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Ecological Economics 52 (2005) 81–95

ECOLOGICAL ECONOMICS

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ANALYSIS

Do stock markets penalize environment-unfriendly behaviour? Evidence from India

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Received 2 May 2003; received in revised form 3 March 2004; accepted 8 June 2004
Available online 18 December 2004

Abstract

A growing body of research points to the fact that capital markets react to environmental news and thus create incentives for pollution control in both developed and emerging market economies. In this paper, we conduct an event study to examine the impact of environmental rating of large pulp and paper, auto, and chlor alkali firms on their stock prices. We find that the market generally penalizes environmentally unfriendly behaviour in that announcement of weak environmental performance by firms leads to negative abnormal returns of up to 30%. A positive correlation is found between abnormal returns to a firm's stock and the level of its environmental performance. These findings should be viewed as further evidence of the important role that capital markets could play in environmental management, particularly in developing countries where environmental monitoring and enforcement are weak.

Keywords: Green rating; Capital market; Environmental management; Event study

JEL classification: Q25; G14; L73

1. Introduction

A growing body of research points to the fact that capital markets in developed market economies react to environmental news and thus create incentives for pollution control[1]. An important policy implication of this literature is that regulatory effort can be leveraged by the release of information regarding firms' environmental performance to markets. This aspect becomes particularly important in the context of developing countries where monitoring and

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[1] See for instance Lanoie et al. (1998) and Konar and Cohen (2001), and the references therein.

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doi:10.1016/j.ecolecon.2004.06.011

enforcement capabilities are limited (Dasgupta et al., 2001).

Furthermore, if the forgoing view about capital markets is valid, they may be viewed as yet another pressure point in pollution abatement by firms—in addition to the pressure by regulatory agencies [either through command and control (CAC) or through market-based instruments or MBIs] and by communities[2]. Again, this is an important consideration for developing countries that face difficulties in implementing either CAC or MBIs-based solutions.

Finally, in the context of increasing emphasis on voluntary programmes to improve environmental quality, if firms perceive this link (between their stock prices and their environmental track record), this creates another incentive for them to participate in voluntary environmental programmes (Alberini and Segerson, 2002).

In this paper, we conduct an event study to examine the impact of environmental performance of large pulp and paper, automobile, and chlor alkali firms in India on their stock prices. Our finding, namely, that the dissemination of knowledge about weak environmental performance of companies through an environmental rating program tends to lower the return to investors holding the stocks of such companies is important in light of the preceding statements. In sum, it lends credence to the view that even in emerging market economies such as India capital markets can (i) leverage monitoring and enforcement activities, (ii) act as an additional environmental pressure point on firms, and (iii) create incentives for participation in voluntary environmental programmes. To our knowledge, this is the first attempt to examine the impact of public disclosure of environmental performance on the financial performance of firms for a developing economy.

The following section describes how environmental performance is measured for the firms in our sample and compares this with a similar recent study for developing countries. In Section 3, we describe the methodology and data set. Section 4 presents results. The final section discusses directions for further research and concludes.

[2] On the role of communities see Afsah et al. (1996), Blackman and Bannister (1998), and Pargal and Wheeler (1996).

2. Measuring environmental performance of firms in India

In this study, we use the environmental rating by India's leading environmental NGO, the Delhi-based Centre for Science and Environment (CSE). Under its Green Rating Project (GRP), CSE evaluates the environmental performance for various industrial sectors. This project has been funded by the United Nations Development Programme (UNDP) through the central Ministry of Environment and Forests (MoEF). So far, CSE has rated firms/plants in pulp and paper, automobile manufacturing, and chemicals (chlor alkali) sectors. There are plans to rate additional sectors and also to reevaluate sectors that have already been rated, such as pulp and paper (see www.cseindia.org/html/eyou/grp/grp_index.htm for details).

Thirty-one large pulp and paper plants (capacity of 100 tons/day or more) representing 23 firms across 13 states were the first to be rated (Appendix B1). The exercise took about 18 months, and the ratings were released on July 18, 1999. This was followed by a rating of 29 automobile manufacturers that was released on October 29, 2001 (Appendix B2). Finally, 25 chlor alkali firms comprising about 90% of the caustic-chlorine sector were evaluated, and the ratings were released on September 2, 2002 (Appendix B3). As we note below in the description of our data set, the release of these environmental ratings are high profile and prominent events that are widely reported in the media.

While credit rating agencies exist in India, the GRP is the first attempt at environmental rating of firms in the country[3]. In the absence of a comprehensive reporting system, such as the Toxics Release Inventory (TRI) in the United States, the GRP relies heavily on voluntary disclosure of information by firms. This information is acquired by CSE through structured surveys and fieldwork and is reviewed and vetted by technical experts[4]. A life cycle analysis (LCA),

[3] "The uniqueness of GRP is that this is the first time anywhere in the developing world that the environmental performance rating of industrial firms is being undertaken by an NGO and that information of the environmental performance of companies is being made available to the public." (CSE website, accessed 2.3.2003).

[4] For further details see http://www.cseindia.org/html/eyou/grp/grp_rating_method.htm.

beginning from raw material procurement to product recycling, is used to study the environmental impact of a firm. To elaborate, environmental impacts at the following stages of the life cycle are analysed: (a) during sourcing of raw materials, (b) during production, i.e., processing of raw material into final products, (c) during product use, and (d) during disposal of the products. This approach is operationalised through the following six broad criteria and their components:

1. Sourcing and processing raw materials
2. Plant level environmental performance
   (i) input management
   (ii) process management
   (iii) waste management
3. Product-use performance
4. Product-disposal performance
5. Corporate environmental policy and management systems
   (i) corporate policy related to environment
   (ii) procurement policy and supply chain management
   (iii) status of corporate environmental management and environment management systems (EMS)
   (iv) research and development
   (v) health and safety
   (vi) transparency
6. Community and regulatory perception and compliance status
   (i) compliance with pollution control board (PCB) regulations and perception of PCB officials
   (ii) perceptions of local community
   (iii) perceptions of local NGOs and media
   (iv) perception of CSE's green inspector

It should be noted, however, that the weights assigned to various criteria vary substantially across the three sectors based on their inherent characteristics. For instance, in the case of pulp and paper firms, maximum weight was given to procurement of raw material and production phases, whereas for automobile firms, highest weight was assigned to the product-use phase. This reflects the implicit assumption that environmental impacts of different sectors occur at different stages of the life cycle. As we see later, this may have implications for the findings of our study.

