The Impact of Environmental Accidents on the Behaviour of TSE Traded Companies

Ph.D. Thesis

Faculty of Graduate Studies
University of Manitoba

Vanessa Magness
July 14, 2000

0-612-53067-1

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES
*****
COPYRIGHT PERMISSION PAGE

The Impact of Environmental Accidents on the Behaviour of TSE Traded Companies

BY

Vanessa Magness

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University

of Manitoba in partial fulfillment of the requirements of the degree

of

DOCTOR OF PHILOSOPHY

Abstract

Event study methodology is used to assess the sensitivity of stock return and systematic risk (beta) to environmental accidents. This thesis analyses 19 oil spill events, four mining accidents, and 10 miscellaneous incidents including PCB fires, transportation spills, radioactive and other gaseous releases. Most of the events had little impact on beta. Two mining accidents showed a marked downward effect on the betas across the industry. One PCB fire had an upward impact. When the mining event data were pooled in a time series cross-sectional analysis, the location of the accident, the number of people affected, and time, were all statistically significant. When data for the 10 miscellaneous events were pooled, the same three factors were significant. The evidence suggests that when an accident occurs in an industry that is little understood by the general public, beta rises. When it occurs in an industry or jurisdiction where environmental regulation is well understood, systematic risk declines. In either case, the number of people directly affected by the accident is directly (positively) related to changes in beta.

The pooled model was also used to study cumulative abnormal returns. Evidence of a size effect in the miscellaneous events supports the economic consequences theory of accounting. Companies cross-listed on the NYSE, AMEX, or NASDAQ provide conflicting evidence concerning voluntary disclosure theory.

The significance of this study is fourfold. First, event study practitioners concerned with abnormal returns cannot assume the beta parameter is unaffected by the event. Second, while industry regulation entails limitations to management discretion, the results of this analysis suggest that in the mining sector at least, reduced flexibility

in operating and disclosure decisions is associated with a decline in beta. This means that in their lobbyist role, mining industry representatives seeking to satisfy the environmentally conscious segment of the market by supporting additional regulation, need not worry that they do so at the expense of the overall investment community. Also, investors concerned with portfolio risk are interested in knowing the factors which contribute to changes in non-diversifiable risk. Finally, this thesis develops a foundation of Canadian work, upon which future research in accounting disclosure and operating decisions can be based.

Acknowledgements

I would like to thank the members of my doctoral committee at the University of Manitoba. Dr. Milton Boyd, Dr. Nabil Elias, Dr. Charles Mossman, and Dr. Elizabeth Troutt each provided suggestions and approaches to questions which were eventually incorporated into this thesis. Special thanks go to my advisor, Dr. Michael Power, of the University of Waterloo, for his invaluable assistance during the final months of research. Finally, I want to thank the Society of Management Accountants of Canada for their financial support.

Table of Contents

List of Tables

Chapter 1

Introduction

One goal of accounting is to put economic theory into practice by luring funds away from low value uses toward higher value uses. Accounting procedures were designed to track and report business activity with this as the overriding objective. There was no theoretical framework, however, to guide company managers as to what sort of information to disclose in financial statements. Initial attempts to develop external reporting theory focused on the needs of a very narrow segment of society: shareholders and creditors. There is a history, however, of financial statements including non-financial disclosures on human resource management, community involvement, and environmental issues, all directed toward a much broader base of accounting users. This trend gave rise to what is now known as *social responsibility accounting*. In an attempt to explain the particulars of the disclosure decision process, some researchers speculated that managers gauge societal concerns and tailor financial statements in an effort to legitimize the corporation in the "eyes" of society. Other efforts to explain disclosure decisions suggest that management weighs the costs and benefits associated with information disclosure as part of a strategic decision making process.

Of all the social responsibility issues appearing in financial statements over time, environmental information has been the most persistent. This suggests that management believes environmental matters warrant a regular place in external reports. However, accounting procedures rely on market based transactions. For this reason, the accounting profession has shied away from the challenge of adopting a generally accepted format for this type of disclosure. Furthermore, both accounting theory and financial market theory suggest that stock prices incorporate information from a variety of sources, not just that directly disclosed in financial statements. This has allowed the accounting profession to argue that the accounting framework need not be revised to admit environmental values, and that additional, relevant information can be presented through some alternative format.

Changes in stock prices gauge how the market values the information available for assessing the risk/return trade-off of an investment. For this reason, capital market research provides an opportunity to identify information of concern to the accounting community. The volume of research relating to environmental issues and capital market behaviour has grown considerably in recent years. This growth was triggered, in part, by increasing standards in pollution control, and by increasing accounting disclosure requirements. Both of these changes have been driven by mounting societal concern for environmental issues. Much of this research uses American data, for the size of the US stock market facilitates capital markets based research, while data collected from the smaller Canadian markets are subject to difficulties related to infrequent trading. For this reason, the pervasiveness of environmental concerns within the investment community in Canada has not as yet been established.

The main objective of this thesis is to study the intra-industry impacts (also known as contagion effects) of incidents with environmental repercussions. These impacts, if they occur at all, can take one of two forms. First, share prices may be affected. Changes in cash flow projections associated with the incidents are discounted into the value of company stock, and may be reflected in abnormal returns. Another way in which shares may react is through a change in risk. The total risk of a stock is reflected through its standard deviation of returns. A portion of this risk is correlated with the volatility of returns for the overall equity market. This portion is the stock's systematic risk, or equity beta. This research tests for the existence of a contagion effect by testing for both abnormal returns, and beta shifts. Both tests employ the use of event study methodology. For each incident, a portfolio of stocks in the affected industry is used to assess the presence of a contagion effect on share returns. The beta tests are conducted on the individual stocks.

In addition to investigating impacts of environmental incidents on share behaviour, the objective of this research is to provide a foundation of work with Canadian data, upon which future studies may be based. A total of 33 event studies are examined, 32 of which were accidents. While the events themselves need not have occurred in Canada, all companies included in the study are TSE traded Canadian companies. This thesis focuses largely on companies in the natural resource sector, as this sector is frequently targeted by calls for better environmental performance and social responsibility disclosures.

