AN EXAMINATION OF THE IMPACT OF
POLLUTION PERFORMANCE ON ECONOMIC AND
MARKET PERFORMANCE: PULP AND PAPER FIRMS

BIKKI JAGGI AND MARTIN FREEDMAN*

INTRODUCTION

Since 1969 several legislative actions in the United States have been aimed
at abating industrial pollution, and the US Securities and Exchange Commis-
sion has been engaged in developing pollution disclosure requirements to ensure
adequate disclosure of pollution information. The legislative activities, disclosure
requirements, and social, political and economic pressures were expected to
encourage management to become socially responsible and pay greater attention
to environmental and social consequences of corporate activities. (For a debate
on corporate social responsibilities, see Sethi, 1975). Pollution abatement
activities may involve substantial amounts of capital expenditures which could
have an impact on the economic performance of firms. As a result of this
economic impact, there may be a stock market reaction which would influence
management decisions relating to pollution abatement activities. If the economic
impact of these activities is negative and this is followed by a negative market
reaction, management may be encouraged to postpone or reduce pollution
related activities.

Previous research studies on the association between pollution and economic
performance have provided conflicting results. Bragdon and Marlin (1972) and
Spicer (1978) have found that there was a positive association between the
economic and pollution variables at the firm level. Christianosen and Haveman’s
(1981) analysis of economic studies, however, indicates that pollution regulations
which resulted in heavy expenditures for pollution abatement activities have
been one of the contributing factors to the slowdown in productivity growth.
Although their study did not examine directly the impact of pollution
performance on economic performance at the firm level, the results of their
analysis clearly demonstrated that a positive association between pollution
abatement and economic performance of firms was not a realistic expectation.

The Bragdon-Marlin and Spicer studies were based on a pollution data base
which was generated in 1972 by the Council on Economic Priorities (CEP).
This data base was developed by library research and personal contacts rather

*The authors are respectively, Professor in the School of Business, Rutgers University, New Jersey;
and Professor in the School of Management, Suny at Binghamton, New York. They gratefully
acknowledge comments from Professors Robert Ingram, Ahmed Belkaoui and Arieh Ullmann on
earlier drafts of this paper. (Paper received August 1989, revised May 1990)
than by evaluating the actual pollution emissions by firms. Furthermore, a 1972 pollution data base may not be an appropriate one for the analysis because the US Clean Water Act Amendments were not passed until 1972 and these Amendments required that waterways be substantially cleaned-up by 1983 (Federal Water, 1972). Therefore, one would expect more corporate response after 1972 as compared to before 1972. The inadequacy and inappropriateness of the data base, thus, raises the question whether pollution information was reliable for determining the association between economic and pollution performance.

This study examines the association between pollution and economic and market performance of pulp and paper firms on the basis of a pollution data base developed from pollution reports filed by the firms with the US Environmental Protection Agency (EPA) after the Clean Water Act Amendments came into force. The study does not attempt to evaluate how effective the US water pollution control laws (especially the 1972 Federal Water Pollution Control Act Amendments) were in cleaning-up pollution (for an evaluation of these laws, see Freedman and Jaggi, 1988).

The paper is organized as follows: in the next section relevant studies are reviewed to provide background for the study; the third section discusses the rationale and hypotheses for the study; the fourth section explains the research design including a brief discussion of the development of a pollution data base; the fifth section presents empirical test results on the association between pollution performance and economic and market performance; and the final section contains the conclusion and limitations of the study.

BACKGROUND AND LITERATURE REVIEW

Several studies have examined different aspects of corporate pollution performance. Some of these studies focused on measurement problems or on association between pollution and economic performance, while others have examined investors' reaction to pollution disclosures.

The measurement of corporate pollution performance has primarily been the focus of studies sponsored by the Council on Economic Priorities (CEP), a non-profit organization. The CEP sponsored studies on oil refining, steel, pulp and paper, and electric utility industries. Though all of these studies deal with pollution performance of firms from respective industries, their results differ in quality. Some quality differences were caused by the differences in the sample size or methodology used in the study, or by the availability of data. For example, the study on steel used an extensive pollution data set and a sophisticated model for measuring pollution emissions, but the sample size was very small, only seven firms were included in the sample. On the other hand, the study on pulp and paper firms used a sample of 24 firms but the data set was incomplete and the technique used for evaluating the pollution performance
was much simpler than that used for steel. Moreover, raw data on pollution performance for pulp and paper firms was gathered indirectly rather than using actual pollution emissions.