Table 1 summarises the weights used by the CSE for the computation of environmental scores based on which green ratings are given. Some more details regarding the weights assigned to various criteria for rating pulp and paper and automobile firms are shown in Appendix A.1 and A.2, respectively. While the rating categories across the two sectors are not identical, nevertheless there are some striking differences in the weights assigned. First, while plant-level performance (particularly process management) is assigned considerable weight for pulp and paper (50), the corresponding weight for automobiles is 11.5. Second, product use and disposal have been assigned zero weight for pulp and paper but 61 for automobiles.

It is also important to note that the Green Rating Project benchmarks environmental performance against 'theoretical best practice" for the various components/criteria. In other words, companies/plants/products are *not* rated against current environmental norms, standards, or regulations but against an ideal best practice. In fact, full compliance with current environmental regulations merely fetches a score of 2 on a 10 point scale.

Specifically, the green rating uses the following scores on a 10-point scale for each component/criterion: Indian average/standard/legal requirement 2, global best practice 8, theoretical best practice 10. In other words, wherever a domestic source-specific discharge standard exists, it is taken as the lowest benchmark (2 points). In case there is no such standard as in the case of SO_2 emissions, the average discharge for all plants in the sample is taken as the

Table 1
Weights assigned for computation of green rating by the CSE

Segment	Weights		
	Automobile sector	Pulp and paper sector	Chlor alkali sector
Corporate environmental policy and management	20.0	35.0	15.0
Life cycle analysis	77.0	50.0	75.0
- Sourcing phase	7.5	8.0	6.0
- Production phase	8.5	42.0	52.5
- Product use and disposal phase	61.0	0.0	16.5
Primary survey (perceptions of local community, NGOs, etc.)	3.0	15.0	10.0

Source: Centre for Science and Environment (CSE), New Delhi.

lowest benchmark and below-average performance is given zero, the best performance gets 8, and there is a linear scale between 2 and 8[5]. The points given to global best practice and theoretical best practice reflect an incentive for better environmental performance. It is, therefore, important to bear in mind that the rating emphasises overcompliance with current standards or practices. This point is particularly relevant when we interpret the results of our study. In other words, what is the nature of the 'event' that capital markets is reacting to?

The final rating is a "green leaves" award ranging from no award to five leaves[6]. While such ratings are subject to the usual index number problem, we believe they are a consistent and careful evaluation of firm-level environmental performance. Similar exercises entailing public disclosure of firms' environmental performance have been carried out in a few other developing countries, such as in Indonesia under the PROPER programme, in the Philippines under the Ecowatch programme, and in China under the Green Watch programme[7]. There are, however, very few studies for developing market economies that examine the impact of such environmental performance on capital markets. Notable among these is a recent exercise by Dasgupta et al. (2001) that shows capital markets in Argentina, Chile, Mexico, and the Philippines react to both positive and negative environmental news. In that study for each of the four countries, environmental news on firms traded in local capital markets was collected over a 4-year period (1990–1994) from one leading daily newspaper. This news (or 'event') was classified as positive (e.g., rewards, investment in pollution control) and negative (e.g., spills, complaints, and warnings). Total 'events' during this period ranged from 18 (Philippines) to 53 (Chile) covering 10 firms each in the Philippines and Mexico, 11 in Argentina, and 17 in Chile. On the whole, with respect to positive news, there was a statistically significant increase in market values for 20 events out of 39. For negative news, the corresponding figure was 33 events out of 85.

In contrast, our study uses a standardised one-shot event, namely, the announcement of green ratings and leaf awards on July 18, 1999 for pulp and paper firms, October 29, 2001 for automobile firms, and September 2, 2002 for firms in the chlor alkali sector. This has the advantage that it rules out possible selection bias of only 'newsworthy' (very good/bad) events being reported, and it is the same event across all firms. Furthermore, in our study, we only consider one event per firm, whereas Dasgupta et al. (2001) consider multiple bad (and good) 'events' for various firms. For instance, in the Philippines for San Miguel (a brewing company), positive news was reported three times within a span of 10 months (Table V, op. cit.). Only one of these three 'events' resulted in a statistically significant increase in market value. In such instances of repeated positive (or negative) news for the same firm, it is possible that investors may be discounting such news. Finally, unlike classification of events simply as positive or negative, the environmental rating we use provides a complete ordering of firms (see Appendix B.1, B.2 and B.3). In sum, we believe that we are able to bring to data a more objective and consistent measure of firm-level environmental performance for a developing country than has been done so far.

In this context, it may be mentioned that India's stock market capitalisation is about US$ 300 billion (April 2000)—the highest among emerging market economies. Furthermore, the industrial sectors rated by CSE so far are experiencing rapid growth or occupy an important position on the Indian industrial scene[8]. Paper and pulp and caustic soda are also

[5] For paper and pulp the linear scale ranged from 2 through 10 but was later capped at 8 for automobiles and chlor alkali.

[6] The cutoff scores for each level are five leaves (75–100), four leaves (50–74.9), three leaves (35–49.9), two leaves (25–34.9), one leaf (15–24.9), and no award for <15.

[7] For details on the disclosure programmes in Indonesia and the Philippines, see World Bank (1999), and for that in China, see Wang et al. (2002). The impact of Indonesia's PROPER on environmental quality is examined by Afsah and Vincent (1997).

[8] The chlor alkali industry forms the backbone of the chemicals sector in the country. In recent years, all three segments of this industry (caustic soda, soda ash, and chlorine) have experienced generally positive although sluggish growth in output, except chlorine that has recorded double-digit growth. Caustic soda, a basic inorganic chemical, is primarily used for the manufacture of paper, detergents, aluminium, viscose, and other products. Chlorine is a by-product, and for every ton of caustic soda manufactured, 0.8 tons of chlorine is produced. In the automobile sector, two- and three-wheelers make up the largest segment in terms of numbers and have registered growth rates in double digits. The four-wheeler segment shows slower although steady growth, as does the pulp and paper sector.

among the 17 "highly polluting" industrial sectors as identified by the Central Pollution Control Board (CPCB) for implementation of pollution control programs (http://cpcb.nic.in/17cat/17cat.html). In other words, these two sectors are among those that appear to be the focus of environmental regulatory attention and are regularly highlighted in the annual reports of CPCB and on its website. Most state pollution control boards (SPCBs) also take their cue from CPCB in focusing on these sectors. The same is the case with automobile firms where the environmental performance of their products, namely, motor vehicles, has been the subject of intense judicial and regulatory activity in India in recent years.