The results of this study are relevant to investors and managers alike. Fund managers take systematic risk into consideration as part of the investment decision making process. The stability of beta in the wake of an accident is a guide to how closely specific investments need to be monitored. For this reason, institutional investors should find this research of value. Furthermore, as systematic risk cannot be eliminated through portfolio diversification, both institutional and individual investors are concerned with the propensity of beta to change. Factors tested for explanatory power include company size and industry, as these features are often cited as having a major impact on investor sentiment. The number of people affected by the accident, as well as accident location, are two other factors that are considered. The explanatory power of a listing factor is also assessed, as some Canadian companies are cross-listed on US exchanges. These companies have a much broader investor base and are therefore subject to wider investor scrutiny.

If changes in stock behaviour are tempered by factors that are within management control, or at least subject to management scrutiny, the investment community overall will factor this information into their decision framework. This means that new knowledge concerning the impact of environmental accidents on share behaviour could affect the availability of capital and lead to new or revised demands on management.

Because of the security that portfolio diversification offers against abnormal returns on any individual stock, investors are apt to be less concerned with what may be a one time price change. On the other hand, the managers of these individual companies have several reasons for concern. A company may become a takeover target after a sudden drop in share price. Part of management's compensation may be tied to stock performance. A company may risk becoming a social pariah. For these reasons, management is concerned with the price level of the company's shares. They are also concerned with beta, for institutional (especially pension fund) managers often target stocks with relatively low risk. For their part, managers are cognizant of the growing societal demand for environmental responsibility.

The following chapter explores the evolution of the stakeholder concept, external reporting objectives, and the theories that attempt to explain the disclosure decision process. Studies of the correlation between environmental performance and investment risk, between independent ratings of environmental performance and managements' claims, and between environmental and economic performance, are all reviewed. Studies of the correlations between environmental disclosure and stock behaviour in the wake of an accident, and in the wake of legislative change are also discussed. Finally, chapter 2 reviews individual company efforts to disclose monetized environmental impacts, and ways in which this sort of information can be incorporated into the operating decision making process.

Chapter 3 discusses the research methodology, the hypotheses to be tested, and the empirical models to be used later in this study. Chapter 4 discusses the data, the results of the analyses, and reviews the hypotheses in light of the test results. In chapter 5, these results are discussed in a much broader context, taking societal trends, changes in legislation, and changes in professional standards into consideration. Finally, chapter 6 summarizes the results of this study, and comments on possible avenues for further research.

Chapter 2

Literature Review

2.1 Financial Accounting, External Reporting Theory and Corporate Social Responsibility

The origins of accounting lie in the 15th century when double entry bookkeeping was developed. Initially there was no theoretical underpinning to the discipline. Prior to 1973, when the US Financial Accounting Standards Board (FASB) took over from its predecessor organization, there was not even agreement within the accounting profession as to what the objectives of accounting should be (Viper 1994). One of the initial moves of the FASB was to launch what became known as the *conceptual framework project*. This framework, drawing from decision theory, economic theory, and financial market theory, was intended to provide a common language through which issues could be discussed, and a theoretical basis for the Board's consideration of specific accounting issues. *Decision usefulness* was defined as the first objective of accounting: the goal was to help investors - both shareholders and creditors - to make economic decisions (Viper 1994, Scott 1997). This was the profession's first official acknowledgment of the distinction between the needs of management and those of outsiders, a distinction that accompanied the rise of the corporate structure, and stemmed from the asymmetry of information readily available to those with access to insider information, and those without.

Out of the conceptual framework grew the Statements of Financial Accounting Standards (SFAS). These are guidelines designed to tailor externally reported information so that it brings to investors' attention information relevant to their assessment of a company's current financial position and future prospects. Financial statement users are assumed to be rational, that is, interested in maximizing their utility. Any information perceived to be helpful in assessing future states of nature was considered relevant to their decision making needs. Responsibility for the evolution of accounting theory and reporting standards was gradually moved into the hands of the professional bodies such as the FASB, the Canadian Institute of Chartered Accountants (CICA), and regulatory bodies such as the US Securities Exchange Commission (SEC).

> *...the underlying cost of an accounting standard from a reporting entity's perspective is loss of control over information: that is, loss of ability to decide whether, when, or how to present information. It is loss of management flexibility and, to a significant degree, loss of the advantage of insider information. The counterpart of the reporting entity's loss is the using entity's gain - access to information with analytic power, the power to make better investment decisions.* (Dennis Beresford - chairman of the FASB in 1990)

In the absence of specific reporting guidelines on a particular issue, management remained free to decide on how and what to include in their external reports. The form and content of these reports became the focus of considerable academic study. Over the years management had included social disclosures such as news about human resource development, community or environmental issues, areas that had seemingly little to do with states of nature or future profitability. Socio-political explanations of management behaviour became an alternative to decision based attempts to explain the disclosure decision process. *Social accounting theory* (Ramanathan 1976), based on the notion of a social contract, envisioned company responsibilities to include the adoption of strategies consistent with social priorities, the measurement of "net social contribution," and the disclosure of reliable information to all social constituents so as to support the effective evaluation of company performance. Related to this was the *legitimacy theory* of disclosure, which claimed the survival prospects of a business depend upon its ability to deliver economic, social and political benefits to the groups in society from which it derives its power (Patten 1992). The needs of these groups are subject to change. Therefore, management must monitor and respond to changes in order to sustain the approval of relevant groups. This suggests management reacts to current social issues and chooses what to disclose in the annual report in an effort to "legitimize" its place in the community. According to this theory, disclosures have the potential to: show how the company has improved its performance with regard to a particular issue; deflect attention away from its performance; correct a public misunderstanding as to its performance; or, alter public expectations (Lindblom 1994). In a similar vein, Lev (1992) said an effective disclosure strategy may deter political or regulatory intervention; attract institutional investment (often regarded as a seal of approval); increase trading activity; and correct perceived mis-evaluations. If accurate, these objectives lend support to legitimacy theory, but also introduce a strategic element to the disclosure decision process.

Early studies cast doubt on legitimacy theory as an explanation for patterns of corporate disclosure. While social reporting had been observed in annual reports for years (Guthrie and Parker 1989), Ingram and Frazier (1980) found little public call for social disclosures. While mutual fund managers showed some concern for corporate social reporting (CSR), social reporting issues ranked lower in importance than financial ones (Busby and Falk 1978). Guthrie and Parker (1989) found little empirical evidence linking management disclosure decisions to community concerns, with the exception of environmental issues. Rockness and Williams (1988) found that environmental issues were a concern to business and securities regulators, and financial statement users. The relationship of disclosures and community concerns was tested again, in the wake of the Exxon Valdez oil spill, and this time clear evidence was found (Patten 1992). Individual investors surveyed in 1991 revealed strong demand for environmental disclosures, ranking pollution abatement of greater importance than higher dividends (Epstein and Freedman 1994). Filsner and Cooper (1992) noted that ethical investors were prepared to accept a lower than average return on their investment, providing their investments were in "environmentally friendly" companies. Therefore, while social accounting and legitimacy theories found only limited support, and CSR did not itself become an ongoing part of the external reporting framework, there is evidence to suggest that environmental reporting was a subject of growing management concern (Epstein 1996).