The association between pollution and economic performance has primarily been the focus of three research studies. The first study was conducted by Bragdon and Marlin (1972), which reported that there was a positive correlation between pollution control and economic performance of pulp and paper companies. The measures of EPS growth, average return on equity and average return on capital were used to measure economic performance. The second study was conducted by Spicer (1978), and it included some market variables in the analysis. According to the results of this study, ‘... for the 1968–73 period, it appears that the most profitable large companies in the sample tend to have the best pollution control records and that these companies in general, were judged by investors to be less risky in terms of both total and systematic risk (p. 108).’ Bragdon-Marlin’s as well as Spicer’s study were based on the pollution performance data set developed by the CEP. Because both studies used the same data base, similarity in their test results are not surprising.

Christainsen and Haveman (1981) analyzed the contribution of environmental regulations to slowdown in productivity growth by reviewing studies which estimated pollution control costs and their impact on productivity growth. They concluded that ‘environmental regulations can have major adverse output and productivity impacts on certain sectors or industries.’ They, however, pointed out that these impacts were localized and did not have a significant impact on macroeconomic performance. Though their analysis did not consider the environmental regulations to be primarily responsible for economic slowdown, it indicated that the pollution performance in certain industries had a negative impact on economic performance.

A number of studies have been conducted to examine investors’ reaction to pollution disclosures (for example, see Belkaoui, 1976; Ingram, 1978; Anderson and Frankle, 1980; Jaggi and Freedman, 1982; and Shane and Spicer, 1983). The results of these studies have indicated that disclosure of social information, especially pollution information, triggered investor reaction as reflected in stock price movements.

RATIONALITY AND HYPOTHESES

The 1972 US Federal Water Pollution Control Act had as one of its goals the elimination of discharge of pollutants into the nation’s navigable waters by 1985 (Federal Water, 1972). To achieve this goal, effluent standards for industrial discharges were set. Industries affected by these standards, including the pulp and paper industry, argued that imposition of these standards would have a negative impact on the economic performance of firms. Considering the industries’ concern, President Nixon vetoed the original bill. The 1972 Act
Amendments were, however, later passed over his veto.

The arguments advanced by industries in opposing the 1972 Federal Water Pollution Act Amendments raise an important issue of an association between pollution and economic performance and of the market's reaction to this association. As discussed earlier, Bragdon-Marlin's (1972) as well as Spicer's (1978) studies indicated that the economic impact of pollution performance would be positive. A close scrutiny of these studies have, however, indicated that the results of these studies were questionable, especially because they were based on a data base which was developed even before the Water Pollution Control Act Amendments were legislated. Furthermore, Christainsen-Haveman's (1981) analyses of several studies on productivity indicated that an expectation of a positive association between pollution control and economic performance over a short period of time would not be realistic.

It is obvious that heavy expenditures on pollution abatement activities would take away funds from productive investment activities, which will result in a negative impact on the net income as well as on cash flows of firms in the short run. It, however, needs to be recognized that the extent of negative association will be influenced by the materiality of pollution expenditures and the type of pollution abatement processes installed. For example, a stop-gap measure (e.g. catalytic converter) would have little payback impact. But the redesigning and renovating of a plant may have a considerable impact. In view of negative net income and cash flow effect, an expectation of a positive association between pollution and economic performance is not supportable; instead, this association is likely to be negative in the short run.

However, over a long time, corporate pollution abatement activities may result in benefits which could counter-balance the short-term negative effects. Bowman (1973) argues that corporate expenditures to reduce externalities (side-effects) will ultimately benefit the firm, and these benefits will manifest themselves in better productivity and reduced costs. For example, if as a result of pollution abatement activities, old equipment is replaced with modern sophisticated equipment, benefits will clearly be manifested in improved productivity. Furthermore, pollution abatement activities meeting pollution standards can be expected to reduce legal suits emanating from violation of environmental rules and regulations, which will reduce legal and liability costs.

Since the measurement of pollution performance has only been generated for one year no attempt is made here to measure the long-term impact of pollution abatement. Therefore, this study examines the short-term effects of pollution performance on economic performance upon the following null hypothesis:

\[ H_0: \] There is no association between pollution and economic performance of pulp and paper firms over a short time period.

