Has the behaviour of the stock market been affected by the scam? — A statistical analysis

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It is generally believed that the recent boom in the Indian stock market is caused by the scam (termed variously as stock/bank/security) associated with it. Because of this tendency to associate the boom with the scam there has been a strong notion among the public that the stock market has been highly manipulated by the scam. While the recent CBI investigations appear to imply that the money connected with the bank scam has been passed through the hands or records of the people connected with the stock market (the so-called bulls), it is not clear what proportion of it has actually flown into the stock market to manipulate it. In fact, it is not even clear whether there could have been the boom independent of the scam, conversely if there could have been the scam independent of the boom?

Even considering that the scam money completely flooded the stock market, the major question not critically analysed is whether the scam has affected the behaviour of the market. The common belief is that it has. And this belief is based on the fact that the stock market registered an all-time record high index of >4000 (Bombay Stock Exchange Index (BSE index); Figure 1) in a very short span of time associated with the period when the bank scam occurred.

But the index value of stock market in general has always been on the rise and the Indian stock market has been experiencing a few such periods of boom and crash when the BSE sensitivity index (SI) has, in fact, fluctuated substantially in a short span. For instance, during the last decade there were at least two such recognizable booms during 1981 and 1985–86. These were attributed to various extraneous factors such as policy changes and/or political instability and were not known to be associated with any scam. In other words, the increase in the SI value *per se* during the scam is not an appropriate indicator of the manipulation of the stock market and of its altered behaviour, as several issues such as devaluation of the rupee and economic reforms confound with the possible effect of the scam. Therefore the question whether the stock market behaviour has been affected by the scam can only be assessed by other parameters that are independent of the changes in the absolute value of the stock index.

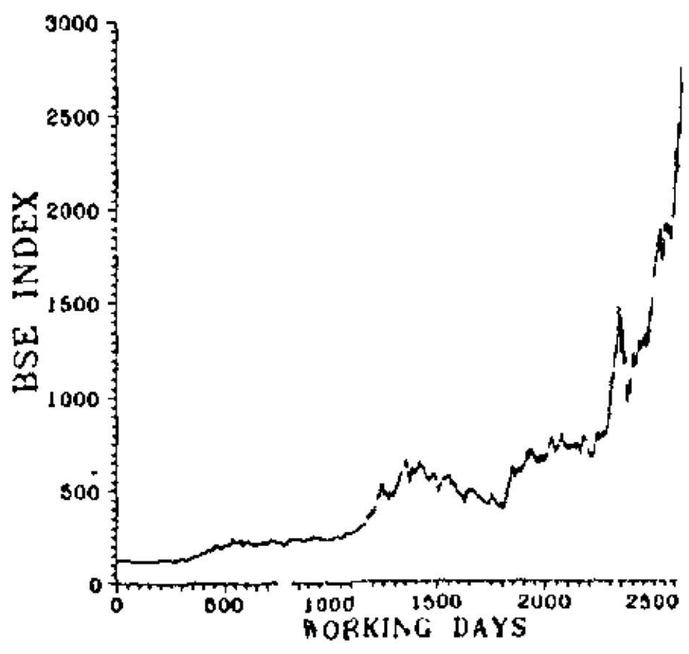

Figure 1. Bombay Stock Exchange Sensitivity Index values for the period from 3 April 1979 to 31 March 1992. The X-axis refers to the number of working days from 3 April 1992.

I attempted to study this in the most primitive way. I gathered the data on the Bombay Stock Market SI for 2618 consecutive working days from the Research and Analysis Wing of the BSE. These data comprising the SI values for the period from April 1979 to March 1992 cover the scam period also. From these data the daily increase (positive deviations; $+d_i$) or decrease

(negative deviations; $-d_i$) in the SI over to the previous working day was computed for the whole period. The data were then divided into 26 consecutive periods of 100 days each (the last period, however, included data for 118 days). For each of these periods the average of the positive deviations (PD), negative deviations (ND), and absolute deviations (AD) were computed neglecting the sign of d_i (AD = Σ (\\d_i\\)/n, where n = total number of days in a period and \\ indicates modulus). The relative deviations (RD), measured as the ratio of the absolute deviations of a given day to the SI of the previous day, were also computed. The variance of these parameters was also computed for each period. Further, the number of days when the d_i was positive (P) or negative (N) was also recorded.