A significant increase in environment related disclosures in Australia coincided with an increase in membership in environmental lobby groups (Deegan and Gordon 1996). The trend was also observed in the United Kingdom (Gray, Kouhy and Lavers 1995). For companies in environmentally sensitive industries, a positive relationship between the quantity of environmental disclosure and company size was observed in

Australia (Deegan and Gordon 1996) and Canada (Simmons, Neu, and Ruff 1993, Buhr 1994, Bewley and Li 1998). This is in keeping with a view that large firms attract more public attention than smaller ones (Watts and Zimmerman 1987).

Buhr (1994) found that most environmental disclosures in Canada are voluntary and made by large companies. This suggests the cost of producing the information will be weighed against the benefits of disseminating that information. The uncertainties associated with environmental risk characterization (McKone 1996, Solomon 1996) complicate the cost/benefit analysis, which suggests that more extensive disclosures will be associated with larger companies with greater access to financial resources. These issues are associated with another theoretical attempt to capture the essence of the disclosure decision process, called *voluntary disclosure theory* (VDT). According to VDT, voluntary market forces elicit a "disclosure equilibrium" that works as efficiently as if disclosures were mandated (Richardson 1998). Factors taken into consideration when deciding whether or not to disclose information include: costs (Trueman 1986), "proprietary costs" resulting from the hostile use of information by lawyers and lobby groups (Wagmire 1985, Richardson 1998), the degree of outsider awareness of management information (Li, Richardson and Thornton 1997), company size (Verrecchia 1983), and the benefits resulting from disclosure.

Another socio-political approach to explain disclosure decisions is *political economy accounting* (PEA), which argues that conventional accounting is based upon an accepted though unwritten decision to value the interests of certain groups within society (such as shareholders and creditors) above those of other groups. According to

PEA, the institutions of capitalism define the boundaries of accounting theory, and the tasks of accountants are delineated within those boundaries (Cooper and Sherer 1984). Evidence of this view may be found in section 1000 of the CICA handbook, which defines "capital maintenance", in terms of shareholders' equity. That this focus was chosen over operating capital, or human capital, or natural capital, suggests there could be some merit to PEA. The failure of traditional financial statements to capture environmental impacts may be a reflection of the social values which gave rise to accounting traditions in the first place.

The FASB's role is to provide an accounting and reporting framework that is "scrupulously neutral, reporting economic activity as objectively as possible in order to provide information that can be used with confidence as a basis for making economic decisions, and not fostering the interests of any particular viewpoint" (Viper 1994). PEA adherents argue that it has not succeeded (Cooper and Sherer 1984). Furthermore, there are other problems associated with this claim to neutrality, for in its commitment to reliability and objectivity, the FASB loses sight of potential economic and social consequences of information disclosures (Viper 1994). This notion, that users' decisions are influenced by information disclosure format (Watts and Zimmerman 1990), is contrary to the *efficient market theory* claim that disclosure format is irrelevant as it does not affect cash flow (Beaver 1973). *Economic Consequences theory* recognizes that a firm may have undertaken contractual obligations which are affected by disclosure format, and that users may respond to disclosures in a manner that triggers cash flow repercussions. For example, it should not matter if a liability associated with an environmental spill is incorporated into the face of the financial statements, or shown as a footnote. However, research by Harper, Mister and Strawser (1987, 1991) on footnote versus financial statement accrual showed that commercial lenders interpret the two disclosure formats very differently. Should one format lead to the conclusion that a debt/equity term in a loan covenant has been breached, there could be significant cash flow consequences for the company involved. Other ways in which information disclosure could impact cash flow prospects include the reactions of environmental lobby groups, who could push for stringent controls on the industry, potential stock market repercussions, and international trade agreement stipulations for environmental protection.

The information content of the reports generated by US companies has been described as vague, incomplete, or unreliable (Wiseman 1982, Rockness 1985, Freedman and Wasley 1990, Gamble et al. 1995). Similar conclusions apply to reports from companies in the United Kingdom (Harte and Owen 1991), Europe and Japan (Fekrat, Inclan and Petroni 1996), Australia (Deegan and Gordon 1996), and Canada (Blunn 1992). When statement disclosures are left to management discretion, there continues to be a considerable amount of environment related information that is omitted from external reports (Freedman and Jaggi 1986, 1988, Little, Muoghalu, and Robison 1995, Li, Richardson and Thornton 1997).

Early academic accounting literature stressed the need for information on *externalities* (Mobley 1970, Estes 1972, Ramanathan 1976), as these may result in future claims against the company. Externalities are impacts of business activity which are omitted from accounting records but borne by outside parties. In 1991 the Investors' Responsibility Research Center (IRRC) surveyed institutional investors and found they wanted better, financially quantified information on environmental liabilities (Epstein 1996). In their 1997 research project *Full Cost Accounting from an Environmental Perspective,* the CICA confirmed an ongoing concern that financial reports fail to adequately reflect the impact of externalities. On the other hand, the *information perspective* of accounting information (Ball and Brown 1968), suggested that financial statements are but one source of information that stock market investors will use in assessing equity values. Furthermore, much of the information investors deem relevant for decision making is reflected in share price well in advance of the release of company financial statements. This could be interpreted as proof that financial statements do not need to be adapted to address changing needs. Then again, if the accounting profession is to maintain its usefulness in the business community, financial statements must compete with these other sources of information to provide investment related information in a timely, and cost effective manner (Beaver 1973, Rockness 1985).

If the market is efficient, and if all relevant information is effectively disclosed, then no investor should be able to earn abnormal returns using publicly available information (Beaver 1973). With the increasing disclosure requirements stipulated by both accounting and securities regulators over the years, many investment managers have moved away from a "beat the market" philosophy to one with an emphasis on managing risk (Beaver 1973). This move is significant to the managers of the companies targeted for investment, because companies with better pollution control records were found to have lower total risk, measured by the standard deviation of company returns, than those with relatively poor records (Spicer 1978). The companies with better pollution performance were also found to have lower *systematic* risk, or beta (the covariance of overall market and individual stock returns), and higher price earnings ratios (Spicer 1978).

