

Disclosure of Environmental Violations and the Stock Market in the Republic of Korea

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Summary. For almost 20 years, the Ministry of Environment of the Republic of Korea has published on a monthly basis a list of enterprises which fail to comply with national environmental laws and regulations. In this paper, we examine the reaction of investors to the publication of these lists, and show that enterprises appearing on these lists have experienced a significant decline in their market valuation.

Key words – Environmental violations, public disclosure, stock market, Korea.

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I. Introduction

It is often said that firms in developing countries do not have incentives to invest in pollution control effort because of weak implementation of environmental regulations: the cost of complying with the regulation exceed expected benefits resulting from a reduction in expected penalty. However, this argument assumes that the environmental regulator is the only agent that can effectively penalize firms lacking compliance. Recent research indicates that local communities may exercise considerable leverage to pressure firms to improve their environmental performance.¹ The argument also ignores that capital markets may react *negatively* to the announcement of adverse environmental incidents (such as violation of permits, spills, court actions, complaints, etc.) or *positively* to the announcement of superior environmental performance. Hence, when accounting solely for regulators' fines and penalties and ignoring the pressure that communities and markets may bear, the expected costs associated with a poor environmental performance may be significantly under-estimated. The inability of formal institutions especially in developing countries to provide incentives for pollution control effort via the traditional channel of fines and penalties may not be as serious an impediment to pollution control as is generally argued: Communities and capital markets, if properly informed, may in specific circumstances provide appropriate incentives.

A limited number of papers have analyzed the reaction of capital markets to environmental news in Canada and the United States. These studies have generally shown that firms suffer from a decline in market values following the announcement of

¹ See Afsah et al. (1996), Blackman et al. (1998), and Pargal and Wheeler (1996).

adverse environmental news.² The impact of firm-specific environmental news on market value may work its way through various channels: a high level of pollution intensity may signal to investors the inefficiency of the firm's production process; it may invite stricter scrutiny by environmental groups and/or facility neighbours; it may result in the loss of reputation, goodwill, etc. On the other hand, the announcement of a good environmental performance or of the investment in cleaner technologies may have the opposite effect: lesser scrutiny by regulators and communities (including the financial community), and greater access to international markets among other benefits.³

Studies of this nature in developing countries have been very limited in numbers. In a recent paper, Dasgupta et al. (2001) have shown that capital markets in Argentina, Chile, Mexico, and the Philippines do react negatively (decrease in firms' value) to citizens' complaints targeted at specific firms, and positively to the announcement of rewards and recognition of superior environmental performance. These results suggest that environmental regulators in developing countries may explicitly harness those market forces by introducing structured programs of information release on firms' environmental performance, and empower communities and stakeholders through environmental education programs.

Numerous countries, both developing and developed have in fact implemented such programs. An increasing number of environmental regulators around the world have

² In the United States, these studies include analyses of the reaction of capital markets to releases of the *Toxics Release Inventory* (Hamilton (1995), and Konar and Cohen (1997)). Lanoie and Laplante (1994) analyze the reaction of capital markets to environmental news in Canada. For a survey of these studies, see Lanoie, Laplante and Roy (1998).

³ See Porter and Van Linde (1995), and Konar and Cohen (1997) for a more detailed discussion.

indeed sought to complement or supplement traditional enforcement actions (fines and penalties) with the adoption of structured information programs (or public disclosure programs) by which the environmental performance of industrial facilities is revealed. Programs such as the Toxics Release Inventory (TRI) in the United States (also implemented in Canada and Great Britain), or the Proper Prokasih program in Indonesia and the EcoWatch program in the Philippines are examples of structured information programs that rely on non-regulatory forces to create incentives for (mainly industrial) facilities to improve environmental performance.⁴

While this may not be as well-known, the Republic of Korea (henceforth Korea) has developed its own extensive experience with the public disclosure of environmental performance of regulated facilities. Since the mid 1980s, the Ministry of Environment of Korea has published on a monthly basis a list of facilities in violation with existing Korean environmental laws and regulations. Over the sole period of 1993 to 2002, over 7,000 *violations* have been reported on those lists, involving more than 3,400 facilities. As such, the Korean experience with a structured public disclosure program may very well be one of the most extensive experiences of this nature in the world.⁵ In this paper, building upon the existing, albeit limited literature on this topic, we examine whether or not capital markets in Korea have reacted to the information contained in these monthly violation lists.

⁴ See Foulon et al. (2002), Lanoie et al. (1998), and World Bank (2000) for a description of such programs.

⁵ While it covers a larger number of years and facilities, the US TRI does not, by its very nature, focus necessarily on facilities in *violation* of existing laws and regulations.

In the next section, we provide a brief description of the Korean public disclosure program. In Section 3, the event-study methodology is briefly described. We present the dataset and our results in Section 4, and conclude in Section 5.

2. Description of the Korean public disclosure program⁶

In the course of the rapid economic expansion of the 70's and 80's, the Government of Korea expressed a reluctance to strictly enforce its environmental regulations worrying to damage the economic performance and competitiveness of industrial facilities. On the other hand, there was mounting pressure on the Government to improve environmental protection in the country. It is in this context that the Monthly Violations Report (henceforth MVR) was first published in March 1984 by the Environment Administration as news material distributed to media reporters. The government's rationale behind the disclosure of the MVR was to provide incentives for industrial facilities not to practice illegal polluting activities while not resorting to legal fines and penalties. The MVR then consisted of a list of facilities in violation with existing Korean environmental laws and regulations. The violations included, among others, emission standard violation and failure to operate pollution control equipment. Given the limited monitoring capacity in terms both of financial and human resources, the MVR then had a very limited coverage.

In 1990, the Environment Administration became the Ministry of the Environment and was upgraded to the cabinet level, thereby being able to take greater charge of environmental policies and affairs within the government. The MVR disclosure

⁶ For a detailed description, see Hong et al. (2003).

program has continued throughout the 1990s. Under the Ministry, the program has enlarged considerably in terms of human and financial resources. A typical MVR in this period is based on information gathered through monthly government inspections on about 10,000 air and water polluting facilities, using a total of approximately 15,000 man-days from local governments and Regional Environmental Offices. Since November 1990, the Reports are also publicly disclosed through the Ministry of Environment official website, thus widening considerably its public outreach.⁷

While similar in spirit to the U.S. EPA's Toxics Release Inventory (TRI), the Korean MVR differs significantly from the TRI in that it reports the names of companies that are effectively deemed to be *in violation* of Korean environmental laws, as well as the nature of enforcement actions undertaken by the Ministry. The TRI is limited to reporting quantities of toxic wastes produced by a set of facilities, without attempting to assess the compliance status of these facilities. To this extent, the Korean MVR is conceptually similar to the lists by the Ministry of Environment, Lands and Parks of British Columbia (Canada) which aims to publicly disclose firms that either do not comply with the existing regulation or whose environmental performance is of concern to the Ministry.⁸

Over the period 1993-2002,⁹ a total of 7,073 violation events appeared on a total of 113 violation lists published on a monthly basis. Over this period of observation, a

⁷ See: www.me.go.kr

⁸ See Foulon et al. (2002) for more details.

⁹ The Korean regulation pertaining to the length of time that information must be stored is such that all records previous to 1993 are unfortunately no longer available. While in this paper we shall refer to the

total of 3,455 different facilities have appeared on the monthly violation lists, some more than once. The number of events and facilities indicates that on average each facility appeared 2.5 times on the violation lists. Most of these facilities (85%) belong to the manufacturing sector. Of greater interest for the purpose of the current paper is that 17% of the facilities appearing on these lists are listed on the Korea Stock Exchange (KSE) whose headquarters are located in Seoul. While the percentage of events involving traded companies may appear relatively small (approximately 17%), it is worth noting that in 2001, 690 companies were listed on the Korea Stock Exchange, out of a total of 106 550 manufacturing firms with 5 employees or more, thus representing less than 1% of the total number of manufacturing facilities. This would suggest that traded companies are in fact overly represented in the monthly violation lists relative to their overall number in the population of enterprises in Korea.