Using these data I first identified some features of the stock market that are independent of the absolute SI values and hence might serve as indicators of the behaviour of the stock market. While a number of such features might exist, my choice is purely arbitrary and I relied more on their tendency to be independent of the absolute value of the stock indices. In the process, a few interesting relationships emerged. Using these relations, the behaviour of the stock market during the scam period was compared with the rest of the period. These features and the comparisons are discussed below.

Relation between the mean and the standard deviation (SD) of daily deviations (d_i)

There was a significant association between the mean and the standard deviation for both the absolute (AD; Figure 2*a*; $r = 0.988$; $Y = 0.10 + 879\ X$; $P < 0.01$) and the relative (RD; Figure 2*b*; $r = 0.912$; $Y = 0.745\ X$; $P < 0.01$) deviations. Moreover the SD values were almost equal to the mean of the deviations of each period. Strikingly the three points, viz. 24, 25 and 26 (comprising of 318 days from July 1990 to February 1992), corresponding to the scam period, did not deviate from this relation. In fact the coefficients obtained for the period earlier to the scam were almost identical to those obtained for the period inclusive of the scam (see legend to Figures 2*a* and *b*). In other words, the variations around the mean of the daily deviations in the stock index value have not changed during the scam period from what is expected from the rest of the period. Further, these deviations exhibited highly positively skewed distributions which, on log transformation, showed normal distributions. The frequency distributions of these deviations for the scam period were also highly positively skewed and did not differ from those of the pre-scam period.

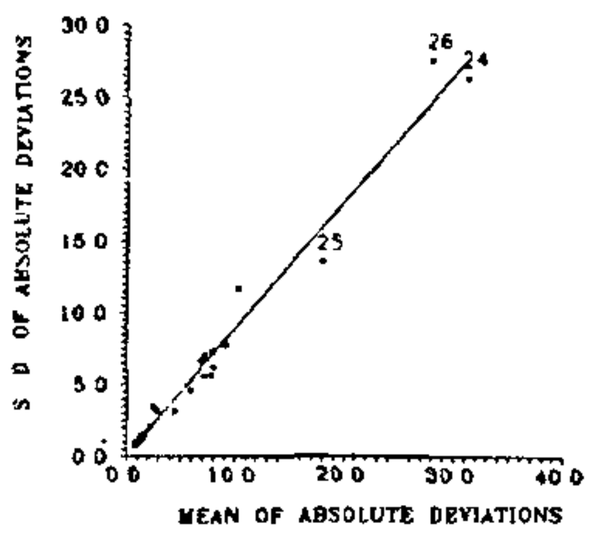

Figure 2 *a*. Relation between mean of absolute deviations (AD) and their standard deviations (SD) of 26 periods of 100 days each. The numbers 24, 25 and 26 represent the scam period. Analysis was done for the first 23 periods ($r = 0.965$; $Y = 0.883\ X$; $P < 0.0001$) and for all the 26 periods ($r = 0.988$, $Y = 0.10 + 0.879\ X$; $P < 0.0001$) separately but the regression line is given only for the latter.