Certain factors of risk perception have a significant effect on the "signal potential" of an incident (Slovic 1987). For example, lack of experience with, or understanding of, the repercussions of an accident can trigger intense anxiety that is associated with "higher order" impacts. These impacts go beyond the victims and the company directly involved, to include the industry or even an entire technology (Slovic 1987). On the other hand, accidents which are well understood have a much lower signal potential, regardless of injuries or loss of life. This would explain, for example, why a train wreck that kills many people has low signal potential, while the Three Mile Island accident, in which there were no deaths, inspired tremendous fear and triggered more costly societal impacts than any other accident prior to that time (Slovic 1987). A study of changes in share behaviour in response to changes in investor perceptions found the systematic risk of most companies in the electrical utility industry rose, following the Three Mile Island accident (Bowen, Castanias and Daley 1983).

In their study of the Union Carbide accident in Bhopal, Blacconiere and Patten (1994) found the equity prices of companies in the chemical industry which made more extensive environmental disclosures suffered less of a negative reaction in comparison to shares in companies which made limited disclosures. On a less dramatic note, Freedman and Stagliano (1991) found shares in high disclosure companies in the textile industry suffered less in the wake of a US court ruling upholding new, more stringent dust emission regulations. Furthermore, a correlation has been observed between security price movements, and environmental performance ratings assessed by parties outside the company such as the Council on Economic Priorities (Shane and Spicer 1983). All of this suggests that better (clearer) disclosures as to how management is discharging its stewardship responsibilities reduces investor uncertainty as to management's understanding of, and ability to deal with, the environmental repercussions associated with business activity. In other words, there is a possible ex ante effect of environmental accounting disclosures on investors' perception.

Despite these findings, the FASB has no reporting standard specific to environmental disclosure. SFAS 5, on *Accounting for Contingent Liabilities*, is not suitable for environment related matters, as obligations of this nature are generally not determined by a distinct event. Nor is there a CICA handbook section specifically addressing environmental disclosures. In 1990 the CICA introduced s3060, pertaining to *Fixed Assets*. This section is of particular concern to companies in the extractive industries as it provides guidelines for the accounting of restoration costs. The suggested treatment however, is at odds with accounting theory (CICA 1993) because it does not provide financial statement users with an understanding of the true restoration liability at any point in time. Shortly after its introduction, this handbook section was deemed inadequate and scheduled for review. However, in late 1997 the CICA Accounting Standards Board *Task Force on Environmental Costs and Liabilities*, whose mandate was to review s3060 and develop new guidelines, was disbanded, its goals unaccomplished.

The goal of accounting is to operationalize the objectives of economic theory (Milne 1991). One objective is to attain pareto optimality, a state of the economy in which it is impossible to make anyone economically better off without also making someone worse off (Goodland and Ledec 1987). This is achieved by counting costs so as to direct resources away from inefficient uses and toward more efficient ones (Wildavsky 1994). At some point in time, however, "cost" for accounting purposes was reduced to "private cost," or those costs a company decides to internalize (Beams and Fertig 1971). The optimal allocation of resources is not achievable, however, when externalities exist (Estes 1972). Furthermore, as was discussed earlier, the interests of one or two groups in society may have been perceived to have higher priority (Cooper and Sherer 1984), or at least to subsume the needs of other groups (CICA 1993). These two issues, cost definition and target group, affect not only the choice of content for corporate reporting, but also the choice of investment projects. For example, the cash flows associated with a long-term project are discounted at a rate based on the cost of investment capital and the assessed riskiness of the project. Environmental protection procedures usually entail large cash outflows early during the life of the project. On the other hand, potential inflows (such as those associated with sustainable forestry) occur in the future. Furthermore, the costs associated with irreversible environmental damage (such as contamination of a water table) are very uncertain, and would be treated as having very little consequence, if counted at all. This has the effect of making environmentally sound projects uneconomical from a business perspective.

In the cost/benefit and net present value analyses applied to business investment, the issue of relative values is ignored. When basic needs are satisfied, it is questionable whether an increase in overall value as assessed in the manner described above has significant effect on aggregate utility (Goodland and Ledec 1987). Mobley (1970) suggested social costs become more important as a nation becomes economically secure. In other words, new values, the magnitude of which is not necessarily measurable using market based transactions, may become prominent. This means the market value of an amenity, or an investment proposal, may no longer be a comprehensive reflection of its value.

The concept of the stakeholder has been open to redefinition for several years (Mobley 1970, Ramanathan 1976, Rubenstein 1994, CICA 1997), largely the result of decisions made by outside organizations. For example, the Australian Bureau of Statistics wants to develop an information system based on a national pollutant inventory, so that people can assess the sustainability of an industry, or the environmental health of the country itself (Gibson 1995). Such a system, however, would best function if it could articulate with an environmental accounting system at the company level. In this manner, individuals with no direct association with a company become dependent upon the information released by that company. Another example is the Canadian government's decision to make the integration of environmental, economic, and social performance a national objective (Commissioner of the

Environment and Sustainable Development 1997). At the professional level, the CICA has currently defined external users of financial accounting statements to include, in addition to the traditional investor and lender groups: insurers, suppliers, consumers, industry associations, governments and their agencies, communities, environmental groups, the media and the general public (CICA 1997).

The CICA has acknowledged the evolving role of the corporation within society, and the changing responsibilities of Boards of Directors in major nations. Both give rise to information needs that go well beyond those addressed by traditional financial statements. At the same time the accounting profession acknowledges a current inability to establish generally accepted disclosure standards because of its reliance on market transactions as a guide to valuations. Key obstacles to the development of environmental reporting guidelines are:

1) the method of valuation of environmental impacts (Society of Management Accountants of Canada 1997, CICA 1997), and

2) senior managers' lack of understanding of *just what* they are to account for (International Institute of Sustainable Development 1997).

On the topic of what to account for, Gray (1992) noted that economic theory, upon which business principles are based, and which profoundly influences our attitudes, also fails to encompass environmental issues. However, unlike accounting at the company level, economists working at the national level have for some years experimented with revisions to the national accounting framework. Furthermore, a variety of economic approaches to non-market valuations have been developed

(Appendix B). A small number of companies have attempted to incorporate some of these ideas into their internal or external reporting frameworks. These efforts are discussed in the following section.