If the above hypothesis is rejected, the alternative hypothesis will be that
pollution performance is associated with economic performance, and the sign of association will indicate whether this association is negative or positive.

In addition, this study examines the nature of market reaction to pollution performance. Most studies so far have examined the market reaction to pollution disclosures upon the assumption that pollution performance would be reflected in pollution disclosures. Ingram and Frazier's (1980) study, however, indicated that pollution disclosures do not seem to reflect pollution performance. Therefore, a direct examination of the association between pollution performance and market performance will provide useful information.

The nature of association between pollution and market performance will depend upon a number of factors and the most important are likely to be the impact of pollution performance on economic performance and the nature of investors' interest in the firm. If investors have a short term interest in the firm, their reaction could be negative because of the expected negative economic impact. On the other hand, if investors have a long term interest in the firm and they perceive the long term economic impact to be positive, their decisions may result in a positive association between pollution and market performance. There is still another group of investors whose investment activities may always result in a positive association between pollution control and market performance. This group will consist of those investors who look for only those firms which have done a good job cleaning-up the environment, or have not been cited or fined by the EPA; and they will not be deterred by the short term negative economic consequences of the firms' pollution abatement activities. Although this group of 'ethical investors' is likely to be small, its numbers have been increasing as people are becoming more interested in environmental concerns.

It needs to be recognised that the nature of association will depend upon the availability of pollution information. It is assumed that pollution information would be available from one of the following sources: EPA offices, 10Ks, annual reports, EPA rulings (fines and citations for violations), newspapers, journals, etc.

This study examines investors' reaction to pollution performance upon the assumption that investors would react to pollution performance as soon as pollution information becomes available from any source, and that this reaction will take into account short term, as well as long term economic effects of pollution performance. The following hypothesis is developed for this purpose:

\[ H_0^3: \text{There is no association between pollution and market performance of pulp and paper firms over a short period of time.} \]

The rejection of the above hypothesis will indicate that there is an association between pollution and market performance and the sign of the association will indicate whether it is positive or negative.
RESEARCH DESIGN

Sample and Data Collection

The sample for the study consists of 13 firms whose primary product is pulp and paper. All of the firms included in this study were included in the CEP study. Since pollution reports are filed with the EPA on a plant basis, individual plants of each firm throughout the United States were identified for the study. A list of 13 firms along with their eighty-one plant locations is included in the Appendix.

Each plant is required to file a water pollution report on a monthly basis for each pipe in the plant. The report usually indicates the amount of pollution intake and pollution outflow for each important pollution measure specified by the EPA. Pollution data for 1978 was extracted from pollution reports filed by firms with the EPA. Financial data for these firms was extracted from the COMPUSTAT tapes.

Water Pollutants

All types of pulp and paper mills use vast amounts of water. Most of the water is not consumed, it is used and returned to the waterways. The discharged water, if not treated properly before returning to the waterways, brings a variety of waste matter from the mills. The waste matter includes fibers, bark, uncooked wood chips; dissolved solids like carbohydrates and soluble wood matters; and cooking and bleaching chemicals. In order to determine the extent of water pollution caused by the waste matter, the impact of harmful pollutants needs to be related to important pollution measures. Three measures have been considered critical in determining water quality (for example see, EPA, 1976) and have consistently been included in the pollution reports filed by pulp and paper mills with the EPA. These are: Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and pH for water acidity-alkalinity.

The Biochemical Oxygen Demand (BOD) measure has been defined as 'a measure of rate at which the oxygen in a sample of water is used up by the natural self-purifying process that breaks down organic pollution such as sewage or various chemicals' (EPA, 1976). The Total Suspended Solids (TSS) of paper mills, which include materials and compounds used in making paper, may remain suspended in the body of water for sometime before settling down to the bottom and may cause fish to die by clogging their respiratory passages. pH is technically a measure of hydrogen ion concentration in a given amount of water and is related directly to the acidity or alkalinity of waste water streams. Extremes or rapid changes in pH create conditions that can kill aquatic life.
Development of a Pollution Index

A methodology similar to the one used by Cannon (1974) for the development of a pollution index for the steel industry has been developed by Freedman and Jaggi (1986) for pulp and paper firms. This methodology is used in this study for developing the pollution performance index. The procedures used in developing the index are briefly described below.

