Research Note

Environmental regulation, capital intensity, and cross-sectional variation in market returns

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Abstract

My paper examines the relevance of capital intensity in explaining the cross-sectional variation in market returns to chemical industry firms following the Bhopal, India chemical leak. The Bhopal accident was expected to increase environmental regulation (see Blacconiere and Patten, 1994, p. 358), and negative market returns to chemical industry firms were observed (Blacconiere and Patten, 1994, p. 358). It is assumed that investors used capital intensity as a proxy for the level of pollution abatement controls presently in place. Consistent with this assumption, I found a positive, significant relation between market returns and capital intensity. I also found that, in the presence of a capital intensity variable, environmental disclosures continued to be positively related to market returns. © 2000 Elsevier Science Ltd. All rights reserved.

1. Introduction

My paper extends Blacconiere and Patten (1994) by examining the relevance of capital intensity in explaining the cross-sectional variation in market returns to chemical industry firms (other than Union Carbide) following the Bhopal, India Chemical leak that occurred in December 1984. This chemical leak resulted in the death of a number of people in the surrounding area (see, Blacconiere and Patten, 1994, p. 359). The Bhopal accident was followed by talk of
increased government regulation \(^1\) and negative intra-industry market returns in the chemical industry. \(^2\) Blacconiere and Patten (1994, pp. 370–371) found that the negative returns were mitigated by financial statement environmental disclosures.

I extend Blacconiere and Patten’s (1994, p. 370) model estimating market returns to chemical industry firms (other than Union Carbide) following the Bhopal accident to include capital intensity. I expect capital intensity to be related positively to chemical firm market returns following the Bhopal accident. This would occur if investors believed that capital intensive firms had more pollution abatement controls in place.

Blacconiere and Patten (1994, p. 375) note that one explanation for their results relative to environmental disclosure is that investors used this information to develop a firm-specific proxy for the exposure to environmental risk. It is possible, however, that the level of capital intensity also has a mitigating effect on the negative impact of potential increases in regulatory costs. Finding that environmental disclosure remains significant in the presence of capital intensity, therefore, would further support Blacconiere and Patten’s (1994, p. 375) interpretation of the value of environmental disclosures.

In this extension, I found that capital intensity was significantly, positively related to market returns to chemical firms (other than Union Carbide) following the Bhopal accident. In the presence of a capital intensity variable, however, environmental disclosure continued to be significantly, positively related to market returns to chemical firms (other than Union Carbide) following the Bhopal accident. Overall, a possible interpretation of the results is that capital intensity was used by investors in developing firm-specific estimates of pollution abatement controls already in place, while investors used environmental disclosures as a more general proxy, likely related to the overall exposure to environmental risk.

The remainder of the paper is organized as follows. Two hypotheses related to capital intensity and environmental disclosure are developed in Section 2. Section 3 described the methodology used in the note including, sample selection, variable construction and empirical models. Results are presented in Section 4. Conclusions and limitations are discussed in Section 5 of my paper.

2. Hypothesis development

Several studies found negative intra-industry market returns to firms in affected industries following announcements related to proposed environ-

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mental regulations (e.g., Wallace et al., 1988, p. 80; Shane, 1995, p. 496; Blacconiere and Northcutt, 1997, pp. 162–163) or following events that were expected to increase regulatory activity (e.g., Bowen et al., 1983, p. 98; Hill and Schneeweis, 1983, p. 1290; Blacconiere and Patten, 1994, p. 368; Patten and Nance, 1998, p. 410). One factor that may have contributed to the decline in market value for firms in affected industries was the expectation that new environmental regulations would require the implementation of costly pollution abatement controls. For example, Pashigian (1984, p. 6) suggested that environmental regulation would favor capital intensive methods of reducing emissions. Following the Bhopal accident, industry observers predicted that the event would indeed lead to higher capital expenditures (Starr, 1985, p. 28).

It is possible that the cost of complying with new environmental regulations would be lower for firms with more extensive pollution abatement controls already in place. This would occur if a high level of existing pollution abatement controls reduced the level of capital expenditures required to comply with new environmental regulations. Therefore, for each firm, the amount of spending required to comply with new environmental regulations would be dependent upon pollution abatement controls already in place. Essentially, new environmental regulation could force firms with fewer pollution abatement controls already in place to catch up to firms that had already invested in this technology.

Following the Bhopal accident, information concerning pollution abatement controls already in place could have been used by investors in developing firm-specific estimates of compliance costs related to potential environmental regulation. However, publicly available sources of data, such as 10-K reports, generally do not contain specific information related to pollution abatement controls already in place. Therefore, investors must develop proxies for firms' levels of existing pollution abatement controls.