2.2 Company Endeavours and Current Reporting Guidelines

BSO/Origin, a publicly traded company offering consulting services worldwide, has since 1990, included a bottom line adjustment to its income statements to reflect environmental impacts (Huizing and Dekker 1992, BSO/Origin Annual Reports 1990 to 1994). Environmental impact categories include atmospheric emissions, waste water emissions, waste production, plus other items. They are valued using the control costs necessary to reduce the impacts to some target level. The target levels are obtained from government, economic, and academic studies of society's willingness to accept a level of environmental disruption, based on the premise that emissions or other environmental disruptions should be controlled to the point at which the marginal control costs equal the marginal benefits (Huizing and Dekker 1992). BSO/Origin's disclosure format provides year by year comparative figures which facilitate comparison of environmental impacts on a per employee, or per dollar of revenue basis.

Ontario Hydro utilized a variety of methods to value the externalities associated with its fossil fuel generating plants. Management chose a *damage function approach*, which attempts to define the site specific nature of impacts, be they on crops, building materials, human morbidity, or mortality (EPA 1996). Damage assessments are monetized where possible, using a variety of techniques to establish willingness to pay or accept. Unlike BSO/Origin, Ontario Hydro is not a publicly traded company. The information is used for internal management purposes to support decisions like the location of a proposed new development, or the method of maintaining transmission lines.

Earth Sanctuaries Limited (ESL) is an Australian publicly traded company specializing in the protection of endangered species and wilderness areas. In addition to financial statements based on market transactions, an income statement and balance sheet using *economic* valuations are released to the public. The economic accounts are measured using a variety of techniques designed to measure assets according to their value to society, as opposed to their financial value. For example in 1996, the economic value of total assets was 58 million dollars, versus only seven million dollars using conventional accounting valuation methods. This experiment with external reports has not escaped criticism. Following a complaint from the Australian Institute of Valuers and Land Economists, the Australian Securities Exchange has stated that no company may "say anything which in any way can infer that endangered wildlife have any sort of dollar value" (ESL Annual Report 1996).

The FASB's Emerging Issues Task Force has issued three guidelines pertaining to the treatment of environmental costs. The first, *Capitalization of Costs to Treat Environmental Contamination*, recommends expensing the costs. Limited capitalization, (carrying the expenditure as an asset rather than treating it as an expense) is permitted under certain circumstances. *Accounting for the Costs of Asbestos Removal* recommends capitalization, but pertains to a very specific problem. *Accounting for*

Environmental Liabilities says that when a liability for future remediation is recognized in the financial statements, discounting is permitted providing the amount and timing of payments is fixed or reliably determinable. The SEC requirements for 10K reporting provide more specific stipulations as to when environmental costs must be reported, and how to determine the discount rate. The FASB's SFAS number five, *Accounting for Contingencies*, calls for recognition of a loss if:

1) it is probable that a liability has been incurred or the value of an asset impaired; and,

2) the amount can be reasonably determined.

FASB Interpretation Bulletin number 14 provides guidance as to what "reasonably determined" means. In Canada, s3290 on *Contingencies* in the CICA handbook parallels the FASB's SFAS number five. Also in Canada, the CICA interprets "liability" with sufficient breadth to include "constructive liability" (CICA 1993). These are obligations derived, not from legislation or contract, but from management commitment. In 1995 the CICA added s1508 on *Measurement Uncertainty* to the handbook, stipulating how this issue should be handled for disclosure purposes. Also in 1995 the CICA amended auditing procedures by adding s5136 on *Misstatements–Illegal Acts* to the handbook, requiring auditors to consider environmental risks when planning an audit, and to obtain written representations from management regarding compliance with environmental laws. These recommendations, however, are sufficiently nebulous to allow companies in both countries to withhold information on environmental releases and spills from financial statements (Freedman and Jaggi 1986, Li, Richardson, and Thornton 1997).

CICA handbook s3060 discusses liabilities associated with future restoration. These guidelines, introduced for fiscal years beginning on or after December 1, 1990, recommend disclosure of the basis used for calculating the current charge against income. This information enables investors to calculate the total estimated future restoration liability. Li and McConomy (1998) found the inclusion of such information to affect market value. However, only 66 of 106 annual reports from 1990 and 1991 disclosed this information. More recent annual reports indicate even less tendency to disclose, with 13 of 67 (1995) and 12 of 68 (1996) companies reporting this information (Byrd and Chen 1997). The fact that this information is more often than not withheld from the annual report indicates that companies are not fully responding to investor needs.

Michael Lickiss, President of the Institute of Chartered Accountants for England and Wales, said that all aspects of accounting (financial, management, taxation, auditing) must change so as to recognize the responsibility of companies to disclose different categories of asset, and to track and disclose how each is maintained (Owen 1992). Environmental protection through enhanced reporting may be possible without monetization (Hines 1991) through the use of some physical units indicator. However, the availability of a generally accepted environmental performance indicator for either internal or external reporting is questionable (Willis 1994). In fact the monetization of natural assets might actually reduce the usefulness of the annual report. For example, a physical reduction in natural capital could be offset by higher prices (of oil, timber etc.), In other words, dollar measurements may be adequate to effect the economically efficient allocation of resources, providing they incorporate the non-use values discussed earlier, but may actually cloud the interpretation of financial statements for those stakeholders to whom environmental sustainability is an end in itself. The account balance may be stable, or even rising, when environmental resources are actually declining. The same difficulty with interpretation applies at the national level. For example in the US, the *Genuine Progress Indicator* (GPI), an adaptation of GDP which integrates environmental impacts (i.e. water and air pollution, loss of wetlands and forests, ozone depletion etc.), showed that after 1973 the GPI declined steadily, with the rate of decline increasing in the 80's and 90's. The annual growth rate of conventional gross domestic product measures, however, remained positive (Cobb, Halstead and Rowe 1994). This means the formula for calculating GPI masked the true rate of decline in environmental capital, for it integrates content from conventional GDP calculations with natural capital measurements.