3. Framework, methodology, and data

In an efficient capital market, stock prices on any day fully reflect available information about the present value of the stream of profits that a firm is expected to earn in the future (Fama, 1991). The provision of new information about the environmental performance of a firm may cause abnormal changes in its stock price, if this information diverges from the investors' expectations about such performance and is perceived by them to affect the profitability of the firm. This is the theoretical framework that underlies the event study methodology, applied by Khanna et al. (1998), Arora (2001), Dasgupta et al. (2001), as well as other researchers, to examine the reaction of capital market to environmental news.

It is generally believed that in developing countries capital markets are not as efficient as in developed countries and are therefore not expected to respond to new environmental information about firms in the same way. As discussed earlier however, Dasgupta et al. (2001) show that capital markets in developing countries do respond to environmental news. Accordingly, we conduct an event study to assess the impact of the announcement of environmental rating of large pulp and paper, auto, and chlor alkali plants in India on the stock prices of the firms to which they belong. Our aim is to investigate whether the capital market in India responded significantly to the announcement of the ratings of plants belonging to these industries and the nature of this response.

3.1. Event study methodology

There are alternative models for carrying out an event study (MacKinlay, 1997). One of them is the market model. Khanna et al. (1998), Arora (2001), and several other event studies have used the market model[9] [see MacKinlay (op. cit.) on the advantages of the market model]. In this study, we use the market model as well.

The market model assumes a linear relationship between the return of any security and the return of the market portfolio:

$$R_{it} = \alpha_i + \beta_i R_{mt} + e_{it} \quad (1)$$

with $E(e_{it}) = 0$ and $\mathrm{Var}(e_{it}) = \sigma^2_{e_i}$ where t is the time index, and $i = 1, \ldots, N$ represents securities. R_{it} and R_{mt} are the return on security i and the market portfolio, respectively, during period t, and e_{it} is the random error term associated with security i.

For estimation of the model, first the event window is defined. This could be just 1 day after the event or more than 1 day after the event. Sometimes, days prior the event are also included in the event window. Eq. (1) is typically estimated over a period of 120 to 210 days prior to the event window. The commonly used estimation method for the market model is Ordinary Least Squares (OLS). Given the estimates of α and β for each firm, the abnormal return for firm i in period t (say, day t) in the event window is defined as

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \quad (2)$$

The abnormal return is the disturbance term of the market model calculated on an out-of-sample basis. Under the null hypothesis, conditional on the event window market returns, the abnormal returns will be jointly normally distributed with a zero conditional mean and conditional variance $\sigma^2(R_{it})$ (MacKinlay, 1997). If the period used for the estimation of the model is large, $\sigma^2(R_{it}) \rightarrow \sigma^2_{e_i}$.

[9] Dasgupta et al. (2001) have applied the constant mean return model as they did not have data on market returns. Where they could find data on market returns, they also obtained results using the market model.

To test for the persistence of the impact of the event during a period T_1 to T_2 (in the event window), the abnormal returns of a given security can be added to obtain cumulative abnormal returns. Cumulative abnormal return (CAR) for security i for the period T_1 to T_2 is given by

$$\mathrm{CAR}_i(T_1, T_2) = \sum_{t=T_1}^{T_2} AR_{it} \tag{3}$$

The variance is given by

$$\sigma_i^2(T_1, T_2) = (T_2 - T_1 + 1)\sigma_{e_i}^2 \tag{4}$$

Given the CAR and its variance, the null hypothesis of zero cumulative returns can be tested by applying a z-test, because $\mathrm{CAR}_i(T_1, T_2) \sim N(0, \sigma_i^2(T_1, T_2))$.

These cumulative returns can also be aggregated across the N scripts and average cumulative abnormal returns (CAAR) can be obtained as

$$\mathrm{CAAR}(T_1, T_2) = \frac{1}{N} \sum_{i=1}^{N} \mathrm{CAR}_i(T_1, T_2) \tag{5}$$

and, the variance of CAAR is

$$\mathrm{var}(\mathrm{CAAR}(T_1, T_2)) = \frac{1}{N^2} \sum_{i=1}^{N} \sigma_i^2(T_1, T_2) \tag{6}$$

Under the null hypothesis that the abnormal returns are zero,

$$Z = \frac{\mathrm{CAAR}(T_1, T_2)}{(\mathrm{var}(\mathrm{CAAR}(T_1, T_2))^{1/2}} \sim N(0, 1) \tag{7}$$

Thus, a z-test can be carried out to test for the statistical significance of average cumulative abnormal return across the N scripts. It should be pointed out here that the distributional result in Eq. (7) above is asymptotic with respect to the number of scripts and the period of estimation (MacKinlay, 1997).

3.2. Data

We use data on stock prices for 17 pulp and paper firms, 15 auto firms, and 18 chlor alkali firms for this study. These are firms whose plants were included in the Green Rating Project of CSE. As mentioned earlier, environmental ratings for the pulp and paper industry were announced by CSE on July 18th 1999, those for automobile firms were announced on October 29th 2001, and for chlor alkali firms, the ratings were declared recently on September 2nd 2002. The announcements of environmental ratings were high-profile events with prominent persons, such as the former Indian Finance Minister (Dr. Manmohan Singh) releasing the scores and distributing the 'leaf' awards. Dr. Singh also chairs the advisory panel for GRP comprising distinguished members, such as P.N. Bhagwati, former Chief Justice of India and T.N. Ninan, editor-in-chief of *Business Standard*, one of India's leading business dailies. (See http://www.cseindia.org/programme/grp/grp_project_team.htm for details.) Thus, the release of ratings was accompanied by extensive media coverage[10].

To carry out the analysis, closing stock prices (adjusted for splits, bonuses, etc.) for the selected companies for 150 trading days prior to the announcement of the rating and 30 trading days after the announcement have been taken from the corporate database PROWESS of Centre for Monitoring the Indian Economy (CMIE)[11]. Because the market model is used, data on market returns are also needed.

