indexes. The values $q = 2, 4, 8, 16$ correspond to Lo and MacKinlay (1988) and Chow and Denning (1994).
- 8 We also conducted the variance ratio tests on real stock prices and found the same results - rejection of the null hypothesis in the pre-liberalisation period and acceptance of the random walk after the beginning of the reforms.
- 9 To further support our claim that the post-1980s stock prices behave as a random walk, we conducted some sensitivity tests for the variance ratios test by applying the test to the sample sizes: December 1981-December 1985, December 1981-December 1986, December 1981-December 1987, December 1981-December 1988. The rationale behind this was that as we increased the sample size and included more of the beginning of the liberalised post-1985 period, we should eventually see the variance ratios be not significantly different from one. In other words, the serial correlation should eventually turn into a non-rejection of the random walk as we increased the sample size. The results are not presented here in the interest of conserving space but they show the variance ratios did significantly decline as the sample sizes were increased. Indeed, in the longest sample period,

December 1982-December 1988, we could not reject the null of unity for all values of q using the higher Chow and Denning critical values. These sensitivity results confirm that our results are not critically dependent on the choice of January 1985 as the cut-off point.

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The people of India fought for the independence of our country on a secular and democratic platform and have successfully retained a government at the centre formally committed to secularism. We representing non-resident Indians (NRIs) of the USA and Canada hope that the people of India would ensure the victory of secular and democratic forces in the present elections and not be deceived by the backward forces of Hindutva, which threaten to destroy the very fabric of multinational, multicultural and multireligious culture and polity of India. The victory of secular and democratic forces is a necessary condition for India entering into the Twenty First Century as a modern democratic state ensuring communal harmony, progress and prosperity.

Coalition Against Communalism, Berkeley, CA, USA;

Punjabi People's Cultural Association, Concord, CA, USA;

Coalition for Egalitarian and Secular India, Los Angeles, CA, USA;

Gadarite Cell, Bakersfield, CA, USA;

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