Approximately 60% of the violations reported in the MVR pertain to the violation of Korean emissions standards. The second largest type of violation (18.0%) is the failure of pollution abatement equipment to operate effectively. Insofar as government actions are concerned, the largest number (61%) is government orders, followed with warning and prosecutions. Orders include orders to change equipment, and to appoint environmental management personnel. While a large number of facilities have been subjected to only 1 government action, an even larger number of facilities have received more than one government action. For example, 145 facilities have been subjected from 5 to 10 government actions; 13 facilities have received more than 20 government actions;

period 1993-2002, it should be understood that it also includes December 1992, while data for 2002 covers solely the period January to April 2002.

the Busung Paper company has received the largest number of government actions with a total of 84.

Since 1990, the Korea Press Foundation has operated a comprehensive online news database service known as KINDS (Korean Integrated News Database System). This system is the largest service of this nature in Korea. It covers national and economic daily newspapers in both Korean and English, news bulletins, local daily newspapers, magazines, and foreign newspapers. It provides the complete text of 10 major national daily newspapers.¹⁰ On-line users can further search articles in 23 local daily newspapers in Korea. Since its inception, it has cumulated a total of over 3 million articles, and continues to add to its database approximately 2,000 articles each and every day. The KINDS database was searched by entering keywords such as environment, violation, and accident, searching for articles related to environmental news.

Over the period of observation, approximately 11% of the total number of violation events that have appeared on the MVR have been covered by printed news media. In Table 1, note that of the 756 events covered in the printed news media, 40% of them involved traded companies. Given that traded companies represent only 17% of the total number of violation events, it would appear that news media show a particular attention to traded companies (which may also be larger and more prominent companies) in their news coverage of the MVR.

¹⁰ The Kyunghyang Shinmun, the Kukmin Daily, the Korea Daily News, the Dong-A Ilbo, The Numhwa Ilbo, the Segye Ilbo, the Chosun Ilbo, the Joongang Ilbo, the Hankyoreh, and the Hankook Ilbo.

Table 1
Media coverage: Traded vs. non-traded

In news	Total	Traded	% traded	Non-traded	% non-traded
No	6317	887	14 %	5430	86 %
Yes	756	303	40 %	453	60 %

This greater interest in traded companies is also revealed by examining the number of newspapers in Korea that have given coverage to a specific violation event. In Table 2, note that 39.3% of the events involving traded companies have been covered by more than 1 newspaper, while only 24.1% of the events involving non-traded companies have been covered in more than one newspaper.

Table 2
Frequency of news coverage: Traded vs. non-traded

Number of newspapers that have covered the event	Total	Traded	% traded	Non-traded	% non-traded
1	531	187	61.7	344	75.9
2	137	64	21.1	73	16.1
3	52	28	9.2	24	5.3
4	21	15	5.0	6	1.3
5	8	6	2.0	2	0.4
6	4	2	0.7	2	0.4
7	1		0.0	1	0.2
8	2	1	0.3	1	0.2
Total	756	303	100.0	453	100.0

Newspapers appear to be particularly interested by violations pertaining to the failure of pollution abatement equipment (Table 3). While this type of violation represents only 18.0% of the total number of events, it represents more than 25% of the events covered by newspapers. On the other hand, while the failure to report and failure of the monitoring system represent 9.2% of the total number of violations, these two types of violation represent only 5.5% of the events covered by the newspapers.

Table 3
News coverage per type of violation

Nature of violation	% of events covered in news	% of total events
Violation of emissions standards	53.9	60.8
Failure of pollution abatement equipment	25.1	18.0
Failure to report	3.4	5.3
Failure of monitoring system	2.1	3.9
Failure of environmental manager	1.9	3.6
Violation of technical standards on inputs	0.5	0.9
Illegal waste discharges	1.2	0.8
Violation of government order	0.6	0.7
Other violation	11.2	6.1
Total	100.0	100.0

In terms of government actions, orders and warnings appears to receive less interest from the newspapers than their weight as a percentage of the total number of violation events (Table 4). However, while prosecutions represent only 9.9% of the total violation events, they represent almost 16% of the violation events reported in the newspapers. Similarly, shutdowns (temporary or complete) and bans receive more attention in newspapers (7.5% of all events in the newspapers) than their overall importance in the monthly violation lists (11.8% of all violation events).

Table 4
News coverage per type of government actions

Government actions	% of events covered in news	% of total events
Order	53.9	61.3
Warning	8.1	11.4
Prosecution	15.8	9.9
Penalty	4.2	7.1
Temporary shutdown	5.8	4.3
Shutdown	6.0	3.2
Ban to use specific equipment	6.0	2.8
Other	0.1	0.1
Total	100.0	100.0

The above information indicates that newspapers have indeed paid attention to the information released by the Ministry of the Environment in its MVR, and that the media coverage has focused very significantly on publicly traded companies. This therefore sets the stage for an analysis of how the Korean Stock Market reacted to the media coverage of the MVR.

3. Event-study methodology

The event-study methodology is used here to see the extent to which investors react to environmental news (also called events).¹¹ The key assumption of the methodology is that capital markets are sufficiently efficient to evaluate the impact of new information (events) on expected future profits of the firms.

The methodology involves the following steps: (1) identification of the events of interest and definition of the event window;¹² (2) selection of the sample set of firms to

¹¹ For more details, see MacKinlay (1997).

¹² The event window consists of the day where the event occurred (day 0) and some days before and after the event.

include in the analysis;¹³ (3) prediction of a “normal” return during the event window in the absence of the event; (4) estimation of the abnormal return within the event window, where the abnormal return is defined as the difference between the actual and predicted returns; and (5) testing whether the abnormal return is statistically different from zero. The market model is of interest here to estimate abnormal returns.

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

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

with $E(e_{it}) = 0$ and $Var(e_{it}) = \sigma_{e_i}^2$

where t is the time index, $i = 1, 2, \dots, N$ stands for security, R_{it} and R_{mt} are the returns on security i and the market portfolio respectively during period t , and e_{it} is the error term for security i .

Equation (1) is generally estimated over a period which runs between 120 and 210 days prior to the event up to some days prior to the event. The event window is defined as the period from some days prior to the event to some days after the event. The size of the event window is really an empirical matter. With the estimates of α_i and β_i from equation (1), one can predict a “normal” return during the days covered by the event window. The prediction error (the difference between the actual return and the predicted

¹³ Firms may be excluded if simultaneous events are occurring within the event window.

normal return), commonly referred to as the abnormal return (AR) for a single security i at a given time t , is then calculated as:

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

Under the null hypothesis, the abnormal returns will be jointly normally determined with a zero conditional mean and conditional variance $\sigma^2(AR_{it})$:

$$(3) \quad \sigma^2(AR_{it}) = \sigma_{e_i}^2 + \frac{1}{L} \left[1 + \frac{(R_{mt} - \bar{R}_m)^2}{\sigma_m^2} \right]$$

where L is the estimation period length (i.e. number of days used for estimation) and \bar{R}_m is the mean of the market portfolio. With L large, $\sigma^2(AR_{it}) \rightarrow \sigma_{e_i}^2$.

For each individual event, one can estimate the abnormal return and relevant test statistics at each instant in time within the event window. However, in order to draw overall inference about the reaction of capital markets, one can also aggregate the abnormal returns across a number of events (usually across events of a similar nature). Hence, for any given subset of N events (or securities), the subset average abnormal returns (AAR_t) at each instant t within the event window is computed as

$$(4) \quad AAR_t = \frac{1}{N} \sum_{i=1}^N AR_{it}$$

For large L , the variance is

$$(5) \quad VAR(AAR_t) = \frac{1}{N^2} \sum_{i=1}^N \sigma_{e_i}^2$$

To test for the significance of AAR_t , a Z (or t) test can be derived.