[10] For instance, the *Business Standard* wrote an editorial on this on July 20th 1999 ("The greening of rating") and also carried a full-page announcement by CSE on July 21st listing the scores for all pulp and paper firms. This was accompanied by a cover story on the same topic in CSE's influential fortnightly environmental magazine *Down to Earth* (July 16–31, 1999). In addition, all major Indian daily newspapers, such as the *Times of India*, *Hindu, Pioneer*, and the *Indian Express* carried reports and editorials on green rating during the week following the announcement. A similar pattern was observed for subsequent two rounds of green ratings. Finally, a Google Search on "green rating project" and "CSE" in March 2004 (about 18 months after green ratings were last announced) still came up with more than 400 hits.

[11] This database contains financial data on over 8000 Indian firms from 1988–1989 and is regularly updated. These are firms that are registered under the Companies Act and are typically large and medium firms and account for more than 70% of the economic activity in the organised industrial sector of India. The data are primarily gathered from profit and loss statements and balance sheets of companies as well as other secondary sources. See http://www.cmie.com/products/prowess/index.htm for details.

To this end, we use the popular Bombay Stock Exchange (BSE) "Sensex"[12].

The event window has been defined as 10 trading days following the announcement of the green rating of plants. Days prior to the event have not been included in the event window, unlike Dasgupta et al. (2001), because it was felt that the market could not have anticipated the ratings to be given by CSE under its Green Rating Project.[13]

The market model has been estimated with data for 120 trading days prior to the event.[14] In two paper firms, the estimated β turned out to be negative when data for 120 trading days were used. For these two companies, a shorter period within the 120 trading days has been used. The estimation period for these two companies was chosen by repeated trials until the estimate of β became positive and the t-ratio for the regression coefficient was found to be more than one.

As stated earlier, CSE examined 28 units in the pulp and paper sector, 29 in automobiles, and 25 in chlor alkali, with the rating ranging from five leaves (best) to one leaf, or even no leaf for the worst performance/noncooperation. In no case, was a four- or five-leaf rating awarded—as noted earlier, firms/plants/products in the sample were *not* rated against current environmental norms, standards, or regulations but against ideal best practice benchmarks. In fact, as already stated, full compliance with current environmental regulations merely fetches a score of 2 on a 10-point scale. Thus, it seems unlikely that in the near future at least any firm/unit would get a four- or five-leaves award.

The companies chosen for the study are those who own one or more of the plants included in the rating exercise. For some of the plants, share prices of companies owning them were not available. These plants have therefore been excluded from the analysis.

Table 2 shows the distribution of the selected companies according to the ratings of the plants owned by them. Generally, there is a one-to-one correspondence between the plants rated and the companies selected for the study. But there are cases where a company had more than one plant rated. For instance, one pulp and paper company (Ballarpur Industries-BILT) had three plants rated 'two leaves' and two plants rated 'one leaf'. Because this company had the majority of its plants in the 'two leaves' category, the overall rating of the company has been taken as 'two leaves'. Similarly, one company belonging the chlor alkali sample had one plant in the 'three leaves' category and two plants rated as

Table 2
Distribution of companies according to the rating of their unit/plants

Rating	Industries		
	Pulp and paper	Automobiles	Chlor alkali
One leaf	8	4	4
Two leaves	7	8	8
Three leaves	2	2	5
No rating given	–	1[a]	1[a]
Total companies	17	15	18

[a] For plants belonging to these companies, no rating is given. However, their rank and scores indicate that they are at the bottom in terms of environmental performance.

[12] Of 22 stock exchanges in India, the Bombay Stock Exchange is the largest, with over 7500 stocks listed and accounts for over two-thirds of total trading volume in the country. Established in 1875, the exchange is also the oldest in Asia. Approximately 70,000 deals are executed on a daily basis, giving it one of the highest per hour rates of trading in the world. There are about 3500 companies in the country that are listed and have a significant trading volume. The market capitalization of BSE is about 5 trillion rupees (Rs. 45= US$ 1 in February 2004). The BSE Sensex is a widely used market index. It is a value-weighted index comprising 30 companies (base April 1979=100). The set of companies in the index is essentially fixed and account for approximately one-fifth of the market capitalization of BSE.

[13] Note, however, while green ratings of pulp and paper firms were unexpected for players in the stock market, this cannot be assumed for auto and chlor alkali firms. As discussed above, the rating of pulp and paper firms received a good deal of publicity, and the ratings for the other two industries were announced 2 and 3 years later, respectively. Indeed, there is a possibility that prior to the announcement of the ratings for auto and chlor alkali firms, the market may have anticipated the ratings to be poor for most firms (going by past experience), and this may have affected the returns. To explore such a possibility, an event window starting 5 days prior to the announcement and ending 5 days after the announcement has been used and cumulative abnormal returns have been computed for auto and Chlor alkali firms. These results are not discussed in the main text but are reported in footnotes.

[14] To check the sensitivity of the empirical results with respect to the length of preevent window used for the estimation of the market model, alternate estimates have been made by taking the estimation window as 100 and 150 trading days prior to the event. The empirical results obtained by taking the length of the estimation window as 100 or 150 days are qualitatively similar to the results obtained by taking an estimation window of 120 days, and hence not discussed further in the paper. The results are reported in Appendix C.

'two leaves'. Thus, the overall rating of the company has been taken as two leaves.

4. Results

Table 3 shows the average abnormal return for the day following the announcement (event) and average cumulative abnormal returns (CAAR) for 5 and 10 days after the event for the three industrial sectors. The average abnormal return for the 17 pulp and paper firms taken together on the first day after the announcement of green ratings is negative but not statistically significant. That is not the case, however, for event windows longer than a day. Thus, cumulative abnormal returns averaged across the 17 firms (CAAR) are negative and statistically significant for the 5 trading days period (0–5) and the 10 trading days period (0–10). For the 10-day period following the announcement, the cumulative abnormal return is −0.19 on average, which is statistically significant at the 5% level. This may be interpreted as showing an average loss of about 19% in stock value (over and above the changes in the market portfolio) caused by the announcement of green ratings.

It seems the announcement of green rating gave the impression to investors and the public that the environmental performance of pulp and paper mills in India was not up to the mark. Although some plants were rated better than others, even their performance was much below global standards (and of course, theoretical best practice). No pulp and paper mill was given a rating of five or four leaves, and most were given a rating of 'one leaf' or 'two leaves'. The market seems to have taken this news as an adverse indication of the environmental performance of firms.