Capital intensity would be a reasonable proxy for pollution abatement controls already in place if investors assumed that higher levels of capital expenditures translate to higher levels of pollution abatement controls. Consistent with this assumption, Russo and Fouts (1997, p. 538) predicted that environmentally proactive firms will acquire assets related to pollution prevention. Using environmental performance ratings from the Franklin Research

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3 Patten and Nance (1998, p. 410) found direct evidence of positive intra-industry returns for petroleum firms other than Exxon following the Alaska oil spill, which they attributed to higher gasoline prices, and indirect evidence of a negative industry response to regulatory pressure.

4 Consistent with this expectation, Pashigian (1984, p. 12) found that, during a period of increasing regulation (1972–1977), labor's share of value added declined more for high compliance cost firms that for low compliance cost firms (i.e., plants became more capital intensive).

5 Also see Agoos and Savage (1985, p. 8).
and Development Corporation, \(^6\) Russo and Fouts (1997, p. 547) found evidence of a positive relation between capital intensity and environmental performance, which is consistent with more capital intensive firms having more pollution abatement controls in place.

If investors used capital intensity as a proxy for pollution abatement controls already in place when developing firm-specific estimates of potential compliance costs associated with new environmental regulation, more capital intensive firms would suffer smaller declines in market value relative to less capital intensive firms. This leads to hypothesis one. \(^7\)

**H1.** Capital intensity will be related positively with market returns to chemical firms in the period following the Bhopal accident.

Blacconiere and Patten (1994, pp. 370–371), Blacconiere and Northcut (1997, p. 169) and Patten and Nance (1998, p. 409) found that environmental disclosures included in 10-K reports and/or annual reports were positively related to market returns following the Bhopal accident, announcements related to the Superfund Amendments and Reauthorization Act (SARA) and the Exxon Valdez oil spill, respectively. Blacconiere and Patten (1994, p. 375), in addressing their results, concluded that environmental disclosure could be used by investors to assess individual firms’ exposure to environmental risk. This interpretation of environmental disclosure suggests that the disclosures will continue to be relevant in the presence of capital-related variables. This leads to hypothesis 2.

**H2.** The level of environmental disclosure will continue to be related positively with market returns to chemical firms in the period following the Bhopal accident, even in the presence of a capital intensity variable.

In summary, prior research suggests that proposed regulation or the increased threat of regulation is associated with negative intra-industry market returns, and that environmental disclosures included in 10-K and/or annual reports appeared to mitigate the negative returns. Capital intensity may be useful in explaining some of the cross-sectional variation in market returns.

### 3. Methodology


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\(^6\) The Franklin Research and Development Corporation ratings are based on criteria such as compliance records, expenditures and waste reduction efforts (Russo and Fouts, 1997, p. 544).

\(^7\) All hypotheses in this note are stated in the alternative form.
selected 47 firms with operations that are similar to Union Carbide’s by identifying chemical firms with operations in one or more of the following four-digit SIC industries: industrial gases (2813), industrial inorganic chemicals (2819), industrial organic chemicals (2869), pesticides and agricultural chemicals (2879) and chemical and chemical preparations not elsewhere classified (2899). For this extension, I collected the additional data needed to construct capital intensity and capital asset age variables. However, one firm had to be deleted due to missing information. Thus the sample for my study consisted of 46 firms.

My analysis uses the ratio of chemical segment revenue to total revenue (CHEMSEG) and the level of environmental disclosure (DISCLOSE) measures used by Blacconiere and Patten (1994, pp. 368–369). A high value for CHEMSEG indicates that the firm was heavily concentrated in the chemical industry. Firms concentrated in the chemical industry will likely be affected to a greater extent by chemical industry environmental regulation. Therefore, CHEMSEG is expected to be related negatively to market returns. Blacconiere and Patten (1994, pp. 368–369) used content analysis to measure the level of environmental disclosure included in each sample firm’s 10-K report. Five areas of environmental concern were considered in Blacconiere and Patten (1994, pp. 368–369). My scoring was consistent with that used by Blacconiere and Patten (1994, pp. 368–369). A maximum score for a firm was five (Blacconiere and Patten, 1994, p. 369). Consistent with Blacconiere and Pattern (1994, p. 363), a high value for DISCLOSE is expected to be interpreted by the market as a signal that the firm is better positioned to deal with environmental regulation. Therefore, DISCLOSE is expected to be related positively to market returns (Blacconiere and Patten, 1994, p. 369).