In order to test for the persistence of the impact of the event during a period $(T_2 - T_1)$, the abnormal return for a given security i can also be added to obtain the cumulated abnormal returns $(CAR_i(T_1, T_2))$ for security i over the period $(T_2 - T_1)$:

$$(6) \quad CAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} AR_{it}$$

where $T_a \leq T_1 < t < T_2 \leq T_b \in$ event window, and T_a and T_b are the lower and upper limits of the event window, respectively.¹⁴ Asymptotically (as L increases) the variance of the cumulative abnormal return for security i is

$$(7) \quad \sigma_i^2(T_1, T_2) = (T_2 - T_1 + 1) \sigma_{e_i}^2.$$

To test the null hypothesis of zero cumulative abnormal return, one can formulate a Z test as $CAR_i(T_1, T_2) \sim N(0, \sigma_i^2(T_1, T_2))$:

$$(8) \quad Z = \frac{CAR}{(\sigma_i^2(T_1, T_2))^{1/2}} \sim N(0,1)$$

¹⁴ T_1 and T_2 are thus contained within the event window and the aggregation of the abnormal return takes place between those days within the window. As a possibility, T_1 can coincide with the lower bound of the event window and T_2 with the upper bound.

An aggregation of interest can also be performed across both time and events. In that scenario, the average cumulative abnormal return for a subset of N events between two dates T_1 and T_2 is defined as:

$$(9) \quad CAAR(T_1, T_2) = \frac{1}{N} \sum_{i=1}^N CAR_i(T_1, T_2)$$

where N is the number of events. The variance of $CAAR$ is

$$(10) \quad \text{var}(CAAR(T_1, T_2)) = \frac{1}{N^2} \sum_{i=1}^N \sigma_i^2(T_1, T_2)$$

Under the null hypotheses that the abnormal returns are zero,

$$(11) \quad Z = \frac{CAAR(T_1, T_2)}{(\text{var}(CAAR(T_1, T_2)))^{1/2}} \sim N(0,1)$$

As pointed out by MacKinlay (1997), this distributional result is asymptotic with respect to the number of securities N and the length of estimation window L . Moreover, the validity of cross-sectional (or pooled) aggregation of abnormal returns rests on the assumption that the event windows do not overlap. If they do then the distributional results presented above are no longer valid since covariances across securities are no longer zero, particularly in the case of complete clustering. There are two solutions to the problem of clustering. The first one is to aggregate abnormal returns into portfolios. The

second one is basically to leave abnormal returns unaggregated; that is, one has to deal with abnormal returns security by security (for details, see MacKinlay, 1997, 27).

In the next section, we present results obtained from using the single-index model (constant mean return model).¹⁵

4. Dataset and Results

The initial dataset comprises 96 environmental news (details appear in Appendix 1). These events were examined to identify whether or not other events (positive or negative) were observed during the identified window. These confounding events could impact the results from the event-study methodology. As a result, 9 events were eliminated from the dataset.¹⁶ Thus, the dataset used for the analysis of stock market reaction comprises 87 environmental news involving 57 publicly traded firms over the period 1993 to 2000. All events are of a negative nature. Of the 87 events, 57 (65.5%) pertain to the violation of emissions standards, while 17 (19.5%) pertain to the failure to operate pollution abatement equipment.

We apply the event-study methodology to each of these 87 events. The study uses an estimation period of 210 days before the event window and an event window of 7 days (3 days prior the event, the day of the announcement, and 3 days after the event).

¹⁵ The single-index model is a particular case of the market model described above. Where market returns were available, we also obtained results using the market model. Results were similar to those presented here. In fact, Henderson (1990) points out that the three estimating methodologies yield results of similar nature.

¹⁶ These are (by code number): 210 (3/4/99), 2270 (12/1/99 and 11/3/99), 2580 (8/31/96), 4800 (8/27/99), 5300 (7/1/94), 9830 (12/30/96), 11780 (1/30/97), and 15760 (8/1/96).

The latter size of the event window has been determined empirically through a search over a period of 10 days before and 10 days after the event.

Appendix 2 presents the list of 87 events and differentiates those events for which a statistically significant stock market reaction has been estimated from those for which no such reaction has been estimated. Detailed statistical results for those events with market reaction are presented in Appendix 3.

As shown in Appendix 2, 52 of the 87 events (60%) included in our dataset show a statistically significant market reaction. However, 5 of these exhibit a positive market reaction.¹⁷ We were not able to identify whether or not these 5 events were plagued by the presence of simultaneous, positive, events. We cannot therefore offer a credible explanation for the unexpected market reaction for these 5 events. Of those events with negative market reactions, the average percentage reduction in market value has been calculated to be 9.7%. As shown in Table 5 below, this average reduction in market value is much higher than results obtained in Canada and the United States, but of a similar order of magnitude as results obtained in Argentina, Chile, Mexico, and the Philippines (Dasgupta et al. (2001)). This would tend to re-enforce the hypothesis that capital markets in developing countries may attach a greater premium to information which otherwise may generally not be as readily available as in more developed markets.

¹⁷ These events are (by code number): 1440 (9/27/93), 1460 (4/27/93), 2270 (1/20/2000), 9840 (3/1/94), and 25830 (8/31/96).

Table 5
Comparative results

Selected studies	Events	Media	Observed Reaction^a
Muoghalu et al. (1990)	Filing of lawsuit for violation of RCRA ^b	Newspaper (USA)	-1.2%
Lanoie and Laplante (1994)	Court finds firm guilty for violating environ. Regulation	Newspaper (Canada)	-1.65%
Klassen and McLaughlin (1996)	Environmental crisis	Newspaper (USA)	-1.5%
Hamilton (1995)	List of polluters	Toxics Release Inventory (USA)	-0.3%
Konar and Cohen (1997)	List of polluters	Toxics Release Inventory (USA)	-1.3%
Lanoie, Laplante, and Roy (1998)	List of polluters	British Columbia (Canada)	-2%
Dasgupta et al. (2001)	Citizens complaints and environmental accidents	Newspaper (Argentina, Chile, Mexico and Philippines)	-4% to -15%

^a Average estimated change in market return.

^b Resource Conservation and Recovery Act.

If we include all events with market reaction, we note in Table 6 that 69% (36/52) of the events with market reaction are violation of emission standard, which is a slightly higher percentage than the percentage of those events in our dataset (65%). On the other hand, the failure to operate PCE properly represents only 15% of those events exhibiting market reaction, which is a slightly lower percentage than the share of those events in the dataset. This would appear to indicate, perhaps as may have been expected, that the market react slightly more frequently to the violation of emission standard than to the failure to operate PCE properly. However, the average percentage reduction of market value for those events pertaining to the violation of emission standard is 8.96%, while the average reduction is calculated to be 15.3% for those events pertaining to the failure of operating PCE properly. It should be noted however that we accept the null hypothesis at

the 10% level of significance that there is no significant difference between negative market reaction from events of violation of emission standard and that of events of failure to operate PCE properly.¹⁸

Table 6
Market reaction per type of events

	Violation of emission standard	Failure to operate PCE properly	Other
With market reaction	36	8	8
Without market reaction	21	9	5
Total	57	17	13

All other things being equaled, it may further be assumed that markets have increasingly reacted to environmental news over the period of analysis as environmental awareness may have increased throughout society. This however does not appear to be case as shown in Table 7. Moreover, we have grouped the events into 3 different sub-groups: (1) a sub-group covering the period 1992-1994; (2) a sub-group covering 1996; and (3) another sub-group covering 1999. Our results show that the average percentage reductions in market value were 13.8%, 4.58%, and 8.21% respectively. A statistical test reveals that the difference in these changes is indeed statistically significant.¹⁹ This would appear to indicate that from its initial large impact, the MVR may have lost some of its capacity to generate incentives for pollution control. On the other hand, even though the reduction in market value may have lessen over time, such percentage reductions do remain significantly lower than those observed in Canada and the United States (Table 5).

¹⁸ See Appendix 5 for details.

¹⁹ See Appendix 6 for details.