Somewhat similar results are obtained for the chlor alkali firms. The average abnormal return for day 0–1 and average cumulative abnormal return for days 0–5 and 0–10 are negative for chlor alkali firms, as in the case of pulp and paper. These, however, are not statistically significant.[15] Also, the negative abnormal return in chlor alkali firms is smaller than that for pulp and paper firms. This is perhaps expected because the proportion of companies awarded two or three leaves is relatively greater among chlor alkali firms compared to pulp and paper (Table 2).

Although the negative abnormal returns in chlor alkali firms are smaller than those in pulp and paper firms, these are not low. Average return for day 0–1 for chlor alkali firms is found to be −0.0077. This may be compared to the average return for day 0–1 reported by Khanna et al. (1998) for announcement of toxic release information for U.S. firms for 5 years, 1990 to 1994. For firms whose emissions increased relative to the previous year's estimate, the average return for day 0–1 was in the range of −0.0016 to −0.0046, compared to which the estimate for Indian chlor alkali firms is high. Average cumulative abnormal return for days 0–5 ranges from −0.0046 to −0.0092 in the study of Khanna et al. The estimate for chlor alkali firms in India, at −0.0078, compares well.

Turning now to automobile firms, the results obtained are sharply at variance with those obtained

Table 3
Average cumulative abnormal returns (CAAR): pulp and paper, automobile, and chlor alkali firms in India

	Number of days		
	0–1	0–5	0–10
Pulp and Paper firms			
Average cumulative abnormal return	−0.0229	−0.1050	−0.1912
z-ratio	−0.8168	−1.6684	−2.1489
Automobile firms			
Average cumulative abnormal return	0.0115	0.0529	0.0869
z-ratio	0.9013	1.8533	2.1508
Chlor alkali firms			
Average cumulative abnormal return	−0.0077	−0.0078	−0.0433
z-ratio	−0.5777	−0.2606	−1.0209
Pulp and Paper and Chlor alkali firms			
Average cumulative abnormal return	−0.0152	−0.0550	−0.1152
z-ratio	−0.9895	−1.6069	−2.3784

[15] It may be pointed out here that for the event window from day −5 to day +5, the average cumulative abnormal return for the 18 chlor alkali firms is −0.132, which is statistically significant at the 1% level. This suggests a significant adverse effect of green rating of chlor alkali firms on their stock value. But one cannot confidently assert that the finding of a significant negative abnormal return in the 10-day event period that starts prior to the announcement is reflective of market's anticipation of the ratings.

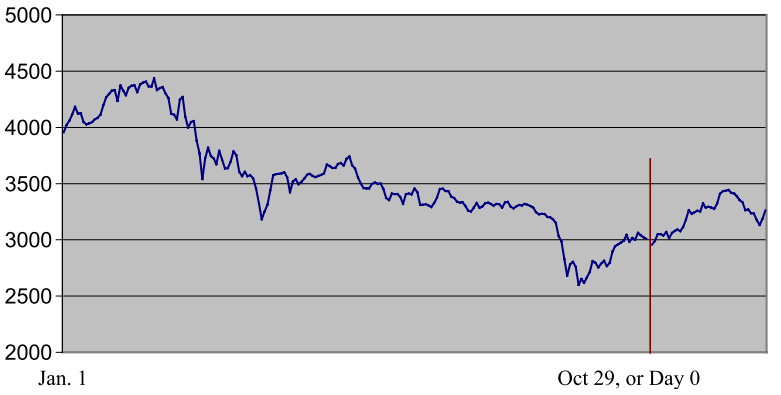

Fig. 1. BSE Sensex 2001.

for pulp and paper and chlor alkali firms. Here, the average abnormal return for day 0–1 and average cumulative abnormal return for trading days 0–5 and 0–10 are positive. Also, the cumulative abnormal returns for days 0–5 and 0–10 are statistically significant.[16]

The finding of positive abnormal return for auto firms could be due to some peculiarities of the industry and/or in the manner of rating. With regard to the latter, as noted earlier, the emphasis in the rating for this sector is on the product per se and not on the production process. Hence, the market may be discounting the mediocre ratings performance by firms in this sector as not being a true reflection of their environmental performance[17]. It is also possible given the CSE's long-running campaign against automobile companies and vehicular pollution, the market expected the worst from the green rating and was in fact pleasantly surprised when the ratings were not so harsh. In other words, better than expected performance could be viewed as positive performance news (with positive abnormal returns).

It should also be pointed out that the announcement of the green rating for this sector came at a time when the stock market was recovering rapidly from a large fall in stock prices it had experienced

Table 4
Average cumulative abnormal returns: pulp and paper and chlor alkali firms

	Number of days		
	0–1	0–5	0–10
Pulp and Paper			
Firms with one leaf rating	−0.0556	−0.1398	−0.3049
Firms with two leaves rating or better	0.0060	−0.0740	−0.0901
Chlor alkali			
Firms with one leaf rating	−0.0079	−0.0384	−0.1056
Firms with two leaves rating or better	−0.0074	0.0010	−0.0225
Pulp and Paper and Chlor alkali			
Firms with one leaf rating (n=12)			
Average cumulative abnormal return	−0.0397	−0.1060	−0.2385
z-ratio	−1.0115	−1.2087	−1.9223
Firms with two-leaves rating or better (n=22)			
Average cumulative abnormal return	−0.0019	−0.0297	−0.0502
z-ratio	−0.1659	−1.1582	−1.3838

[16] As a check on the robustness of the results, an alternate set of estimates has been worked out using the constant mean return model (based on returns in 120 trading days prior to the event). The results obtained are quite similar to the results of the market model. Abnormal return is found to be negative for pulp and paper and chlor alkali firms (statistically significant in the case of the former) and positive for auto firms. It may be pointed out further that the results for the auto firms based on the market model do not change qualitatively when an event window starting 5 days prior to the announcement of rating is used. The average cumulative abnormal return for days −5 to 5 is found to be 0.121, statistically significant at 1%.

[17] This observation goes to the heart of the question—even if we observe the impact of poor environmental performance on stock prices, *what* is the reason for this causality to hold? Does it reflect possible future liability or simply increased pressure from civil society? As of now there is no theory for this causality.