From an overall perspective the procedure to measure both BOD and TSS is to compare the outflow from each pipe with the inflow. This results in either an increase or decrease in pollution which is termed a change in pollution emissions.

Specifically, to measure BOD pollution, for each outflow pipe a daily average outflow for BOD weight (BODW-measured in pounds per day) and BOD concentration (BODC-measured in milligrams per liter) is computed. This is then compared to BOD concentration of the inflow pipe. However, most of the monthly reports filed with the EPA did not provide information on daily BOD inflow and it was therefore necessary to determine a reasonable level for the intake. Based on a technical report prepared by McDuffie and Haney (1973) a BOD concentration level of 5 was felt to be appropriate. In equation (1) the BOD pollution change is computed.

If the BOD weight for the outflow pipe is not available by utilizing water flow (F) per pipe the BOD change can be computed utilizing equation (2).

\[
\begin{align*}
\text{BOD}_{ijk} &= \left[1 - \frac{5}{\text{BODC}_{ijk}}\right] \times \text{BODW}_{ijk} \\
\text{BOD}_{ijk} &= (\text{BODC}_{ijk} - 5) \times 8.3 \times F_{ijk}
\end{align*}
\]

where,

- \(\text{BOD}_{ijk}\) = BOD change between input and output for pipe \(k\), plant \(j\), and firm \(i\),
- \(\text{BODC}_{ijk}\) = BOD concentration for pipe \(k\), plant \(j\), and firm \(i\),
- \(\text{BODW}_{ijk}\) = BOD weight for pipe \(k\), plant \(j\), and firm \(i\),
- \(F_{ijk}\) = Average water flow for each pipe \(k\), plant \(j\) and firm \(i\).

An average change of BOD for each mill (\(\text{BOD}_{y}\)) is computed by summing the BOD change per pipe in the mill. The average change of BOD for the company as a whole can then be calculated by summing the BOD change per mill.

The procedures to measure TSS are similar to those for the BOD. If data for average TSS intake are not available in the report, the daily intake is assumed to be 20 (see McDuffie and Haney, 1973).
For measurement of pH pollutant, a range between 6 and 8.5 was considered normal (McDuffie and Haney, 1973) and pH outside this range is considered pollution. Equation (3) is used to determine acidity-alkalinity pollution for each pipe, and equation (4) is used for determination of acidity-alkalinity pollution for the firm.

\[
Ph_{ij} = \frac{1}{P} \sum_{k=1}^{p} (Ph \ Max - 8.5) + \frac{1}{P} \sum_{k=1}^{p} (6 - Ph \ Min_{ijk})
\]

\[
Ph_i = \frac{Ph_{i1} \cdot F_{i1} + Ph_{i2} \cdot F_{i2} + \ldots + Ph_{ij} \cdot F_{ij}}{F_i}
\]

where \( F_{i1}, F_{i2}, \ldots F_{ij} \) = water flow for plant \( j \), firm \( i \).

After the measures for each pollutant are calculated, a weighted pollution index is developed for each pollutant. The BOD and TSS raw scores (see column 1 of Table 1) are converted into per ton production scores (see column 2 of Table 1) for making comparative analysis across all firms. The use of BOD and TSS per ton of production provides a relative measure of pollution performance and size and efficiency are taken into account. This is also consistent with the EPA’s policy of basing their mill pollution standards on mill size along with other factors. Furthermore, the studies by Spicer (1978), Ingram and Frazier (1980) and Freedman and Jaggi (1988) all utilized pollution performance adjusted for some measure of size.

The firms with the highest per ton of production score of an individual pollutant is assigned the pollution index of 100. The indices for other firms are calculated in relation to the highest index. For example, the TSS measure of 23.71 per ton of production for International Paper is the highest, this firm is assigned the index of 100. Boise Cascade with a TSS measure of 10.25 of production is given the index of 43.2. This procedure is followed for TSS as well as BOD to calculate a pollution index for each firm (see column 3 of Table 1). The scores based on per ton of production are not considered appropriate for the pH measure since the formula to calculate pH pollution averages the mill sizes based on water flow. Therefore, pH raw scores are used for the calculation of the pH index.

The pollution indices for each pollutant are combined to arrive at an overall pollution index. In view of the difficulty of determining the relative detriment of the three pollutants to the environment, each pollutant is weighted equally.