In 1982 the FASB introduced SFAS 69, calling for supplementary disclosures in the annual reports of publicly traded oil and gas companies. These disclosures, updated annually based on proven reserves, include information in both physical unit and monetary terms. The purpose of these disclosures is to reduce investor uncertainty as to future operations (Scott 1997). They should not be interpreted as an attempt to "capture" natural capital transactions in the annual report. On the other hand, the call for supplementary disclosures of this kind indicates the FASB realizes a physical count of environmental "assets" is of concern to at least some financial statement users.

One criticism of all such attempts to integrate environmental impacts into financial reporting is that they fail to provide any practical steps toward environmental sustainability (Hinterberger et al. 1997). If the intricate interrelationships among ecosystem components are unknowable (Robinson 1993), and our ability to predict the consequences of anthropogenic environmental impacts is limited (Hinterberger et al. 1997), or at best "estimated guesswork" (Goodland and Ledec 1987), the key to sustainable development may lie, not in the measurement and reporting of environmental depletion, but in altering lifestyles and corporate behaviour so as to reduce these impacts (Hinterberger et al. 1997). If, on the other hand, two key functions of environmental accounting at the company level are to keep management informed of the extent to which the company is depleting natural capital, and to keep society informed about the degree to which capital is being maintained (Gray 1992), then disclosure of the depreciation of natural capital is an end in itself. However, the accounting profession has long contended with the fact that different stakeholders have different sets of needs (Rosen 1997). Birnberg (1980) said the problems we have with disclosure are the result of contemporary economic relationships requiring more than a single accounting to properly portray their effects to the users of financial statements. The FASB, when setting reporting standards, attempts to cater to these diverse needs while simultaneously considering the burden on company management, who must provide the information (Reither 1997).

The CICA research group investigating environmental costs and liabilities (1993) noted that in order to operationalize the concept of sustainable development, any degradation of the environment should be expensed in company financial statements. On the other hand, their full cost accounting study (1997) noted that while disclosure of externalities is something to be explored further, wide scale adoption of the practice is not likely in the foreseeable future. While the difficulties associated with monetization are cited as a major obstacle, the research group also claimed that full cost accounting for environmental impacts is desired by only a small segment of stakeholders. Regardless of the demand for full cost accounting, environmentally conscious investors could constitute a large segment of the overall equity market (Cormier, Magnan and Morard 1993). Market based research, very little of which has been done in Canada, is one method of exploring whether or not this is really the case. This is an important issue for company managers. If environmentally conscious investors are just a small group, companies that incur environmental protection expenditures may do so at the expense of alienating the remainder of the investment community. On the other hand, if environmentally conscious investors are a large part of the market, such expenditures, in addition to management's overall approach to environmental issues, will attract a more cohesive market response. Whether this response acknowledges a true belief in the innate value of environmental resources, or simply an understanding that accidents trigger cash flow impacts is irrelevant to the decision making process. If there is no overall response, companies may or may not choose to adopt environmentally conscious policies, depending upon the overall philosophy of management. If there is an overall response, the decision becomes much simpler, for the market itself is acknowledging a concern for environmental issues by registering an impact on stock behaviour. Chapter three details an approach using daily stock data to explore this issue.

Chapter 3

Research Questions & Methodology

This study will analyse stock behaviour in response to environmental incidents. Incidents are defined as liquid spills, abnormal gaseous discharges or other unanticipated environmental disruptions. The objective is to study the association, if any, between environmental incidents over the past several years, and changes in investor perceived value and/or systematic risk.

Information for this study comes from a variety of sources. Stock market data is available from the Toronto Stock Exchange Review, and the Canadian Financial Markets Research Centre (CFMRC). The CFMRC database contains price and returns data for every stock traded on the TSE since 1950 (monthly basis) or 1975 (daily basis). Only common shares will be considered. This will focus the analysis on shares subject to operating risk.

For the purpose of this study, it is not necessary for the accident to have occurred in Canada. Furthermore, while only shares of Canadian companies will be included in the study samples, the accident need not have directly involved a Canadian company. Studies of intra-industry effects are not uncommon, for the operating risks faced by one company are common to others in the same industry. Furthermore, should an accident or other unexpected event precipitate tighter regulation, all companies in the industry may be affected. Intra-industry studies such as this have been conducted in the chemicals industry following the Union Carbide accident in Bhopal (Blacconiere and Patten 1994), in the electrical utilities industry after the Three Mile Island incident

(Bowen, Castanias and Daley 1983), and in the pharmaceuticals industry following the Tylenol poisonings (Dowdell, Govindaraj and Jain 1992).

The first research question (RQ1) to be examined, stated in null hypothesis form, is:

> *there is no negative intra-industry abnormal return in response to environmental incidents among Canadian companies listed on the Toronto Stock Exchange.*

Rejection of the null hypothesis associates the event with a significant decline in equity value. If the null hypothesis is not rejected, this indicates either that investors do not perceive the event as having important repercussions, or that they do not believe the repercussions will spread beyond the company directly associated with the accident.

The analysis of this question will employ event study methodology. Event studies are common in the accounting and finance literature. The Union Carbide, Three Mile Island (TMI), and Tylenol studies all used this approach. Collins, Rozeff and Dhaliwal (1981) used event study methodology to examine the equity impacts of a change in accounting policy on the financial statements of oil and gas companies. Moreschi (1988) used a similar technique to study the impact of increasing environmental legislation on companies in the pulp and paper industry.

The event study approach is built upon three basic assumptions concerning stock prices. The first is that shares react quickly to new information by rapidly adjusting to an equilibrium level that incorporates the market's revised view of the risk/return trade-off (Ball and Brown 1968, Fama, Fisher, Jensen and Roll 1969, Fama 1970, Beaver

1973). The second is that successive changes in share prices are independent, and conform to some (not necessarily normal) probability distribution (Fama 1965). Finally, it is assumed that at least a portion of share movement is explained by some common factor. This last assumption relies on the market model (Sharpe 1964) which relates the return on a stock to the movement in the overall market through the stock's *beta parameter* (defined below). The market model is defined as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \varepsilon_{it} \quad (1).$$

The return R on stock *i* at time *t*, is related to the return on a portfolio of stocks, or the market return, R_M at time *t*. The parameter β_{0i} is the intercept. The term ε_{it} is the ordinary least squares (OLS) error term, and is assumed to have zero mean and constant variance. The β_{1i} parameter in the model is the stock's equity beta, a measure of the sensitivity of stock *i* to the market factor, $R_{M.}$ The equity beta can be measured as:

$$cov(R_i\, R_M)/Var\, R_M \qquad (2)$$

The market itself, or the average stock, has a beta of one. Stocks with betas greater (less) than one are considered to be more (less) risky than the market average, with risk interpreted by the investor as volatility in price or return.