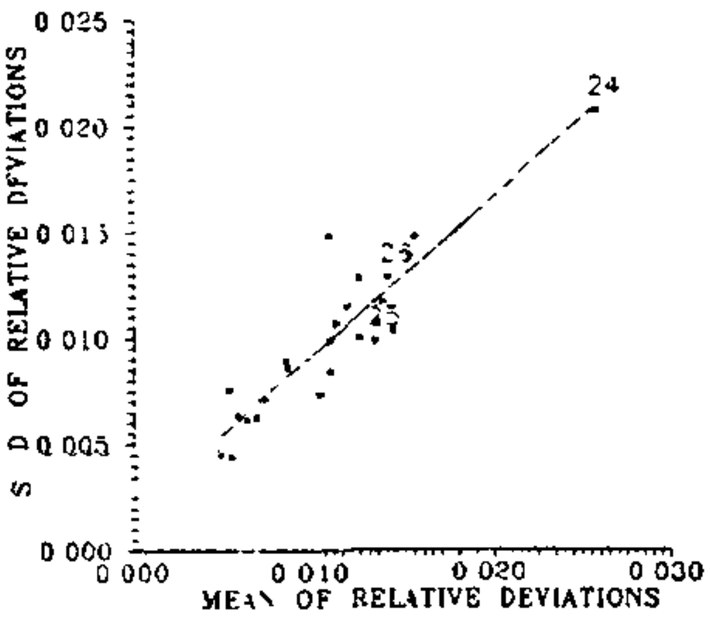

Figure 2 *b*. Relation between mean of relative deviations (RD) and their standard deviations (SD) of the 26 periods. Other details as in Figure 2*a* ($r = 0.862$, $Y = 0.773\ X$; $P < 0.0001$ for the first 23 periods and $r = 0.912$; $Y = 0.743\ X$; $P < 0.0001$ for all the 26 periods).

Symmetry in the direction of the deviations

Figures 3*a* and 3*b* depict the mean absolute and relative deviations in both negative and positive directions for each of the 26 periods. Clearly, there appears to be an almost perfect symmetry in the extent to which the SI values deviate in positive (increase) and negative (decrease) directions within each of the 26 periods. In other words, any increase in the SI value in a given period is invariably associated with the decrease in that period. The strength of this symmetry is indicated by the significant association between the two directional changes (ND vs PD; $r = -0.940$; $P < 0.01$) or (NRD vs PRD; $r = -0.891$; $P < 0.01$). Figure 4, where this relation is depicted for the relative deviations, shows that the three points representing the scam period do not deviate from this symmetric feature of the market. In fact two of the scam points have merged with others from the rest of the period. One

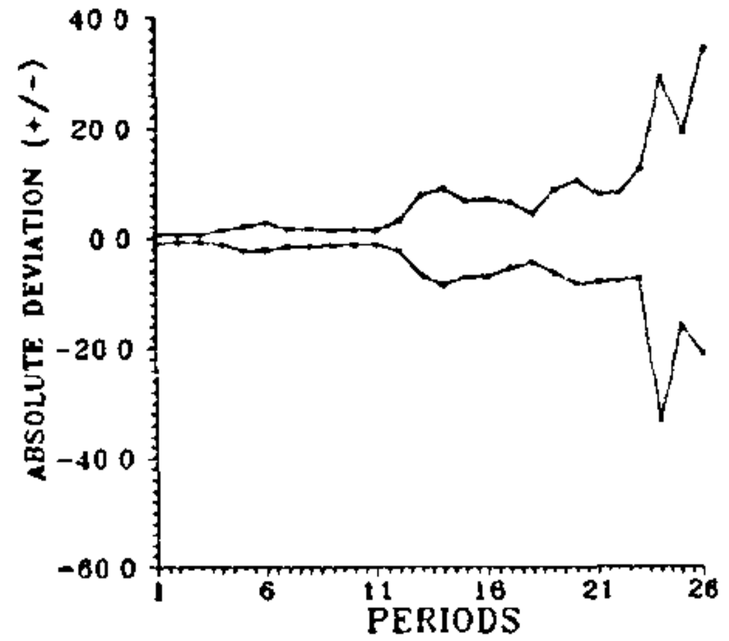

Figure 3 *a*. Mean positive (PD) and negative daily deviations (ND) for each of the 26 periods.