Table 7
Number of events with and without market reaction over time

	With market reaction	Without market reaction
1992	1	0
1993	14	12
1994	12	6
1995	0	5
1996	15	8
1997	0	0
1998	0	0
1999	10	6
2000	0	3

Finally, we examine whether or not the extent of news coverage by media (as measured by the number of newspapers that have covered by the environmental events) may have an impact on the nature and extent of the market reaction. Appendix 4 reports the presence or absence of market reaction for each event, along with the number of newspapers that have reported the particular event. Of those events with market reaction, the average number of newspaper that have covered the event amounts to 1.89 per event; of those events without market reaction, the average number of news coverage is 1.77. Though the difference may not be very large, it does support the assumption that the larger the number of newspapers coverage, the greater the likelihood of market reaction. To this effect, it may be further noted that the 2 events which have been covered by 5 newspapers, and the (one) event that has been covered by 6 newspapers have all experienced market reaction. We have also grouped these events into 3 sub-groups: (1) a sub-group of events which have been covered by 1 or 2 newspapers; (2) a sub-group of events which have been covered by 3, 4, 5 and 6 newspapers; (3) a sub-group of events which have received coverage by 5 or 6 newspapers. Our results reveal an average

percentage reduction of market value for each of these sub-groups of 4.46%, 16.1%, and 38.23% respectively.²⁰ It would thus appear that the larger or wider the coverage of the events by newspapers, which may itself be reflective of the nature and/or importance of the event, the larger the percentage reduction in market value.

6. Conclusion

Since the late 1980's, the government of Korea has actively implemented a public disclosure program to inform citizens of the fact that some large companies in Korea are not complying with Korean environmental laws and regulations. Perhaps contrary to expectations that capital markets in developing countries may not reach to such news, it was shown in this paper that investors on the Korean Stock Exchange do in fact strongly react to the disclosure of such news. The average reduction in market value was estimated to be much higher than the estimated changes in market value for similar events in Canada and the United States, and of a similar magnitude as observed changes in other developing countries (Argentina, Chile, Mexico, and Philippines). It was further shown that the larger the extent of coverage by newspapers, the larger the reduction in market value, reaching above 35% for those events covered by 5 or more newspapers.

While a number of papers have examined the reaction of stock markets to environmental news, it is not immediately clear whether or not such reactions then induced changes in the actual environmental performance of the involved facilities. This is subject to on-going research.

²⁰ The difference between these percentage reductions in market value is statistically significant. See Appendix 7 for details.

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Appendix 1
Description of the dataset

Code	Company Name	Event date	Nature of Event
80	Jinro	5/31/1994	Emission standard violation
140	Hite Brewery Co. Ltd	4/27/1993	Emission standard violation
210	Daelim Industrial Co. Ltd	7/22/1993	Failure to operate PCE properly
210	Daelim Industrial Co. Ltd	3/4/1999	Emission standard violation
210	Daelim Industrial Co. Ltd	12/28/1999	Emission standard violation
240	Hankook Tire Co. Ltd	7/22/1993	Emission standard violation
240	Hankook Tire Co. Ltd	7/6/1996	Emission standard violation
240	Hankook Tire Co. Ltd	8/26/1999	Emission standard violation
270	Kia Motors	8/26/1999	Emission standard violation
990	Dongbu Hannong Chemical Co. Ltd	6/23/1993	Violation of measures on environmental manager
990	Dongbu Hannong Chemical Co. Ltd	4/28/1994	Emission standard violation
990	Dongbu Hannong Chemical Co. Ltd	5/4/1996	Failure to operate PCE properly
1390	Gyeonggi Chemical	8/28/1994	Use of equipment without government permission
1390	Gyeonggi Chemical	8/31/1996	Failure to operate PCE properly
1430	Kia Steel Co. Ltd	8/27/1993	Emission standard violation
1430	Kia Steel Co. Ltd	12/29/1996	Emission standard violation
1440	Taihan Electric Wire Co. Ltd	9/27/1993	Emission standard violation
1460	BYC Co. Ltd	4/27/1993	Emission standard violation
1630	Chongkundang Pharmaceutical Co.	8/1/1996	Emission standard violation
1740	SK Corporation	7/20/1999	Use of equipment without government permission
1740	SK Corporation	7/29/1999	Use of equipment without government permission
2030	Asia Cement Industry	8/28/1994	Failure to operate PCE properly
2030	Asia Cement Industry	10/28/1996	Emission standard violation
2030	Asia Cement Industry	12/30/1996	Emission standard violation
2170	Samyang Tongsang Co. Ltd	4/3/1993	Use of equipment without government permission
2270	Lotte samkang Co. Ltd	11/3/1999	Violation of standard on offensive odor
2270	Lotte samkang Co. Ltd	12/1/1999	Emission standard violation
2270	Lotte samkang Co. Ltd	1/20/2000	Emission standard violation
2310	Asia Paper	7/22/1993	Emission standard violation
2450	Samick Musical Instruments Co. Ltd	1/26/1994	Failure to operate PCE properly
2580	Sammi Steel Co. Ltd	8/31/1996	Failure to operate PCE properly
2840	Miwon Commercial Co. Ltd	10/28/1996	Emission standard violation
3190	Daewon Paper	9/27/1993	Failure to operate PCE properly
3190	Daewon Paper	10/28/1996	Failure to employ environmental manager
3230	Samyang Foods Co. Ltd	4/4/1993	Failure to employ full-time environmental manager
3230	Samyang Foods Co. Ltd	8/1/1996	Emission standard violation
3240	Taekwang Industrial Co. Ltd	4/27/1994	Emission standard violation
3240	Taekwang Industrial Co. Ltd	8/27/1999	Emission standard violation
3410	Ssangyong Cement Industrial Co. Ltd	4/27/1993	Emission standard violation
3920	Namyang Dairy Products Co. Ltd	7/22/1993	Emission standard violation
3920	Namyang Dairy Products Co. Ltd	7/6/1996	Emission standard violation
3980	Hanil Synthetic Fiber Co. Ltd	4/27/1994	Failure to operate PCE properly
3980	Hanil Synthetic Fiber Co. Ltd	5/31/1994	Failure to operate PCE properly
4370	Nong Shim Co. Ltd	9/27/1993	Emission standard violation
4460	Kohap Corporation	4/27/1993	Use of equipment without government permission
4460	Kohap Corporation	6/24/1993	Emission standard violation