Companies also have asset betas (β_A), which measure the sensitivity of the company's cash flows to market returns. These cash flows are based upon the projects which management invests in. A company's equity beta (β_E) is related to its asset beta, and to its financial structure, through the formula:

$$\beta_A = \beta_D * \%\ debt\ in\ financial\ structure + \beta_E * \%\ equity\ in\ financial\ structure \quad (3)$$

Since debt is a legally binding obligation, the market value of debt is relatively insensitive to market volatility. For this reason, the debt beta (β_D) portion of the asset beta is usually considered to be zero (Brealey, Myers, Sick, and Whaley 1986). Asset betas, on the other hand, are driven by the variability of cash flows from the company's investment projects, and are independent of capital structure. The formula can also be expressed as:

$$\beta_E = \beta_A - (\beta_A - \beta_D)Debt/Equity \qquad (4)$$

which shows the equity beta's sensitivity to financial structure, and to β_A. The higher the debt component, the higher the risk associated with the cash flows of the project, because debt obligations are legally binding. This additional risk is transferred to the equity, thus raising β_E. Equity betas are sensitive to β_A because the same economic uncertainties that affect project cash flows also face the equity investor.

By incorporating beta into the analysis, the return on a stock can be studied while controlling for the impact of the market itself. Event study methodology involves tracking the return on a stock (or portfolio of stocks) during the *estimation period*. The estimation period is defined to be the period of time prior to the occurrence of the event, and data from the period are used to estimate the β_{0i} and β_{1i} parameters of the market model. These parameters are then used to forecast R_{it}, using equation (1), for a period immediately following the event known as the *event period*. The error term, ε_{it}, reflects the variation of actual returns around the regression line and is computed as:

$$\varepsilon_{it} = R_{it} - (\beta_{0i} + \beta_{1i} R_{Mt}) \quad (5).$$

Successive price changes outside of an event period have been shown to conform to a random walk (Fama 1965, King 1966). If the event triggers an investor reaction however, the pattern of residuals changes. For example, if the event has a positive impact on equity value, successive residuals (ε_{it}) show a positive trend as they accumulate over the event period. Researchers employing the event study methodology assess the impact of the event by testing the null hypothesis of no abnormal returns. This is accomplished by assessing the statistical significance of the cumulative abnormal return (CAR), as it accumulates during the event period. Practical problems associated with event study methodology include:

1. determination of the event period;
2. the confounding influence of other factors affecting stock price behaviour;
3. event date, and industry clustering;
4. thin trading; and,
5. the assumption of stationarity in the beta parameter.

The implications of each problem are discussed in sequence in the paragraphs that follow.

In an efficient market, shares should react quickly to new information. On the one hand this should make the identification of the event starting date relatively easy. In the Tylenol case the event period began with the first day the poisonings became public knowledge. Similarly in the Union Carbide study, the event period began the first trading day following the accident. On the other hand it cannot be assumed that all relevant information reaches the public simultaneously. For example, Blacconiere and

Patten (1994) found the full impact of the disaster in Bhopal was not known until at least four trading days after the accident. Furthermore it is possible that when new information is made available to the market, it is not always immediately evaluated with precision. Initial price reactions may, therefore, represent over or under adjustments (Fama 1970). This argues in favour of measuring the CAR over a longer event period. However, if the event period is lengthened to accommodate these uncertainties, the chances increase that some other event will affect the stock price. Researchers have dealt with this by using daily data, starting with a short event period, and testing the robustness of their findings by experimenting with alternative event windows (Dowdell, Govindaraj and Jain 1992, Blacconniere and Patten 1994).

While keeping the event period short eliminates much of the threat of potentially confounding factors, it does not eliminate the problem entirely. For example, changes in commodity prices and currency exchange rates will influence the equity values of natural resource companies. In the TMI study, Bowen, Castanias and Daley (1983) dealt with the influence of oil price volatility and natural gas deregulation discussions by eliminating companies from their sample set considered to be overly dependent on oil or gas for electricity generation. In the Union Carbide study, Blacconiere and Patten (1994) eliminated firms from their sample set which had market related news releases such as earnings or dividend announcements during the event period. In recognition of the work by King (1966), who found that industry factors explain an average of 10% of the variation in market return, some researchers have considered incorporating an industry factor into the market model. For example, in the TMI study, Bowen, Castanias and Daley (1983) derived their residuals using the standard market model of equation (1) but tested them for industry effects using changes in long-term lending rates as a proxy for industry-specific factors. Collins, Rozeff and Dhaliwal (1981) also experimented by adding an industry factor into the market model in their study of oil and gas companies. Blacconiere and Patten (1994) looked specifically for an effect of the Union Carbide accident on the chemical industry as a whole.

The decision as to whether or not to include an industry factor depends to some extent on the research question. The decision also depends upon the way the market index *(R_M)* is defined. For example, if the TSE 300 is used to derive R_M, and the study sample consists of companies in any of the natural resource sectors, as this one does, the inclusion of a resource sector index could create problems with multicollinearity. This is because the TSE index is heavily weighted in favour of natural resource companies. On the other hand, since commodity prices are subject to considerable fluctuation, events outside of the accident such as a shift in world supply of oil, could confound the analysis of the data. For this reason, an industry factor will be incorporated into part of the analysis. The CFMRC database includes, in addition to TSE 300 data, returns calculated on a portfolio consisting of every TSE traded stock. Using this total return as a market index in lieu of the resource heavy TSE 300 reduces the problem of multicollinearity.

When the event date is common across all the firms in a sample, as will be the case with environmental accidents, the number of securities whose behaviour is independent is lowered considerably. Such *event date clustering* must be taken into account when organizing the data. Bernard (1987) showed the bias arising from cross-sectional dependence is a function of both sample size, and the degree of residual cross-correlation. The problem can be largely avoided by aggregating firm data for the sample to create a single time series of cumulative residuals. This portfolio approach was used by Blacconiere and Patten (1994), who also noted that when portfolio average returns are used, the explanatory power of the model is improved. Furthermore, the problem of non-normality of the distribution is often resolved when a portfolio is used in place of individual stocks. Finally, testing the distribution of average returns avoids another criticism to which event study methodology has been subject. Researchers have been accused of simply increasing the number of stocks tested until the desired results are obtained (Frankfurter and McGoun 1993). Where there is an intra-industry impact, however, the use of portfolio returns reflects the combined effects on several stocks in the industry, rather than the results of one or two individual stocks.