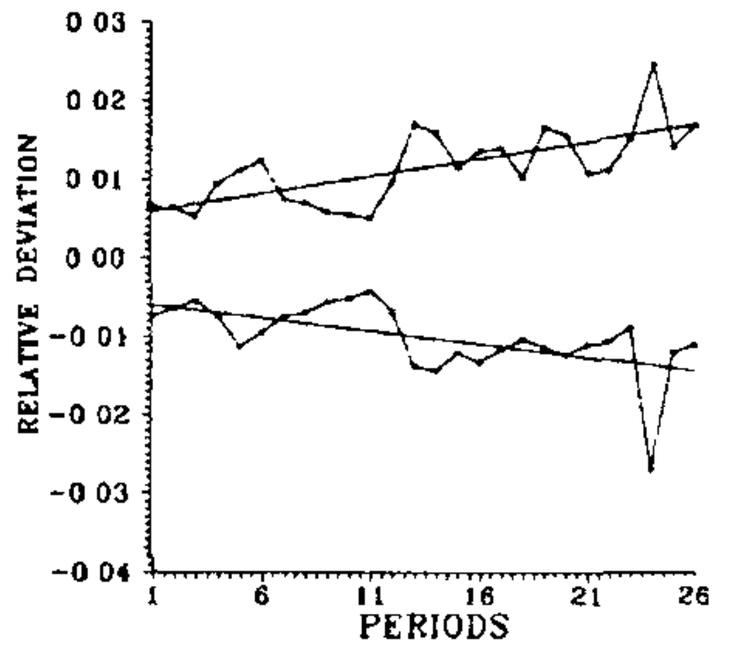

Figure 3 *b*. Mean relative positive and negative deviations for each of the 26 periods. $r = 0.70$ ($P < 0.001$) for positive and $r = 0.57$ ($P < 0.05$) for negative deviations. For details see text.

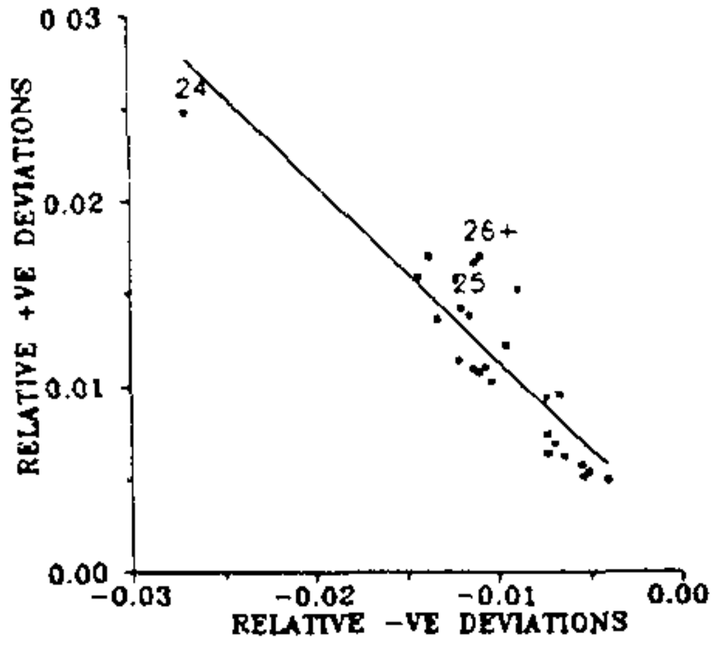

Figure 4. Relation between negative and positive relative deviations depicting the extent of symmetry in the increase and decrease in SI values within each of the 26 periods. $r = -0.88$ ($P < 0.0001$) for all the 26 periods. Other details as in Figure 2 *a*.

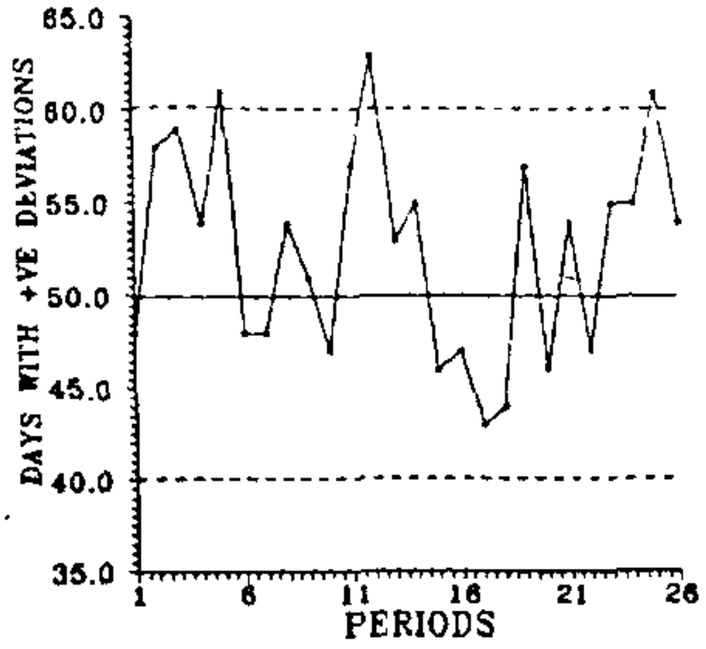

Figure 5. Number of days when the SI values have shown an increase compared to that on the previous day in each of 26 periods. The dashed lines indicate the critical range within which the numbers (days) are not significantly different from the random phenomenon wherein days with positive deviations occur as frequently as those on the negative direction.