Using data from the segment reporting section of the 10-K reports, I developed the following proxy for capital intensity (CAP):

\[
\text{CAP}_i = \frac{1983 \text{ Chemical Depreciation}_i}{1983 \text{ Chemical Revenues}_i}.
\]

I assumed that more capital intensive firms would have larger chemical depreciation expense relative to chemical revenue. Therefore, CAP is expected to be related positively to market returns following the Bhopal accident. Depreciation was used instead of capital assets because only total assets are available in the segment reports. Unlike total assets, depreciation will not be influenced by other assets, such as inventory. For the sample firms, the mean

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8 One company did not disclose chemical segment depreciation in 1983.

9 Firms are required to report industry segment data if the industries’ revenues or identifiable assets represent 10% or more of total revenues or total assets, respectively.
(median) level of CAP was 0.049 (0.042) with a minimum of 0.006 and a maximum of 0.120.  

My paper uses Blacconiere and Patten’s (1994, p. 367) estimates of cumulative abnormal returns (CARs). Blacconiere and Patten (1994, p. 367) calculated CARs for each company using the market model. The Betas were estimated using data from 6 February 1984 to 16 November 1984. The five-day event window was 3 December 1984 to 7 December 1984. Adding capital intensity (CAP) to Blacconiere and Patten’s (1994, p. 370) empirical model (see CAR, CHEMSEG, and DISCLOSE below) leads to the following model (with predicted signs shown in parentheses).  

$$\text{CAR}_i = \gamma_0 + \gamma_1 \text{CHEMSEG}_i + \gamma_2 \text{DISCLOSE}_i + \gamma_3 \text{CAP}_i + e_i,$$

where CAR<sub>i</sub> is the “five-day CAR for firm i to the Bhopal chemical leak”, CHEMSEG<sub>i</sub> the “ratio of chemical segment revenues to total revenues for firm i”, DISCLOSE<sub>i</sub> the “environmental content rating for firm i”, CAP<sub>i</sub> the ratio of chemical depreciation to chemical revenues for firm i, and e<sub>i</sub> is the error term for firm i.

The model was estimated using ordinary least squares (OLS) regression based on observations from the 46 sample firms.

4. Results

4.1. Correlation analysis

In Table 1, the Pearson correlation coefficients for cumulative abnormal returns (CAR), the ratio of chemical segment revenue to total revenue (CHEMSEG), environmental disclosure (DISCLOSE), capital intensity (CAP) and the log of total revenue (LNREV) are reported.

The univariate results show that all variables are the correct sign and are related significantly to CAR. As expected, capital intensity was associated with higher returns following the Bhopal accident (p = 0.007, two-tailed). Capital...
intensity is also positively, significantly correlated with the log of total revenue ($p^* = 0.003$, two-tailed), suggesting that larger firms are more likely to make capital investments.

Capital intensity and environmental disclosure are significantly, positively correlated ($p^* = 0.048$, two-tailed). However, since both variables are significantly correlated with the log of total revenue, it is possible that firm size is driving both the level of capital intensity and the level of environmental disclosure. After controlling for the log of total revenue, the partial correlation between capital intensity and environmental disclosure is positive but, insignificant ($p^* = 0.888$, two-tailed).

4.2. OLS multiple-regression analysis

The results of the OLS multiple regression analyses are reported in Table 2. As expected, the coefficient for CAP is positive and significant ($p = 0.022$, one-tailed). The results suggest that capital intensity was important in explaining the cross-sectional variation in returns to chemical firms following the Bhopal accident. Firms that were more capital intensive had less negative abnormal returns following the Bhopal accident.

The results with respect to chemical segment revenues and environmental disclosure are similar to those found by Blacconiere and Patten (1994).\footnote{Blacconiere and Patten (1994, p. 372) found coefficients and ($p$-values) for CHEMSEG and DISCLOSE of $-0.383$ (0.011, one-tailed) and $0.0072$ (0.012, one-tailed), respectively.} Firms with a greater portion of revenues in the chemical industry suffered larger negative abnormal returns following the Bhopal accident. Importantly,
in the presence of a capital intensity variable, environmental disclosure continues to be significant and related positively with market returns to chemical firms following the Bhopal accident, suggesting that environmental disclosures contain information not included in the capital intensity variable. The evidence is consistent with environmental disclosure being a proxy for firms’ overall exposure to environmental risk.