4690	Samchully Co. Ltd	4/3/1993	Use of equipment without government permission
4800	Hyosung Co. Ltd	8/27/1999	Emission standard violation
4980	Sungshin Cement Mfg. Corp.	10/28/1996	Emission standard violation
5070	Saehan Media Co. Ltd	4/3/1993	Emission standard violation
5070	Saehan Media Co. Ltd	8/27/1993	Emission standard violation
5070	Saehan Media Co. Ltd	8/1/1996	Emission standard violation
5180	Binggrae	1/31/2000	Emission standard violation
5300	Lotte Chilsung Beverage Co. Ltd	7/22/1993	Emission standard violation
5300	Lotte Chilsung Beverage Co. Ltd	7/1/1994	Emission standard violation
5300	Lotte Chilsung Beverage Co. Ltd	7/29/1999	Emission standard violation
5420	Hankook Titanium Industry	2/6/1992	Emission standard violation
5490	Pohang Iron & Steel Co., Ltd	11/30/1996	Failure to operate PCE properly
5600	Joongang Paper	9/27/1993	Emission standard violation
5740	Crown Confectionary Co. Ltd	11/3/1999	Emission standard violation
5810	Pungsan	9/27/1993	Emission standard violation
5810	Pungsan	7/30/1996	Failure to operate PCE properly
5950	Isuchemical Co. Ltd	7/20/1999	Emission standard violation
6040	Dongwon Industries Co. Ltd	3/4/1999	Emission standard violation
6070	Kirin	3/11/1993	Use of equipment without government permission
6390	Hyundai Cement Industrial	4/27/1993	Failure to operate PCE properly
6390	Hyundai Cement Industrial	10/28/1996	Emission standard violation
6390	Hyundai Cement Industrial	12/30/1996	Emission standard violation
6400	Samsung SDI Co. Ltd	8/22/1996	Emission standard violation
7410	Daewoo Electronics Co. Ltd	8/28/1994	Emission standard violation
7410	Daewoo Electronics Co. Ltd	8/31/1996	Emission standard violation
7810	Korea Cerkit	10/1/1994	Failure to operate PCE properly
8720	Samyang Heavy Machinery Co.	11/30/1993	Failure to operate PCE properly
8900	SBW Co. Ltd	6/23/1993	Emission standard violation
8900	SBW Co. Ltd	12/25/1994	Emission standard violation
8970	Dongyangcheolgwan	1/26/1994	Failure to operate PCE properly
9580	Donghae Pulp Co. Ltd	7/1/1994	Emission standard violation
9830	Hanwha Chemical Co. Ltd	12/30/1996	Emission standard violation
9840	Kabool Co. Ltd	3/1/1994	Emission standard violation
9840	Kabool Co. Ltd	3/30/1994	Emission standard violation
9840	Kabool Co. Ltd	4/27/1994	Emission standard violation
10140	Samsung Heavy Industries Co. Ltd	12/25/1994	Failure to operate PCE properly
10780	Dongseo Industrial	7/1/1994	Failure to operate PCE properly
10780	Dongseo Industrial	12/1/1999	Emission standard violation
11780	Kumho Petrochemical Co. Ltd	7/6/1996	Emission standard violation
11780	Kumho Petrochemical Co. Ltd	1/30/1997	Violation of measures on environmental manager
14580	Bakgwang Material	12/28/1999	Emission standard violation
15760	Korea Electric Power Corporation	8/1/1996	Emission standard violation
15760	Korea Electric Power Corporation	7/29/1999	Use of equipment without government permission
15760	Korea Electric Power Corporation	8/27/1999	Emission standard violation
16380	Dongbu Steel Co. Ltd	8/31/1996	Emission standard violation
16380	Dongbu Steel Co. Ltd	6/30/1999	Polluting water resource
16380	Dongbu Steel Co. Ltd	8/27/1999	Polluting water resource
23150	Muhak Jujeong	1/31/2000	Emission standard violation
25830	Hankook Synthetic Fiber	8/31/1996	Emission standard violation
25860	Namhae Chemical	11/30/1996	Failure to operate PCE properly

Appendix 2

Market reaction / No reaction to event

Code	Company Name	Reaction	No Reaction	Nature of Event
80	Jinro		5/31/1994	Emission standard violation
140	Hite Brewery Co.	4/27/1993		Emission standard violation
210	Daelim Industrial Co.		7/22/1993	Failure to operate PCE properly
210	Daelim Industrial Co.	12/28/1999		Emission standard violation
240	Hankook Tire Co.	7/22/1993		Emission standard violation
240	Hankook Tire Co.		7/6/1996	Emission standard violation
240	Hankook Tire Co.		8/26/1999	Emission standard violation
270	Kia Motors		8/26/1999	Emission standard violation
990	Dongbu Hannong Chemical Co.	6/23/1993		Violation of measures on environmental manager
990	Dongbu Hannong Chemical Co.		4/28/1994	Emission standard violation
990	Dongbu Hannong Chemical Co.	5/4/1996		Failure to operate PCE properly
1390	Gyeonggi Chemical		8/28/1994	Use of equipment without government permission
1390	Gyeonggi Chemical		8/31/1996	Failure to operate PCE properly
1430	Kia Steel Co.		8/27/1993	Emission standard violation
1430	Kia Steel Co.		12/29/1996	Emission standard violation
1440	Taihan Electric Wire Co.	9/27/1993		Emission standard violation
1460	BYC Co.	4/27/1993		Emission standard violation
1630	Chongkundang Pharmaceutical Co.	8/1/1996		Emission standard violation
1740	SK Co.	7/20/1999		Use of equipment without government permission
1740	SK Co.	7/29/1999		Use of equipment without government permission
2030	Asia Cement Industry		8/28/1994	Failure to operate PCE properly
2030	Asia Cement Industry	10/28/1996		Emission standard violation
2030	Asia Cement Industry	12/30/1996		Emission standard violation
2170	Samyang Tongsang Co.		4/3/1993	Use of equipment without government permission
2270	Lotte samkang Co.		1/20/2000	Emission standard violation
2310	Asia Paper	7/22/1993		Emission standard violation
2450	Samick Musical Instruments Co.	1/26/1994		Failure to operate PCE properly
2840	Miwon Commercial Co.	10/28/1996		Emission standard violation
3190	Daewon Paper		9/27/1993	Failure to operate PCE properly
3190	Daewon Paper	10/28/1996		Failure to employ environmental manager
3230	Samyang Foods Co.		4/4/1993	Failure to employ full-time environmental manager
3230	Samyang Foods Co.	8/1/1996		Emission standard violation
3240	Taekwang Industrial Co.	4/27/1994		Emission standard violation
3240	Taekwang Industrial Co.	8/27/1999		Emission standard violation
3410	Ssangyong Cement Industrial Co.	4/27/1993		Emission standard violation
3920	Namyang Dairy Products Co.	7/22/1993		Emission standard violation
3920	Namyang Dairy Products Co.	7/6/1996		Emission standard violation
3980	Hanil Synthetic Fiber Co.	4/27/1994		Failure to operate PCE properly
3980	Hanil Synthetic Fiber Co.		5/31/1994	Failure to operate PCE properly
4370	Nong Shim Co.	9/27/1993		Emission standard violation
4460	Kohap Co.	4/27/1993		Use of equipment without government permission
4460	Kohap Co.		6/24/1993	Emission standard violation
4690	Samchully Co.		4/3/1993	Use of equipment without government permission
4980	Sungshin Cement Mfg. Co.		10/28/1996	Emission standard violation
5070	Saehan Media Co.		4/3/1993	Emission standard violation
5070	Saehan Media Co.		8/27/1993	Emission standard violation

5070	Saehan Media Co.	8/1/1996		Emission standard violation
5180	Binggrae		1/31/2000	Emission standard violation
5300	Lotte Chilsung Beverage Co.	7/22/1993		Emission standard violation
5300	Lotte Chilsung Beverage Co.	7/29/1999		Emission standard violation
5420	Hankook Titanium Industry	2/6/1992		Emission standard violation
5490	Pohang Iron & Steel Co.		11/30/1996	Failure to operate PCE properly
5600	Joongang Paper		9/27/1993	Emission standard violation
5740	Crown Confectionary Co.		11/3/1999	Emission standard violation
5810	Pungsan		9/27/1993	Emission standard violation
5810	Pungsan		7/30/1996	Failure to operate PCE properly
5950	Isuchemical Co.	7/20/1999		Emission standard violation
6040	Dongwon Industries Co.		3/4/1999	Emission standard violation
6070	Kirin	3/11/1993		Use of equipment without government permission
6390	Hyundai Cement Industrial		4/27/1993	Failure to operate PCE properly
6390	Hyundai Cement Industrial	10/28/1996		Emission standard violation
6390	Hyundai Cement Industrial		12/30/1996	Emission standard violation
6400	Samsung SDI Co.	8/22/1996		Emission standard violation
7410	Daewoo Electronics Co.	8/28/1994		Emission standard violation
7410	Daewoo Electronics Co.	8/31/1996		Emission standard violation
7810	Korea Cerkit	10/1/1994		Failure to operate PCE properly
8720	Samyang Heavy Machinery Co.	11/30/1993		Failure to operate PCE properly
8900	SBW Co.	6/23/1993		Emission standard violation
8900	SBW Co.	12/25/1994		Emission standard violation
8970	Dongyangcheolgan	1/26/1994		Failure to operate PCE properly
9580	Donghae Pulp Co.		7/1/1994	Emission standard violation
9840	Kabool Co.	3/1/1994		Emission standard violation
9840	Kabool Co.	3/30/1994		Emission standard violation
9840	Kabool Co.	4/27/1994		Emission standard violation
10140	Samsung Heavy Industries Co.	12/25/1994		Failure to operate PCE properly
10780	Dongseo Industrial	7/1/1994		Failure to operate PCE properly
10780	Dongseo Industrial		12/1/1999	Emission standard violation
11780	Kumho Petrochemical Co.	7/6/1996		Emission standard violation
14580	Bakgwang Material	12/28/1999		Emission standard violation
15760	Korea Electric Power Corporation	7/29/1999		Use of equipment without government permission
15760	Korea Electric Power Corporation	8/27/1999		Emission standard violation
16380	Dongbu Steel Co.	8/31/1996		Emission standard violation
16380	Dongbu Steel Co.	6/30/1999		Polluting water resource
16380	Dongbu Steel Co.		8/27/1999	Polluting water resource
23150	Muhak Jujeong		1/31/2000	Emission standard violation
25830	Hankook Synthetic Fiber	8/31/1996		Emission standard violation
25860	Namhae Chemical		11/30/1996	Failure to operate PCE properly