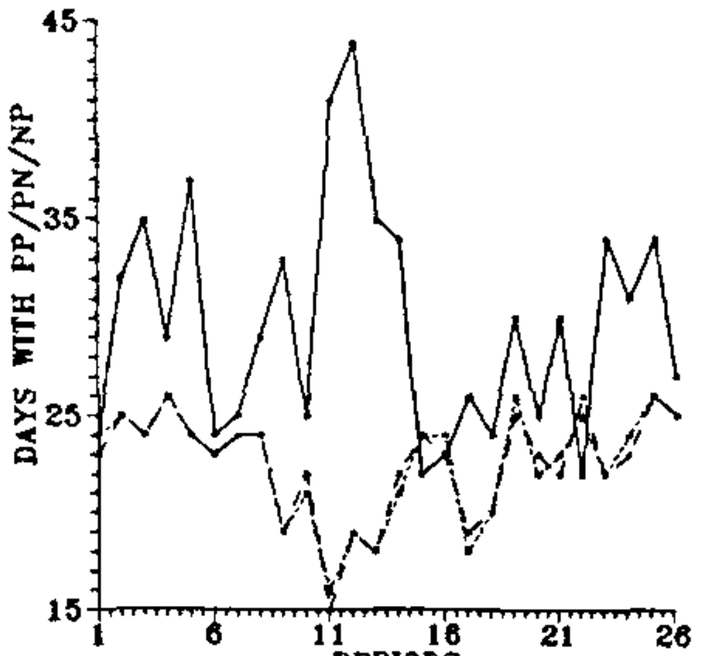

Figure 6. Number of consecutive runs (i.e. three consecutive working days) when the SI value has shown a positive followed by a positive (PP; solid line) or a positive followed by a negative (PN; dashed line) and a negative followed by a positive deviation (NP; dotted line) in each of the 26 periods.

question emerges from this relation: if the market is so symmetric with respect to the extent of deviations in the negative and positive directions, how can the stock index value increase? This can probably be explained by the slight increase in the number of days on which the index value increases compared to those when it decreases (see below).

Days with positive deviations (*P*)

In all there were 1373 days with positive and 1233 days with negative deviations (10 days recorded no deviations). These differences were significant ($\chi^2 = 7.52$; $df = 1$; $P < 0.01$), indicating a bias towards the days with positive deviations. This probably contributes to the overall increase in the index value.

Figure 5 shows the number of days on which the SI value recorded an increase compared to that on the previous day in each of the 26 periods. Interestingly, except for three occasions, all through the market has not deviated from what is expected from a random phenomenon (i.e. the number of days with positive and negative deviations being equal). Among the three periods that show deviations, one (#25 corresponding to the period from December 1990 to June 1991) is associated with the scam period, the other two (#5: October 1981 to May 1982 and #12: November 1984 to May 1985) are not known to be associated with any scams. In other words, increase in the number of days with positive deviations does not seem to be a specific consequence of the scam.

The frequency with which an increase in SI value is immediately followed by another increase (P followed P) or a decrease (P followed by N) on the subsequent day could be an indicator of the extent of randomness in the stock market behaviour. The complementary of these would be a decrease followed by another decrease (N–N) or an increase (N–P) on the consecutive days. These (PP, PN, NP) are plotted in Figure 6 (NN not shown since it is complementary to the rest). It is clear that the scam period does not in any way differ from the rest of the periods in this behaviour also.

Thus a few features of the stock market that I consider represent its behaviour, have not changed during the scam period, indicating the stability of the market despite the scam. These features used here for comparison are identified from the behaviour of the market *per se* during the period earlier to the scam and therefore they are not eclectic. There are no immediately recognizable factors intrinsic to the market that make these features immune to the external influences. Therefore some of these such as the strong dependence of the variance over the mean of the daily deviations and the symmetry in the extent of deviations in positive and negative directions could be highly vulnerable. But the fact that these features have remained stable during the scam period suggests that the behaviour of the stock market has not been altered by the scam. *Finally, I conclude that despite the scam, the Indian stock market is as stable as it probably ever was, and therefore the fears such as 'Chaos in the stock market', 'Deflated confidence among the investors', etc. appearing in daily newspapers are wrongly based and irrelevant in view of the long-term performance of the market.*

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