**Economic and Market Performance Indicators**

Because the impact of pollution performance will be felt both on profitability as well as on productivity, the following five economic performance indicators have been selected for the study: Net Income, Return on Equity, Return of Assets, Cash Flow/Equity, and Cash Flow/Assets. The measure of Net Income is selected because this measure is commonly used for evaluating the economic performance of firms. But net income alone does not sufficiently reflect economic
### Table 1

Pollution Emissions and Weighted Index

<table>
<thead>
<tr>
<th>Firm</th>
<th>Change</th>
<th>TSS/Ton of Production</th>
<th>Weighted Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boise Cascade</td>
<td>49,953</td>
<td>10.25</td>
<td>43.20</td>
</tr>
<tr>
<td>Champion</td>
<td>24,325</td>
<td>5.66</td>
<td>23.90</td>
</tr>
<tr>
<td>Crown Zellerbach</td>
<td>56,817</td>
<td>20.00</td>
<td>84.35</td>
</tr>
<tr>
<td>Georgia Pacific</td>
<td>43,781</td>
<td>6.04</td>
<td>25.47</td>
</tr>
<tr>
<td>Great N. Nekoosa</td>
<td>34,046</td>
<td>6.78</td>
<td>28.59</td>
</tr>
<tr>
<td>Hammermill</td>
<td>1,344</td>
<td>0.53</td>
<td>2.23</td>
</tr>
<tr>
<td>Int'l. Paper</td>
<td>220,228</td>
<td>23.71</td>
<td>100.00</td>
</tr>
<tr>
<td>Mead</td>
<td>3,030</td>
<td>1.80</td>
<td>7.59</td>
</tr>
<tr>
<td>Potlatch</td>
<td>16,314</td>
<td>9.00</td>
<td>37.95</td>
</tr>
<tr>
<td>St. Regis</td>
<td>28,938</td>
<td>3.39</td>
<td>14.30</td>
</tr>
<tr>
<td>Scott</td>
<td>86,098</td>
<td>13.82</td>
<td>58.30</td>
</tr>
<tr>
<td>Westvaco</td>
<td>2,083</td>
<td>0.56</td>
<td>2.36</td>
</tr>
<tr>
<td>Weyerhaeuser</td>
<td>98,906</td>
<td>10.20</td>
<td>43.00</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Firm</th>
<th>Change</th>
<th>BOD/Ton of Production</th>
<th>Weighted Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boise Cascade</td>
<td>31,520</td>
<td>6.46</td>
<td>26.20</td>
</tr>
<tr>
<td>Champion</td>
<td>16,985</td>
<td>3.95</td>
<td>16.10</td>
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<tr>
<td>Crown Zellerbach</td>
<td>69,914</td>
<td>24.61</td>
<td>100.00</td>
</tr>
<tr>
<td>Georgia Pacific</td>
<td>117,564</td>
<td>16.22</td>
<td>65.90</td>
</tr>
<tr>
<td>Great N. Nekoosa</td>
<td>54,593</td>
<td>10.88</td>
<td>44.20</td>
</tr>
<tr>
<td>Hammermill</td>
<td>6,032</td>
<td>2.38</td>
<td>9.70</td>
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<td>Int'l. Paper</td>
<td>198,112</td>
<td>21.32</td>
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<td>Mead</td>
<td>2,158</td>
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<td>5.20</td>
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<td>Potlatch</td>
<td>21,703</td>
<td>11.98</td>
<td>48.70</td>
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<tr>
<td>St. Regis</td>
<td>21,773</td>
<td>2.55</td>
<td>10.40</td>
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<tr>
<td>Scott</td>
<td>50,023</td>
<td>8.03</td>
<td>1.51</td>
</tr>
<tr>
<td>Westvaco</td>
<td>5,589</td>
<td>1.51</td>
<td>6.10</td>
</tr>
<tr>
<td>Weyerhaeuser</td>
<td>117,182</td>
<td>10.10</td>
<td>49.10</td>
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<table>
<thead>
<tr>
<th>Firm</th>
<th>Score</th>
<th>Weighted Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boise Cascade</td>
<td>0.009</td>
<td>0.34</td>
</tr>
<tr>
<td>Champion</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td>Crown Zellerbach</td>
<td>0.182</td>
<td>6.80</td>
</tr>
<tr>
<td>Georgia Pacific</td>
<td>2.678</td>
<td>100.00</td>
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<tr>
<td>Great N. Nekoosa</td>
<td>0.061</td>
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</tr>
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<td>Hammermill</td>
<td>0.611</td>
<td>22.81</td>
</tr>
<tr>
<td>Int'l. Paper</td>
<td>0.099</td>
<td>3.70</td>
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<tr>
<td>Mead</td>
<td>0.125</td>
<td>4.67</td>
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<tr>
<td>Potlatch</td>
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<tr>
<td>St. Regis</td>
<td>0.615</td>
<td>22.96</td>
</tr>
<tr>
<td>Scott</td>
<td>1.489</td>
<td>55.60</td>
</tr>
<tr>
<td>Westvaco</td>
<td>0.413</td>
<td>15.42</td>
</tr>
<tr>
<td>Weyerhaeuser</td>
<td>1.165</td>
<td>43.50</td>
</tr>
</tbody>
</table>
performance. It needs to be related to owners' investment in the firm and/or total investment of the firm. Thus, the commonly used measures of ROE and ROA are selected for this purpose. The last two indicators are included because investors are ultimately interested in cash flows of the firms. The market performance in this study is measured by the systematic risk and price/earnings ratio. The systematic risk will indicate how the investors evaluate the risk of a particular firm. It will be calculated on the basis of the market model by using sixty monthly security prices and the S + P composite index. The PE ratio has been included in the analysis to evaluate investors' reaction to the firm's profitability. It will indicate how the stock prices relate to the changes in earnings resulting from pollution performance.