Appendix 3 Market reaction to news¹

Code	Company Name	Event Date		Day -3	Day -2	Day -1	Day 0	Day + 1	Day + 2	Day + 3
140	Hite Brewery Co.	4/27/1993	AR		-0.028 *		0.055 *			
					(-1.350)		(2.639)			
			CAR		-0.011		0.048			
					(-0.377)		(1.138)			
210	Daelim Industrial Co.	12/28/1999	AR		0.105 *	-0.150 *		-0.020		-0.025
					(2.947)	(-4.235)		(-0.550)		(-0.703)
			CAR		0.095 *	-0.055		-0.105 *		-0.128 *
					(1.898)	(-0.896)		(-1.328)		(-1.357)
240	Hankook Tire Co.	7/22/1993	AR							0.025 *
										(1.750)
			CAR							0.019
										(0.511)
990	Dongbu Hannong Chemical Co.	6/23/1993	AR	0.030 *	0.031 *	-0.009		0.010	-0.023 *	
				(1.695)	(1.741)	(-0.519)		(0.574)	(-1.322)	
			CAR	0.030 *	0.060 *	0.051 *		0.053 *	0.030	
				(1.695)	(2.430)	(1.684)		(1.343)	(0.687)	
990	Dongbu Hannong Chemical Co.	5/4/1996 (5/6/1996) ²	AR						0.069*	0.075 *
									(3.316)	(3.375)
			CAR						0.066*	0.140*
									(1.288)	(2.543)
1440	Taihan Electric Wire Co.	9/27/1993	AR				0.002 *			
							(1.730)			
			CAR				0.013			
							(0.511)			
1460	BYC Co.	4/27/1993	AR					0.029 *		-0.029 *
								(1.463)		(-1.465)
			CAR					0.004		-0.010
								(0.096)		(-0.184)
1630	Chongkundang Pharmaceutical Co.	8/1/1996	AR			-0.031 *				
						(-1.752)				
			CAR			-0.014				
						(-0.443)				
1740	SK Co.	7/20/1999	AR			0.056 *		-0.053 *		
						(1.367)		(-1.306)		
			CAR			0.078		0.024		
						(1.112)		(0.269)		
1740	SK Co.	7/29/1999	AR		0.070 *		-0.066 *			
					(1.718)		(-1.605)			
			CAR		0.038		-0.015			
					(0.658)		(-0.181)			

2030	Asia Cement Industry	10/28/1996	AR				-0.034 *	0.037 *
			CAR				(-1.663)	(1.799)
							-0.020	0.017
							(-0.494)	(0.329)
2030	Asia Cement Industry	12/30/1996	AR	0.053 *		-0.064 *		
				(2.394)		(-3.046)		
			CAR	0.064 *		-0.020		
				(2.047)		(-0.441)		
2310	Asia Paper	7/22/1993	AR	-0.028 *				-0.007
				(-1.340)				(-0.324)
			CAR	0.044 *				-0.066 *
				(-1.500)				(-1.289)
2450	Samick Musical Instruments Co.	1/26/1994	AR	0.046 *	-0.057 *	-0.028	-0.051 *	0.028
				(1.987)	(-2.456)	(-1.213)	(-2.187)	(1.226)
			CAR	0.046 *	-0.011	-0.068 *	-0.118 *	-0.090 *
				(1.987)	(-0.332)	(-1.463)	(-2.287)	(-1.587)
2840	Miwon Commercial Co.	10/28/1996	AR				-0.027 *	
							(-1.745)	
			CAR				-0.028	
							(-0.825)	
3190	Daewon Paper	10/28/1996	AR	0.068 *		-0.042 *	-0.047 *	0.057 *
				(2.747)		(-1.704)	(-1.903)	(2.302)
			CAR	0.042		-0.011	-0.058	0.012
				(1.204)		(-1.171)	(-1.047)	(0.190)
3230	Samyang Foods Co.	8/1/1996	AR	0.057 *	0.041 *	0.002	-0.052 *	-0.033 *
				(2.253)	(1.905)	(0.098)	(-2.057)	(-1.299)
			CAR	0.026	0.074 *	0.076 *	0.025	-0.007
				(0.727)	(1.694)	(1.516)	(0.436)	(-0.105)
3240	Taekwang Industrial Co.	4/27/1994	AR		-0.025 *	-0.032 *	-0.034 *	-0.022 *
					(-1.486)	(-1.943)	(-2.036)	(-1.312)
			CAR		-0.008	-0.04	-0.074 *	-0.096 *
					(-0.269)	(-1.204)	(-1.988)	(-2.350)
								(-2.188)
3240	Taekwang Industrial Co.	8/27/1999	AR	0.056 *				-0.086 *
				(1.349)				(-2.066)
			CAR	0.049				-0.06
				(0.838)				(-0.590)
3410	Ssangyong Cement Industrial Co.	4/27/1993	AR				-0.022 *	
							(-1.416)	
			CAR				-0.017	
							(-0.048)	
3920	Namyang Dairy Products Co.	7/22/1993	AR	-0.020 *	0.039 *	0.003 *	-1.038 *	0.038 *
				(-1.282)	(2.478)	(2.140)	(-2.390)	(2.401)
			CAR	-0.040 *	-0.001	0.033	-0.005	0.025
				(-1.796)	(-0.035)	(1.039)	(-0.139)	(0.592)
3920	Namyang Dairy Products Co.	7/6/1996	AR	0.036 *				0.058*
		(7/8/1996)		(1.458)				(2.320)
			CAR	0.036				0.118*
				(1.458)				(2.127)
								(1.637)

3980	Hanil Synthetic Fiber Co.	4/27/1994	AR	-0.049 *	-0.022	0.005	-0.030	-0.057 *	0.054 *	-0.039 *
				(-1.644)	(-0.738)	(0.151)	(-0.991)	(-1.887)	(1.784)	(-1.326)
			CAR	-0.049 *	-0.071 *	-0.067 *	-0.097 *	-0.153 *	-0.100 *	-0.140 *
				(-1.644)	(-1.684)	(-1.288)	(-1.611)	(-2.284)	(-1.357)	(-1.788)
4370	Nong Shim Co.	9/27/1993	AR			0.018 *				
						(1.328)				
			CAR			0.021				
						(0.788)				
4460	Kohap Co.	4/27/1993	AR		-0.026 *					
					(-1.554)					
			CAR		-0.032 *					
					(-1.360)					
5070	Saehan Media Co.	8/1/1996	AR				-0.030 *			
							(-1.442)			
			CAR				-0.016			
							(-0.389)			
5300	Lotte Chilsung Beverage Co.	7/22/1993	AR	-0.025 *	0.038 *					
				(-1.471)	(2.221)					
			CAR	-0.025 *	0.013					
				(-1.471)	(0.530)					
5300	Lotte Chilsung Beverage Co.	7/29/1999	AR	-0.055 *	-0.015	-0.012	-0.039	-0.003	-0.062 *	0.024
				(-1.687)	(-0.460)	(-0.357)	(-1.188)	(-0.101)	(-1.898)	(0.731)
			CAR	-0.055 *	-0.070 *	-0.082 *	-0.121 *	-0.124 *	-0.186 *	-0.162 *
				(-1.687)	(-1.518)	(-1.445)	(-1.846)	(-1.697)	(-2.323)	(-1.875)
5420	Hankook Titanium Industry	2/6/1992	AR			0.036 *	-0.044 *			0.037 *
						(1.360)	(-1.648)			(1.384)
			CAR			0.073 *	0.028			0.042
						(1.566)	(0.532)			(0.595)
5950	Isuchemical Co.	7/20/1999	AR							-0.057 *
										(-1.819)
			CAR							-0.092
										(-1.119)
6070	Kirin	3/11/1993	AR							0.037 *
										(1.359)
			CAR							0.063
										(0.869)
6390	Hyundai Cement Industrial	10/28/1996	AR						0.052 *	
									(2.507)	
			CAR						0.060 *	
									(1.183)	
6400	Samsung SDI Co.	8/22/1996	AR				-0.017 *	-0.023 *		-0.006
							(-1.316)	(-1.766)		(-0.440)
			CAR				-0.039 *	-0.062 *		-0.068 *
							(-1.316)	(-1.923)		(-1.949)
7410	Daewoo Electronics Co.	8/28/1994	AR			-0.030 *			-0.027 *	
		(8/29/1996)				(-1.541)			(-1.366)	
			CAR			-0.016			-0.054	
						(-0.468)			(-1.131)	