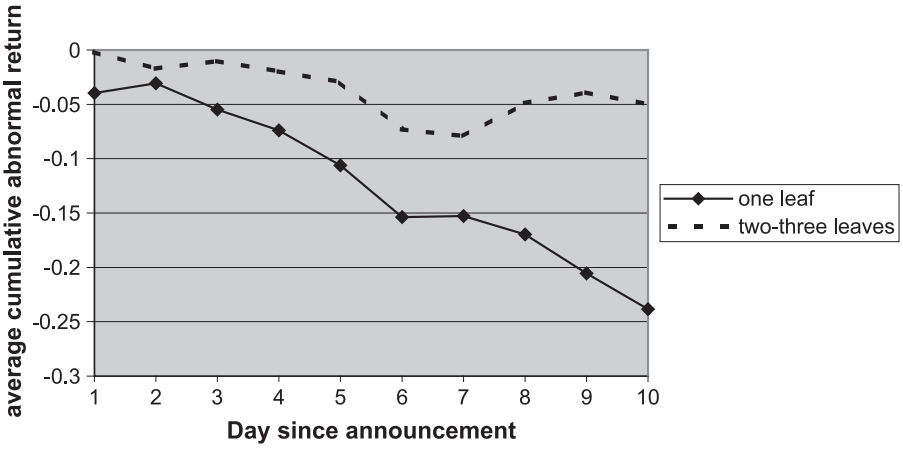

Fig. 2. Cumulative abnormal return: pulp and paper and chlor alkali firms.

for 9 months or so. Between January and September 2001, the BSE Sensex fell from about 4500 to 2500 (Fig. 1). Since October 2001, the stock market made a smart recovery, and by December of that year, the index had recovered to about 3500. Because the announcement of green rating of auto firms was done at the end of October, there was a strong bullish phase in stock prices during the event period. This may have made it difficult for the simple statistical method applied to separate the effect of announcement of green rating by CSE from the effect of other forces working on stock prices of auto companies. This issue has been noted in the event study literature. For instance, Henderson (1990) observes, "If the type of event under study has a greater probability of occurring in a bull market than a bear market, it creates a problem. If expected residuals are based on an estimation interval where the market was not doing well, the conditional expectation of R_{jt} is misspecified, and that misspecification is introduced into the excess return calculation" (p. 294). Similarly, McWilliams and Siegel (1997) note that abnormal returns associated with an event can only be truly identified if, inter alia, (1) markets are efficient, (2) the event was unanticipated, and, most critically, (3) there were no confounding effects during the event window.

It is also interesting to note that although the average of abnormal returns for auto firms as a whole is positive, for some important companies, the abnormal returns for days 0–1 and 0–5 turn out to be negative, for example, Hindustan Motors and Tata Engineering and Locomotives.

Because the results for automobile firms may have been affected by the bullish phase of the stock market at the time of announcement of the green rating and/or by some other factors, the rest of our analysis is based only on estimates for pulp and paper and chlor alkali firms.[18] Thus, the bottom half of Tables 3 and 4 shows average abnormal returns combining only these two sectors, and distinguishing between one-leaf firms and those with more than one leaf. The average abnormal return for day 0–1 and average cumulative abnormal return for days 0–5 and 0–10 are all negative. Moreover, the average for days 0–10 is statistically significant.

Comparing firms that were rated 'one leaf' with those that received two or three leaves, it is found that the average cumulative abnormal return for the 'one-leaf' companies is much more negative than that for the 'two-leaf' and 'three-leaf' groups. For the 0–10 days period, for example, the average cumu-

[18] While the abnormal returns in pulp and paper industry and chlor alkali industry show a clear pattern in relation with the rating of the companies (discussed later), no such pattern is observable in the case of auto firms. Given that the results for the auto firms may have been affected by the bullish phase of the stock market or by other factors, the absence of a correlation between the abnormal return and the rating of auto companies is not unexpected.

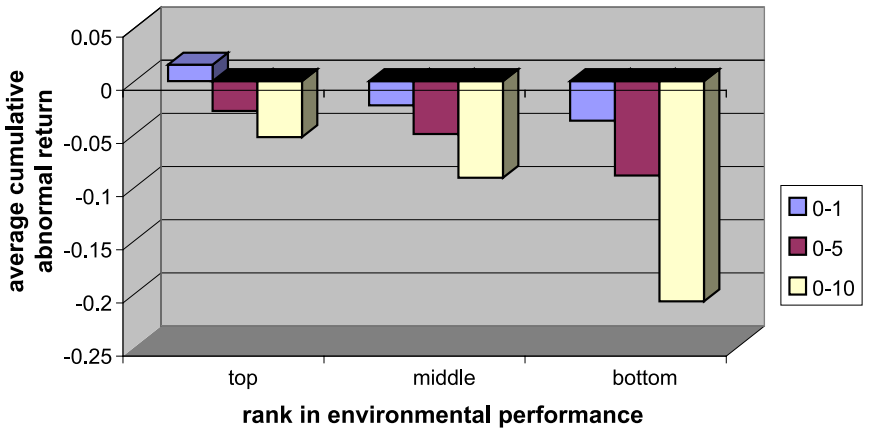

Fig. 3. Average cumulative abnormal return (pulp and paper and chlor alkali firms).

lative abnormal return for pulp for paper firms was −0.30 for the 'one-leaf' firms as against −0.09 for those that received more than one leaf. Similarly, in the case of chlor alkali firms, the average cumulative abnormal return for the 0–10 days period was −0.11 for companies awarded one leaf as against −0.02 for companies awarded two or three leaves. Combining the pulp and paper firms with the chlor alkali firms, the average cumulative abnormal return for the 0–10 days period was −0.24 for companies awarded one leaf, statistically significant at 10% level. The corresponding figure for companies awarded two or three leaves was −0.05, which is statistically insignificant.

The main point that emerges from Tables 3 and 4 is that the capital market seems to have penalized pulp and paper firms and chlor alkali firms for poor environmental performance, especially those whose performance was relatively worse. This is corroborated by Fig. 2 that shows (for pulp and paper and chlor alkali firms combined) average cumulative abnormal return for different lengths of time up to 10 days following the announcement of green ratings.

It is interesting to note that while the average cumulative abnormal return for the 'two-three-leaves' category stabilised after 7 days, that for the 'one-leaf' category continued to fall.