EMPIRICAL TESTS AND RESULTS

Pollution Index

The pollution index for all firms was developed in two steps. First, a weighted index was computed for each of three measures of pollutants, i.e., TSS, BOD, pH, on the basis of the methodology described earlier (see Table 1). The raw pollution scores contained in column 1 of Table 1 were converted to a weighted index for each pollutant. The production data contained in column 2 was used for developing the BOD and TSS pollution index. The weighted index for BOD and TSS is given in column 3 and for pH in column 2.

In the second step, the weighted index of three pollutants was added to develop an overall pollution index for each firm. This index is given in Table 2.

Table 2
An Overall Pollution Index
(Ranked from best to worst)

<table>
<thead>
<tr>
<th>Company</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mead</td>
<td>17.46</td>
</tr>
<tr>
<td>Westvaco</td>
<td>23.88</td>
</tr>
<tr>
<td>Hammermill</td>
<td>34.74</td>
</tr>
<tr>
<td>Champion</td>
<td>40.00</td>
</tr>
<tr>
<td>St. Regis</td>
<td>47.66</td>
</tr>
<tr>
<td>Boise Cascade</td>
<td>69.74</td>
</tr>
<tr>
<td>Great N. Nekoosa</td>
<td>75.07</td>
</tr>
<tr>
<td>Potlatch</td>
<td>104.69</td>
</tr>
<tr>
<td>Weyerhaeuser</td>
<td>135.60</td>
</tr>
<tr>
<td>Scott</td>
<td>146.50</td>
</tr>
<tr>
<td>International Paper</td>
<td>190.30</td>
</tr>
<tr>
<td>Crown Zellerbach</td>
<td>191.15</td>
</tr>
<tr>
<td>Georgia Pacific</td>
<td>191.37</td>
</tr>
</tbody>
</table>
Relationship Between Pollution and Economic Performance

The association between pollution index and economic performance indicators was evaluated by using the Pearson Correlation test for three different time periods. First, the pollution performance of 1978 was correlated with the 1978 economic performance of the firm upon the assumption that economic performance information will reflect the impact of pollution reports filed with the EPA during the same year. Second, 1978 pollution performance was correlated with an average of economic performance for the preceding three years, i.e. 1975–77. This test was conducted upon the assumption that pollution reports filed in 1978 would reflect pollution performance which was the result of expenditures incurred on pollution related activities during the preceding years. Third, the 1978 pollution performance was correlated with an average of economic performance of three years from the year of reporting of pollution emissions, i.e. 1978–80. This period was selected on the assumption that the impact of pollution performance may appear with a time lag of one or two years.