7410	Daewoo Electronics Co.	8/31/1996 (9/2/1996)	AR	0.031 * (2.095)	-0.025 * (-1.773)			-0.026* (-1.780)		
			CAR	0.031 * (2.095)	0.005 (0.227)			0.011 (0.323)		
7810	Korea Cerkit	10/1/1994 (10/3/1994)	AR	0.052 * (2.108)	0.046* (1.883)	0-0.05 (-0.222)	-0.042* (-1.732)	-0.043 * (-1.740)	0.049* (2.013)	
			CAR	0.052* (2.108)	0.098* (2.822)	0.092* (2.176)	0.072* (1.311)	0.051 (0.841)	0.108* (1.664)	
8720	Samyang Heavy Machinery Co.	11/30/1993	AR		-0.044 * (-2.047)	-0.020 (-0.905)				
			CAR		-0.038 (-1.212)	-0.057 * (-1.512)				
8900	SBW Co.	6/23/1993	AR	0.044 * (2.675)	-0.006 (-0.390)				-0.028 * (-1.734)	
			CAR	0.044 * (2.675)	0.037 * (-1.616)				-0.014 (-0.327)	
8900	SBW Co.	12/25/1994 (12/26/1994)	AR						0.037 * (1.655)	
			CAR						-0.002 (-0.041)	
8970	Dongyangcheolgan	1/26/1994	AR				-0.035 * (-1.537)	-0.501 * (-2.241)	-0.051 * (-2.282)	
			CAR				-0.012 (-0.234)	-0.039 (-0.702)	-0.090 * (-1.512)	
9840	Kabool Co.	3/1/1994	AR			0.056 * (2.038)	0.057 * (2.068)	0.016 (0.595)	-0.027 (-0.989)	
			CAR			0.053 (1.111)	0.109 * (1.997)	0.126 * (2.052)	0.099 * (1.470)	
9840	Kabool Co.	3/30/1994	AR				-0.055 * (-1.661)	0.044 * (1.312)		
			CAR				-0.056 (-0.751)	-0.012 (-0.150)		
9840	Kabool Co.	4/27/1994	AR	-0.046 * (-1.581)				0.056 * (1.891)		
			CAR	-0.046 * (-1.581)				-0.031 (-0.385)		
10140	Samsung Heavy Industries Co.	12/25/1994 (12/26/1994)	AR						-0.023 * (-1.417)	
			CAR						-0.012 (-0.268)	
10780	Dongseo Industrial	7/1/1994	AR			-0.041 * (-1.682)	-0.038 * (-1.550)	-0.021 (-0.874)	0.001 (0.464)	0.034 * (1.386)
			CAR			-0.042 (-0.968)	-0.079 * (-1.613)	-0.101 * (-1.834)	-0.100 * (-1.655)	-0.066 (-1.009)
11780	Kumho Petrochemical Co.	7/6/1996 (7/8/1996)	AR				0.036* (2.155)	-0.029* (-1.732)	0.033** (1.971)	0.045 * (2.655)
			CAR				0.018 (0.561)	-0.018 (-0.273)	0.023 (0.555)	0.067 (0.517)

14580 Bakgwang Material	12/28/1999	AR				-0.090 *		
						(-2.110)		
		CAR				0.013		
						(0.812)		
15760 Korea Electric Power Co.	7/29/1999	AR	0.065 *	-0.009		-0.038 *		
			(2.387)	(-0.310)		(-1.362)		
		CAR	0.065 *	0.056 *		-0.010		
			(2.387)	(1.413)		(-0.177)		
15760 Korea Electric Power Co.	8/27/1999	AR		0.119 *	-0.022	0.023	-0.015	-0.016
				(4.226)	(-0.764)	(0.800)	(-0.547)	(-0.582)
		CAR		0.122 *	0.100 *	0.123 *	0.107 *	0.091 *
				(3.057)	(2.055)	(2.180)	(1.705)	(1.319)
16380 Dongbu Steel Co.	8/31/1996	AR			0.026*	-0.032*		-0.013
	(9/2/1996)				(1.333)	(-1.689)		(-0.671)
		CAR			0.003	-0.029*		-0.027*
					(0.172)	(-1.517)		(-1.404)
16380 Dongbu Steel Co.	6/30/1999	AR					0.061 *	0.0666 *
							(1.578)	(1.700)
		CAR					0.136 *	0.202 *
							(1.442)	(1.977)
25830 Hankook Synthetic Fiber	8/31/1996	AR			0.045*	0.051 *	-0.040 *	
	(9/2/1996)				(1.892)	(2.140)	(-1.701)	
		CAR			0.070	0.121	0.081	
					(0.993)	(1.279)	(0.684)	

¹ **AR** stands for abnormal return and **CAR** is the cumulative abnormal return. **CAR** is computed for Day -3 up to the specified day of interest. Within brackets is the value of z statistics. ‘*’ denotes significance at the 10% level (two tailed test). If an event had no statistically significant **AR** for any of the days over the period of the even window (-3 to +3), then that event was not retained as statistically significant even if some of its **CAR** may have been statistically significant. On the other hand, if an event has at least one statistically significant **AR** during the event window, then all statistically significant results are reported for that event, even on those days where only the **CAR** is statistically significant.

² A number of events appears in newspapers on days where the stock market is close (Saturdays, Sundays, or public holidays). In such circumstances, the immediate following day of trading (as indicated by the date in bracket) is used as day 0.

Appendix 4

Market reaction and media coverage

Code	Company Name	Reaction	No Reaction	Number of newspapers that have covered this event
80	Jinro		5/31/1994	2
140	Hite Brewery Co.	4/27/1993		3
210	Daelim Industrial Co.		7/22/1993	3
210	Daelim Industrial Co.	12/28/1999		1
240	Hankook Tire Co.	7/22/1993		3
240	Hankook Tire Co.		7/6/1996	2
240	Hankook Tire Co.		8/26/1999	1
270	Kia Motors		8/26/1999	1
990	Dongbu Hannong Chemical Co.	6/23/1993		1
990	Dongbu Hannong Chemical Co.		4/28/1994	3
990	Dongbu Hannong Chemical Co.	5/4/1996		2
1390	Gyeonggi Chemical		8/28/1994	3
1390	Gyeonggi Chemical		8/31/1996	1
1430	Kia Steel Co.		8/27/1993	3
1430	Kia Steel Co.		12/29/1996	1
1440	Taihan Electric Wire Co.	9/27/1993		1
1460	BYC Co.	4/27/1993		2
1630	Chongkundang Pharmaceutical Co.	8/1/1996		2
1740	SK Co.	7/20/1999		1
1740	SK Co.	7/29/1999		1
2030	Asia Cement Industry		8/28/1994	3
2030	Asia Cement Industry	10/28/1996		2
2030	Asia Cement Industry	12/30/1996		5
2170	Samyang Tongsang Co.		4/3/1993	1
2270	Lotte samkang Co.		1/20/2000	4
2310	Asia Paper	7/22/1993		3
2450	Samick Musical Instruments Co.	1/26/1994		3
2840	Miwon Commercial Co.	10/28/1996		2
3190	Daewon Paper		9/27/1993	1
3190	Daewon Paper	10/28/1996		1
3230	Samyang Foods Co.		4/4/1993	4
3230	Samyang Foods Co.	8/1/1996		1
3240	Taekwang Industrial Co.	4/27/1994		2
3240	Taekwang Industrial Co.	8/27/1999		1
3410	Ssangyong Cement Industrial Co.	4/27/1993		1
3920	Namyang Dairy Products Co.	7/22/1993		5
3920	Namyang Dairy Products Co.	7/6/1996		1
3980	Hanil Synthetic Fiber Co.	4/27/1994		2
3980	Hanil Synthetic Fiber Co.		5/31/1994	1
4370	Nong Shim Co.	9/27/1993		2
4460	Kohap Co.	4/27/1993		4
4460	Kohap Co.		6/24/1993	4
4690	Samchully Co.		4/3/1993	1
4980	Sungshin Cement Mfg. Co.		10/28/1996	1
5070	Saehan Media Co.		4/3/1993	1
5070	Saehan Media Co.		8/27/1993	2