4.3. Sensitivity analysis

4.3.1. Firm size

Blacconiere and Patten (1994, p. 374) tested the sensitivity of their results to firm size and found that environmental disclosure was positive but not significant in the presence of the log of total revenue. The log of total revenue is significantly correlated with CAR, CHEMSEG, DISCLOSE (Blacconiere and Patten, 1994, p. 372) and CAP. To separate the effect of firm size from the other independent variables, the log of total revenue was included in the model. Similar to Blacconiere and Patten (1994, p. 374), the significance levels of CHEMSEG and DISCLOSE decrease. 13 The significance level for CAP also decreases when the log of total revenue is added to the model, but remains significant \( (p = 0.057, \text{ one-tailed}) \). The significance of the capital intensity

<table>
<thead>
<tr>
<th>Variable</th>
<th>Predicted sign</th>
<th>Coefficient</th>
<th>t-value</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>CHEMSEG</td>
<td>-</td>
<td>-0.0414</td>
<td>-2.63</td>
<td>0.006</td>
</tr>
<tr>
<td>DISCLOSE</td>
<td>+</td>
<td>0.0052</td>
<td>1.72</td>
<td>0.046</td>
</tr>
<tr>
<td>CAP</td>
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<td>0.3420</td>
<td>2.07</td>
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<tr>
<td>INTERCEPT</td>
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<td>-0.0264</td>
<td>-1.77</td>
<td>0.083</td>
</tr>
<tr>
<td>Observations</td>
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<td></td>
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<tr>
<td>Adj. R-sqr</td>
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<td>F statistic</td>
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<tr>
<td>p-value of F</td>
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<td>0.000</td>
<td></td>
<td></td>
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</tbody>
</table>

CHEMSEG, DISCLOSE, CAP and NEW p-values are based on a one-tailed test. The model estimated is: \( \text{CAR}_i = \gamma_0 + \gamma_1 \text{CHEMSEG}_i + \gamma_2 \text{DISCLOSE}_i + \gamma_3 \text{CAP}_i + e_i \), where \( \text{CAR}_i \) – cumulative abnormal returns for firm \( i \), CHEMSEG\(_i\) – the portion of total revenues from chemical operations for firm \( i \), DISCLOSE\(_i\) – number of environmental disclosures for firm \( i \), CAP\(_i\), the ratio of chemical depreciation to chemical revenues for firm \( i \) and \( e_i \) is the error term for firm \( i \).

13 In the presence of LNREV, Blacconiere and Patten (1994, p. 374) found p-values for CHEMSEG and DISCLOSE of \( (p = 0.093, \text{ one-tailed}) \) and \( (p = 0.143, \text{ one-tailed}) \), respectively.
variable in the presence of the log of total firm revenue suggests that the capital intensity variable is not a proxy for some unidentified size-related variable. \(^{14}\)

4.3.2. Capital asset age

Since older assets may be fully depreciated, capital asset age could influence the value of CAP, with newer assets leading to higher values for CAP. There is evidence that the rate of emissions is lower for new electric utility plants (Maloney and Brady 1988, p. 222), suggesting that new assets may be related to more effective pollution abatement controls. \(^{15}\) To control for possible effects of asset age, an additional variable was constructed by summing the prior four years of chemical capital expenditures and scaling this sum by 1983 chemical revenue. Models were estimated including the asset age variable in place of the CAP variable, and with both the asset age variable and the CAP variable. In each case, the asset age variable was not significant. The capital intensity variable did, however, retain significance \((p = 0.009, \text{one-tailed})\) when asset age was included. \(^{16}\)

5. Conclusion

My paper provides evidence that capital intensity was related to cross-sectional returns to chemical firms following the Bhopal accident, and the capital intensity variable was robust to alternative model specifications. The results support the hypothesis that more capital intensive firms suffered smaller negative abnormal returns following the Bhopal accident. Environmental disclosure continued to be significant in the presence of capital-related variables (except where the log of total revenue is included in the model). This suggests that these disclosures included a substantial amount of non capital-related information. This result further supports Blacconiere and Patten’s (1994, p. 375) conclusion that environmental disclosures were a proxy for the exposure to environmental risk.

It should be noted that the results of this note can only be generalized to situations where potential industry-wide regulations are related to pollution abatement or the environmental safety of plants. Future research in this area should consider capital intensity when assessing the incremental effect of proposed environmental regulations.

\(^{14}\) Overall model results are similar to those reported in Table 2 and are not presented here.
\(^{15}\) It is also possible that new plants are more capital intensive. Maloney and Brady (1988) do not address this possibility.
\(^{16}\) Results are not presented here but can be obtained by contacting the author.
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References