The results of correlation tests for the three periods are contained in Table 3. The results relating to the association between 1978 pollution performance and 1978 economic performance indicate that pollution performance is negatively correlated with all economic performance indicators, except for the ratio of Cash Flow/Equity. However, only the correlation coefficient relating to NI is marginally significant at the 0.09 level. All other correlation coefficients are insignificant.

The results on the association between 1978 pollution index and economic performance for the preceding three years, i.e. 1975–77, indicate that the correlation coefficients are negative for all economic performance indicators

Table 3

Results of Association Between Pollution Performance and Economic Performance of Pulp and Paper Firms

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pearson Correlation Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Income</td>
<td>-0.630</td>
</tr>
<tr>
<td>(0.021)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Return on Equity</td>
<td>-0.305</td>
</tr>
<tr>
<td>(0.31)</td>
<td>(0.85)</td>
</tr>
<tr>
<td>Return on Assets</td>
<td>-0.357</td>
</tr>
<tr>
<td>(0.23)</td>
<td>(0.97)</td>
</tr>
<tr>
<td>Cash Flows/Equity</td>
<td>-0.559</td>
</tr>
<tr>
<td>(0.047)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Cash Flows/Assets</td>
<td>-0.558</td>
</tr>
<tr>
<td>(0.048)</td>
<td>(0.13)</td>
</tr>
</tbody>
</table>

( ) Probability
and these are significant for NI and Cash Flow indicators at the 0.05 level. These results thus suggest that pollution related activities of firms undertaken during the preceding three years as reflected in the 1978 pollution emission reports are negatively correlated with economic performance of three years preceding pollution reporting. This negative association is especially significant for ratios based on cash flows.

The results on association between 1978 pollution performance and 1978–80 economic performance indicate that the association is negative for NI and cash flow based ratios, but positive for ROE and ROA. However, the correlation coefficients are insignificant at the classical levels of significance except for NI, which is marginally significant at the level of 0.08.

The above results provide evidence, though not very strong, that pollution performance is negatively associated with the economic performance over a short period of time, especially for the period preceding the year of pollution reporting. This negative association continued during the period after the reporting year for cash based economic indicators. On the basis of these results, we reject the first null hypothesis that there was no association between pollution performance and economic performance and accept the alternative hypothesis that there was a negative association between these variables.

These results differ from the results of Bradgon-Marlin’s and Spicer’s studies which indicated that there was a positive association between pollution performance and economic performance. The difference in the results may be due to differences in the pollution data bases or it may be due to different time periods of the study. The results of this study are, however, consistent with the expectation of a negative association between the variables over a short time period, as discussed in the section on rationale.

Relationship Between Pollution and Market Performance

The association between pollution and market performance was examined by conducting the Pearson Correlation test on the 1978 pollution index and two market variables: Beta and PE Ratio. The betas for the sample firms were calculated for 60 months preceding the filing of pollution reports. Similarly, an average of the PE ratio was calculated for the preceding 5 years. The results are contained in Table 4.

The negative coefficient for systematic risk in Table 4 indicates that the firms with higher pollution levels were associated with higher risk. However, the correlation coefficient was statistically not significant. The Price-Earnings ratio results show that the PE-ratio was lower for firms with better pollution performance (i.e. lower pollution index) and the coefficient was statistically significant.

The above results provide evidence, though not strong, that the market performance has been lower for better pollution performers in the short-run. On the basis of these results, we cannot accept the null hypothesis that there
Table 4

Results on Association Between Pollution Performance and Market Performance of Pulp and Paper Firms

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pearson Correlation Coefficients (1973–77)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systematic Risk</td>
<td>-0.132</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
</tr>
<tr>
<td>Price Earning Ratio</td>
<td>-0.665</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
</tr>
</tbody>
</table>

was no association between pollution performance and market performance. The PE ratio results especially show that investors valued firms with better pollution performance lower than they did firms which were worse polluters.

Implications of Results

The results of earlier studies on market reaction to pollution disclosures provided mixed evidence as to how the market reacts to pollution performance. The findings of several studies (e.g. Belkaoui 1979; Andersen and Frankle, 1980; Jaggi and Freedman, 1982; and Spicer and Shane, 1983) suggested that pollution disclosures were associated with market reaction. However, these studies were all concerned with whether the market reacted to the information and not whether there was a positive or negative reaction. Furthermore, a close scrutiny of market reaction to extensive and limited pollution disclosures indicated that the market did not perceive extensive disclosures to contain any additional information (Freedman and Jaggi, 1986). The neglect of detailed information on corporate pollution performance by the market provided evidence that it did not reward good pollution disclosures; instead a minimal pollution disclosure was apparently considered to be sufficient in meeting the responsibility of disclosing pollution information. These results thus show that the market has not been encouraging management to do an effective job on reporting pollution performance.