5070	Saehan Media Co.	8/1/1996		1
5180	Binggrae		1/31/2000	1
5300	Lotte Chilsung Beverage Co.	7/22/1993		6
5300	Lotte Chilsung Beverage Co.	7/29/1999		1
5420	Hankook Titanium Industry	2/6/1993		1
5490	Pohang Iron & Steel Co.		11/30/1996	1
5600	Joongang Paper		9/27/1993	1
5740	Crown Confectionary Co.		11/3/1999	1
5810	Pungsan		9/27/1993	2
5810	Pungsan		7/30/1996	1
5950	Isuchemical Co.	7/20/1999		1
6040	Dongwon Industries Co.		3/4/1999	1
6070	Kirin	3/11/1993		1
6390	Hyundai Cement Industrial		4/27/1993	1
6390	Hyundai Cement Industrial	10/28/1996		3
6390	Hyundai Cement Industrial		12/30/1996	3
6400	Samsung SDI Co.	8/22/1996		1
7410	Daewoo Electronics Co.	8/28/1994		3
7410	Daewoo Electronics Co.	8/31/1996		1
7810	Korea Cerkit	10/1/1994		2
8720	Samyang Heavy Machinery Co.	11/30/1993		1
8900	SBW Co.	6/23/1993		1
8900	SBW Co.	12/25/1994		1
8970	Dongyangcheolgan	1/26/1994		2
9580	Donghae Pulp Co.		7/1/1994	2
9840	Kabool Co.	3/1/1994		1
9840	Kabool Co.	3/30/1994		3
9840	Kabool Co.	4/27/1994		1
10140	Samsung Heavy Industries Co.	12/25/1994		2
10780	Dongseo Industrial	7/1/1994		1
10780	Dongseo Industrial		12/1/1999	1
11780	Kumho Petrochemical Co.	7/6/1996		2
14580	Bakgwang Material	12/28/1999		1
15760	Korea Electric Power Corporation	7/29/1999		1
15760	Korea Electric Power Corporation	8/27/1999		1
16380	Dongbu Steel Co.	8/31/1996		2
16380	Dongbu Steel Co.	6/30/1999		2
16380	Dongbu Steel Co.		8/27/1999	1
23150	Muhak Jujeong		1/31/2000	1
25830	Hankook Synthetic Fiber	8/31/1996		1
25860	Namhae Chemical		11/30/1996	2

Annex 5
Testing for differences in changes in market value:
Violation of emission standard vs. Failure to operate PCE properly

The null hypothesis is $H_0: \mu_2 = \mu_3$ or $\mu_2 - \mu_3 = 0$ and the alternative is $H_1: \mu_2 \neq \mu_3$ or $\mu_2 - \mu_3 \neq 0$ where the μ 's are the respective population means: μ_2 mean reduction for population corresponding to emission standards violation and μ_3 is that for population corresponding to failure to operate PCE properly. The sample means can be defined similarly: \bar{X}_2 and \bar{X}_3 . Since both samples are small (27 stocks with negative reaction and 7 stocks with negative events), we recourse to *t-test statistic*. It is computed as follows:

$$t = \frac{(\bar{X}_2 - \bar{X}_3) - (\mu_2 - \mu_3)}{S_p \sqrt{\frac{1}{n_2} + \frac{1}{n_3}}} \sim t_{n_2+n_3-2}$$

where $S_p^2 = \frac{(n_2 - 1)S_2^2 + (n_3 - 1)S_3^2}{(n_2 + n_3 - 2)}$ is the pooled variance, S_2^2 and S_3^2 are the variance of stocks with negative reactions corresponding to emission standard violation and failure to operate PCE properly, respectively, and the n_2 and n_3 are the number of stocks with negative reactions in each category.

Applying the t-formula above yields:

$$t = \frac{-0.0896 + 0.153 - 0}{0.055921} = 1.134$$

Since $t < t_{32,0.05} \approx 1.697$, we accept the null hypothesis at the 10% level of significance that there is no significant difference between negative market reaction from events of violation of emission standards and that of events of failure to operate PCE.

Annex 6
Testing for differences in changes in market value:
Changes over time

The null hypothesis is $H_0 : \mu_4 = \mu_5 = \mu_6$ and the alternative is $H_1 : \mu_4 \neq \mu_5 \neq \mu_6$ where the μ 's are the respective population means. We have the comparison of more than two means. Here the use of the t test statistic is not appropriate (see Ott and Longnecker (2001)). We recourse to the analysis of variance to solve the problem of size distortion that may entail the use of t. Precisely, we build an F-test statistic:

$$F = \frac{S_B^2}{S_W^2} \sim F_{n-s}^s$$

where S_B^2 and S_W^2 are the between-sample variance(mean square) and the within-sample variance (mean square), respectively. Precisely, $S_B^2 = \frac{\sum_{i=1}^s n_i (\bar{X}_i - \bar{X})^2}{s-1}$ where s stands for the total number of samples and the X bars are the means for a given sample i or the grand mean. The within variance is an extension of the pooled variance developed above. Using the data, the F value is:

$$F = \frac{0.0343310}{0.011227972} = 3.058$$

Since $F > F_{36}^2 \approx 2.44$ at the 10% level of significance, we reject the null hypothesis and conclude that the average % reduction in stock market is changing over time.

Annex 7
Testing for differences in changes in market value:
Extent of coverage by newspapers

We break down this test into two different sub-tests.

Sub-test 1. Is there any difference in % reduction in stock market values between events that are covered only in 1 or 2 in newspapers vs. those events that are covered in 3, 4, 5, or 6 newspapers.

The null hypothesis is $H_0: \mu_7 = \mu_8$ or $\mu_7 - \mu_8 = 0$ the alternative is $H_1: \mu_7 \neq \mu_8$ where the μ 's are the respective population means. Using the t-test statistic as presented in Appendix 5, we obtain:

$$t = \frac{-0.0446 + 0.161 - 0}{0.055844733} = 2.084$$

Since $2.084 > 1.645$ at the 10% level of significance, we reject the null hypothesis and conclude that the number of coverage matters in market reaction.

Sub-test 2. Is there any difference in % reduction in stock market values between events that are covered only in 1 or 2 in newspapers vs. those events that are covered in 5,6 newspapers.

The null hypothesis is $H_0: \mu_7 = \mu_9$ or $\mu_7 - \mu_9 = 0$ the alternative is $H_1: \mu_7 \neq \mu_9$ where the μ 's are the respective population means (equivalent of table 7 and Table 9, respectively). Using the similar t-test statistic, we obtain:

$$t = \frac{-0.0446 + 0.3823 - 0}{0.094617367} = 3.554$$

Since $3.554 > t_{(29,0.10)}=1.699$ at the 10% level of significance, we reject the null hypothesis and conclude that the number of coverage matters in market reaction.