Fig. 3 presents a comparison of average cumulative abnormal return across three groups of firms on the basis of the score/ranking given by CSE—firms have been classified into three groups: the top one-third, the next one-third, and the bottom one-third in terms of environmental performance. Cumulative returns for days 0–1, 0–5, and 0–10 are shown in the graph. It is evident from the graph that the average cumulative

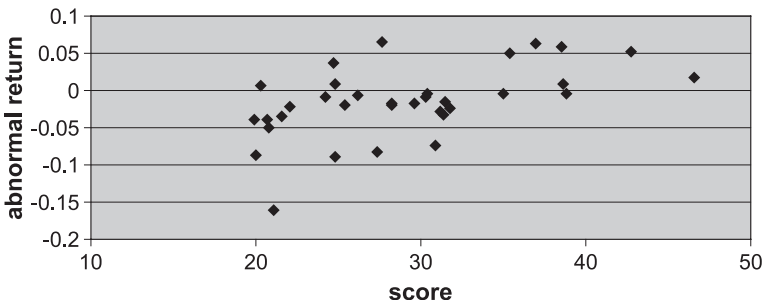

Fig. 4. Environmental score and abnormal return (pulp and paper and chlor alkali firms).

abnormal return is negative for all three groups (except for the top ranking group for day 0–1). Furthermore, the return is the worst for firms that received the lowest score/ranking.

It should be pointed out here that in the sample of pulp and paper and chlor alkali firms combined (and also independently for the two groups), there is a significant positive correlation between the estimated abnormal return and the environmental score. The correlation coefficient between estimated abnormal return on the first day after the announcement and the weighted score is 0.54 (see Fig. 4 for the plot). This is statistically significant at the 1% level. The correlation coefficients for abnormal returns for days 0–5 and 0–10 are 0.35 and 0.43, respectively. All of these are statistically significant at 5% or higher level. The finding of a significant positive correlation between environmental score and abnormal return as one would expect provides basis for confidence in the estimates of abnormal returns we have obtained.

5. Conclusions

As stated earlier, to our knowledge, this is the first attempt to examine the impact of public disclosure of environmental performance on the financial performance of firms for a developing economy. In future work, it would be useful to examine if these findings are robust across sectors and over time. With respect to methodology, alternatives to the market model, such as CAPM and the multifactor model (Tawil, 1999) could be employed, again to test the robustness of the results. More important, however, in a developing country context where market adjustment is slow is the application of diffusion theory to test how markets adjust to 'events' (Boardman et al., 1997). These are issues for further research.

Our findings further strengthen the emerging view that capital markets bolster regulatory efforts in both developed and developing market economies. Specifically, a perception of weak environmental performance by dirty industries is penalized by negative abnormal returns. This result is not driven by disparate 'events' as in an earlier study but by a comprehensive and consistent green rating. Thus, an important policy implication of the research would be institutionalising such public disclosure programmes as a tool for environmental management in developing countries.

Acknowledgements

We would like to thank Supriya Singh for able research assistance in extracting and analysing the data, the Centre for Development Economics, Delhi School of Economics and the Centre for Science and Environment, New Delhi, for providing the data for the study. The article benefited from comments by two anonymous referees. We are responsible for any remaining errors.

Appendix A

A.1. Weights for rating of pulp and paper firms

	Weight
Corporate environmental policy and management systems	35
(i) Corporate environmental policy (7)	
(ii) Corporate policy on procurement of raw materials, water, energy, and chemicals (3)	
(iii) Corporate policy on waste management, technology adoption, and community relations and communications (2)	
(iv) Status of corporate environmental management (19.5)	
(v) Transparency (2)	
(vi) Awards (1.5)	
Plant-level environmental performance	50
(i) Input management (8)	
(ii) Process management (including recycling and reuse of resources and wastes (31)	
(iii) Waste management (11)	
Product use performance	0
Product disposal performance	15
Community and regulatory perception and compliance status	
(i) Compliance with pollution control board (PCB) regulations and perception of PCB officials (2.5)	
(ii) Perception of local community (7.5)	
(iii) Perception of local NGOs and media (2.5)	
(iv) Perception CSE's green inspector (2.5)	
Total	100

Source: "Enter the Green Rating Project", Centre for Science and Environment, New Delhi, 1999.

A.2. Weights for rating of automobile firms

	Weight
Environmental performance of supply chain	7.5
Environmental performance of production plant	11.5
(i) Consumption efficiency (1.5)	
(ii) Process management and process efficiency (4)	
(iii) Pollution generation and pollution prevention and control (2.5)	
(iv) Compliance status at production plant (0.5)	
(v) Perception of CSE's green inspector (3)	
Environmental impact during product use	56
(i) Vehicle and engine design (34.5) of which	
(a) Geometric design of the engine (10.5)	
(b) Fuel supply technology of the vehicle (6)	
(c) Displacement per cylinder (3)	
(d) Compression ratio (3)	
(ii) Pollution control equipment (12)	
(iii) Emissions and noise pollution from vehicles (9.5)	
End-of-life disposal/recycling of product	5
Corporate environmental policy and management systems	20
Total	100

Source: "Green Rating Project: Environmental Rating of Indian Automobile Sector," Centre for Science and Environment 2001.

Appendix B

B.1. Ratings of pulp and paper mills

	Name	Installed capacity (metric tons/year)	Weighted score	Rank	Rating (number of leaves)
1	JK Paper Mills	90,000	42.75	1	3
2	Andhra Pradesh Paper Mills	98,500	38.50	2	3
3	Sinar Mas Pulp and Paper (India)	115,000	37.40	[a]	
4	BILT-Ballarpur Unit	150,000	33.44	3	2
5	Hindustan Newsprint	100,000	33.30	4	2
6	SIV Industries	60,000	31.73	5	2
7	Pudumjee Pulp and Paper Mills	33,000	31.44	6	2
8	Tamil Nadu Newsprint and Papers	180,000	31.40	7	2
9	ITC-Bhadrachalam Paperboards	62,500	31.15	8	2
10	Century Pulp and Paper	151,920	31.07	9	2
11	HPCL-Nagaon Paper Mills	100,000	28.70	10	2
12	Seshasayee Paper and Boards	60,000	28.20	11	2
13	West Coast Paper Mills	119,750	27.67	12	2
14	BILT-Asthi Unit	35,000	27.10	13	2
15	BILT-Yamunanagar Unit	70,000	25.70	14	2
16	Central Pulp Mills	45,000	25.35	15	2
17	Star Paper Mills	53,000	24.76	16	1
18	Shree Vindhya Paper Mills	33,000	24.70	17	1
19	BILT-Sewa Unit	30,000	23.75	18	1
20	Orient Paper Mills	85,000	22.10	19	1
21	Mysore Paper Mills	130,000	21.60	20	1
22	Cachar Paper Mills	100,000	21.43	21	1
23	Rama Newsprint and Papers	61,380	21.10	22	1
24	BILT-Chaudwar Unit	20,000	21.06	23	1
25	Nath Pulp and Paper Mills	41,750	20.80	24	1
26	Grasim Industries (Mavoor)	57,600	20.65	25	1
27	Mukerian Papers	34,650	20.01	26	1
28	Amrit Papers	26,400	19.01	27	1