The results of the current study provide evidence that the markets are not rewarding good pollution performance by firms. The results of negative association between pollution and economic performance suggest that in the short run the firm’s profitability will be negatively affected by pollution abatement activities involving heavy expenditures. In view of this negative economic effect, the market’s reaction on an overall basis to pollution performance has also been negative. This negative market reaction obviously ignores the expected better profitability in the long run resulting from positive counter-balancing effects of pollution abatement activities.
The results of this study indicate that because markets reward short-run profit maximization policies, management is encouraged to follow such policies. Thus, in order to pursue the objective of higher profitability, management continues to pollute the environment. In the absence of encouragement from market forces, strict pollution control standards are necessary, and these need to be strictly enforced. Unfortunately, the progress on the development of these standards has been slow and the enforcement of the existing standards has been weak. In order to improve upon the standards for pollution and other types of social information, the accounting profession might get more involved in the development of these standards.

SUMMARY AND CONCLUSION

This study has examined the association between pollution performance and economic and market performance of pulp and paper firms. The results indicate that the economic performance is negatively associated with pollution performance over a short period of time. Results with regard to market performance indicate that the Price-Earnings ratio is also negatively associated with pollution performance.

The results of this study provide weak evidence that firms with good pollution performance are not being viewed positively by the market because of the negative association between pollution and economic performance. In order to safeguard the public interest for a clean environment, strict pollution standards may be necessary to encourage management to invest in pollution abatement activities.

The results of this study, however, need to be interpreted with caution because of certain limitations inherent in the study. First, the pollution performance index developed in this study related to water pollution only. All CEP studies included air pollution data also. Since air pollution data using the plant as a point source are not available from the EPA or their state equivalents, these could not be included in the study. However, we do not believe that given the nature of the industry, the lack of air pollution data will greatly distort the findings.

Second, the pollution performance index may not truly reflect the pollution performance because of the difficulty in determining relative weights for each pollutant. The consistent application of the methodology to all firms is, however, considered to reduce this weakness of the study.

Third, the pollution reports filed by firms in the EPA may not truly reflect actual pollution performance. There may be a self-reporting bias. However, EPA inspectors' reports were also obtained for a number of plants and no significant differences were detected in inspectors's reports and firms' reports.

Further studies on the subject are extremely desirable, especially for developing a methodology to examine the association between pollution and
economic performance in the long run. Researchers are also encouraged to develop causal models which could provide more useful information for evaluation of pollution performance’s impact on the economic and market performance in the short run as well as in the long run.

APPENDIX

Companies and Plants Included in Study

*Boise Cascade*
- De Ridder
- Rumford
- Wailula

*Champion International*
- Canton
- Courtland

*Crown Zellerbach*
- Camas
- Port Angeles
- Port Townsend

*Georgia Pacific*
- Bellingham
- Crosett
- Delair
- Lyons Falls
- Woodland

*Great Northern Nekoosa*
- Cedar Springs
- East Millinocket
- Millinocket

*Hamermill*
- Erie
- Kaukana

*International Paper*
- Bastrop
- Bay City
- Camden
- Georgetown
- Jay
- Ticonderoga

*Mead*
- Chillicothe
- Strathmore

*Potlatch*
- Cloquet
- Lewiston
JAGGI AND FREEDMAN

St. Regis
- Bucksport
- Jacksonville
- Monticello

Scott Paper
- Chester
- Fort Edward
- Landisville
- Marinette
- Winslow

Westvaco
- Charleston
- Covington
- Luke

Weyerhaeuser
- Cosmopolis
- Craig
- Everett Kraft
- Everett Sulfite
- Longview
- Miquen

NOTE

1 The tests were run using both the Pearson correlation and the Spearman rank correlation. Since there was no significant difference in the test results and the data is interval data the Pearson correlation results are reported.

REFERENCES


Bragdon, H.H. Mr. and J. Martin (1972), 'Is Pollution Profitable?' Risk Management (April 1972), pp. 9–18.