Appendix B.1 (*continued*)

Source: The Green Rating Project, Centre for Science and Environment, New Delhi.

[a] Sinar Mas was operational only since 1996–1997, and therefore it was not included in the rankings.

B.2. Ratings of automobile firms

	Name	Weighted score	Rank	Rating (number of leaves)
1	Daewoo Motors India	43.54	1	3
2	Hyundai Motors India	41.93	2	3
3	General Motors India	40.78	3	3
4	Mercedes-Benz India	39.63	4	3
5	Hero Honda Motors	39.57	5	3
6	Maruti Udyog	39.14	6	3
7	Honda-Siel	38.23	7	3
8	Ford India	37.62	8	3
9	Fiat India	35.67	9	3
10	Volvo India Pvt.	34.60	10	2
11	Bajaj Auto	32.84	11	2
12	Tata Engg. and Loco.	32.03	12	2

(continued on next page)

Appendix B.2 (*continued*)

	Name	Weighted score	Rank	Rating (number of leaves)
13	Hindustan Motors	31.11	13	2
14	TVS Suzuki	30.86	14	2
15	LML Limited	29.36	15	2
16	Toyota Kirloskar Motors	28.13	16	2
17	Scooters India	27.84	17	2
18	Kinetic Motor	27.44	18	2
19	HM-Mitsubishi Lancer	27.38	19	2
20	Ashok Leyland	26.41	20	2
21	Eicher Motors	25.07	21	2
22	Mahindra and Mahindra	24.15	22	1
23	Royal Enfield Motors	23.22	23	1
24	Majestic Auto	20.52	24	1
25	Hero Puch	20.26	25	1
26	Kinetic Engineering	15.82	26	1
27	Bajaj Tempo	0.00	27	–
28	Yamaha Motors Escorts	0.00	27	–
29	Swaraj Mazda	0.00	27	–

Source: The Green Rating Project, Centre for Science and Environment, New Delhi.

B.3. Ratings of chlor alkali firms

	Name	Weighted Score	Rank	Rating (number of leaves)
1	Chemfab Alkalis	46.6	1	3
2	Shriram Alkalis and Chemicals	45.3	2	3
3	Indian Rayon and Industries	38.8	3	3
4	Indian Petrochemicals	38.6	4	3
5	Search Chem Industries	36.2	5	3
6	Sree Rayalseems Alkalis and Allied Chemicals	35.4	6	3
7	TamilNadu Petroproducts	35	7	3
8	Gujarat Alkalis and Chemicals-Vadodra	33	8	2
9	Grasim Industries	30.4	9	2
10	BILT Chemicals	30.36	10	2
11	Century Rayon	29.6	11	2
12	Gujarat Alkalis and Chemicals-Dahej	28.9	12	2
13	Shriram Chemicals and Fertilizers	28.7	13	2
14	DCW	28.2	14	2
15	SIEL	27.4	15	2
16	Bihar Caustic and Chemicals	25.4	16	2
17	Kanoria Chemicals	24.8	17	1
18	Standard Industries	24.2	18	1
19	Hukumchand Jute and Industries (HJI- GMMCO)	21.7	19	1

Appendix B.3 (*continued*)

	Name	Weighted Score	Rank	Rating (number of leaves)
20	NRC- Chemical Division	20.3	20	1
21	Punjab Alkalis and Chemicals	19.9	21	1
22	Travancore Cochin Chemicals	15.1	22	1
23	Andhra Sugars-Kovvur	0.0	23	–
24	Andhra Sugars-Saggonda	0.0	23	–
25	Chemplast Sanmar	0.0	23	–

Source: The Green Rating Project, Centre for Science and Environment, New Delhi.

Appendix C. Sensitivity of CAAR estimates with respect to length of estimation window

	Estimation window	CAAR/*z*-ratio	Number of days		
			0–1	0–5	0–10
Pulp and Paper firms					
	100 days	CAAR	−0.0200	−0.1073	−0.2040
		z-ratio	−0.7109	−1.7079	−2.2965
	120 days	CAAR	−0.0229	−0.1050	−0.1912
		z-ratio	−0.8168	−1.6684	−2.1489
	150 days	CAAR	−0.0176	−0.0910	−0.1694
		z-ratio	−0.6439	−1.4898	−1.9609
Automobile firms					
	100 days	CAAR	0.0114	0.0551	0.0915
		z-ratio	0.8355	1.8053	2.1191
	120 days	CAAR	0.0115	0.0529	0.0869
		z-ratio	0.9013	1.8533	2.1508
	150 days	CAAR	0.0118	0.0565	0.0942
		z-ratio	0.8668	1.8549	2.1869
Chlor alkali firms					
	100 days	CAAR	−0.0065	−0.0017	−0.0320
		z-ratio	−0.4849	−0.0563	−0.7593
	120 days	CAAR	−0.0077	−0.0078	−0.0433
		z-ratio	−0.5777	−0.2606	−1.0209
	150 days	CAAR	−0.0081	−0.0078	−0.0376
		z-ratio	−0.6117	−0.2630	−0.8928
Pulp and paper and chlor alkali firms					
	100 days	CAAR	−0.0130	−0.0530	−0.1155
		z-ratio	−0.8529	−1.5517	−2.3931
	120 days	CAAR	−0.0152	−0.0550	−0.1152
		z-ratio	−0.9895	−1.6069	−2.3784
	150 days	CAAR	−0.0127	−0.0482	−0.1016
		z-ratio	−0.8527	−1.4446	−2.1519

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