Notwithstanding the remedial effects of using portfolio averages, the fact that stocks chosen for a sample come from the same industry (industry clustering) means that cross-correlation remains an issue. Whether the individual stock and market return data are calculated on a daily, weekly or monthly basis is a determining factor here. Brown and Warner (1980) concluded there was no evidence that cross-sectional dependencies create serious problems as long as market wide effects are taken into consideration (as is the case when the market model is used). Bernard (1987) noted that this conclusion might not extend beyond studies based on short (i.e. daily or weekly) return intervals. Furthermore the seriousness of the problem increases as the return interval increases. For example, even in a sample of 100 firms which includes equal representation from 20 industries, true standard errors might exceed estimated standard errors by a factor of three when weekly data are used, and a factor of five if the returns are recorded on a monthly basis (Bernard 1987). Since precise event date identification requires the use of daily data, industry clustering is not expected to be a major concern in this study.

Thin (infrequent) trading in a particular stock, can result if there is an absence of information about a company, or if there are only a few shares outstanding. Fowler, Rorke and Jog (1980) found strong evidence of thin trading in Canadian markets. This problem is associated with a downward bias in the beta estimates, and heteroscedasticity (Dimson 1979). Moreschi, working with US data, dealt with this issue by using weekly geometric mean returns in place of daily return data. Dimson (1979) countered the problem by adding leading and lagging market index variables to the model, and summing the three beta coefficients to produce the final beta estimate. A second approach, developed by Scholes and Williams (1977) combined the betas estimated from three separate regressions on synchronous, lagged and leading market index variables. Both techniques were reviewed by Fowler, Rorke and Jog (1980), who concluded that in most cases OLS provided the best estimates.

In order to test RQ1, for each environmental incident, a 200-day time series of daily returns on a portfolio of companies in the industry will be constructed. These returns, along with the 200 daily market returns, will be used in the market model to estimate β_0 and β_1 as follows:

$$R_t = \beta_0 + \beta_1 R_{Mt} + \varepsilon_t. \qquad (6)$$

Here R_t is the percentage return on the portfolio at time t, β_0 is the intercept, β_1 is the portfolio beta, R_{Mt} is the return on the market (R_M), also measured as a percentage change at time t, and ε_t is the error term at time t. This model is similar to (1). However, since the sample companies will be aggregated into a portfolio so as to avoid the problem of event date clustering, the firm specific subscript i has been deleted. Using the β_0 and β_1 estimates thus obtained, and equation (5), residuals will be estimated during a period of time immediately following the event, with Day 0 as the day the event became public knowledge, Day 1 as the following day etc.. The statistical significance of the ARs will be tested using standard statistical procedures.

In the studies by Dowdell, Govindaraj and Jain (1992), and Blacconiere and Patten (1994), stationarity of the beta parameter was assumed. Where this assumption holds, significant findings in the AR tests correspond to a one time change in price associated with the event. However, if beta shifts in response to the event, this means there is a change in the structural relationship between the stock and the overall market. Incorrect assumptions concerning beta stability may lead to erroneous conclusions about the statistical significance of the ARs. Research question 2 (RQ2), in null hypothesis form, states:

> *there is no change in a stock's beta associated with environmental incidents.*

Two studies have specifically questioned the stable beta assumption in relation to environmental issues. The Three Mile Island study (Bowen, Costanias and Daley

1983) concluded that betas for the companies in the electric utility industry rose after the accident. The Moreschi study (1988) found that betas for firms in the pulp and paper industry fell, in response to tighter environmental regulation. Beta changes have also been associated with changes in operating leverage (Lev 1974). In the absence of factors such as accidents, changes in leverage, and diversification into other industries, however, betas have been found to be quite stable over time intervals of up to five years (Sharpe and Cooper 1972).

The daily returns for each company studied in RQ1 will be used again, along with another 200 daily returns recorded after Day 0. A dummy variable will be incorporated into the RQ1 regression model as follows:

$$R_{it} = \beta_{0i} + \beta_{1i}R_{Mt} + \beta_{2i}R_{Mt}D + \varepsilon_{it} \qquad (7)$$

where D takes a value of zero for data recorded prior to Day 0, and one for data recorded on or after Day 0. R_{it} and R_{Mt} are the daily returns on the sample company and market respectively at time t, β_{0i} is the intercept term, β_{1i} is the beta for the company i prior to Day 0, and β_{2i} is the incremental slope coefficient. If β_{2i} is statistically significant, this supports the conclusion that the beta has changed. It should be noted that unlike the model to be used for testing RQ1 (equation 6), the subscript i has been included in equation 7, signifying the parameter stability model is to be investigated for each company individually.

It should also be noted that equation (7) could be adapted to test for a change in intercept too. Then, for companies whose parameters shifted after Day 0, the revised parameters could be used to review the cumulative residuals from the RQ1 results with the following procedures:

1. insert the new parameters into the market model (equation 1) for each stock,
2. re-forecast the event period returns for each stock,
3. capture the residuals (equation 5) and test for the significance again.

This approach, however, would introduce the cross-sectional dependency issue that was avoided by combining the stocks into a single portfolio, and for this reason the results of RQ1 will not be re-examined. The knowledge however, that beta changes occur (or do not occur) in response to environmental incidents is significant in itself, to individual investors and fund managers concerned with risk management.

The beta stability question will be addressed for each company in an industry which has experienced an accident at a particular point in time since 1976. It is possible that societal awareness of, and concern for, the environmental impacts of business activity shifted at some point in time. For example, if the Union Carbide accident was a turning point, beta shifts associated with environmental accidents prior to late 1984 would be rare, but more common afterward.

Beta stability may also be a function of industry, and company size. Of particular interest is the question of whether stock market reactions differ when the company involved is in one of the natural resource sectors. There are three reasons for focusing on natural resource companies. First, their obvious impact on the environment makes them a natural candidate for any study of environmental accounting. Second, in view of these impacts, the CICA (1997) has stated that progress in full cost accounting will likely be greatest in these companies. The question of whether the market too, recognizes a burden of responsibility on such companies is worth exploring. Third, numerous studies have found that companies, especially large ones in environmentally sensitive industries, were among the first to increase their environmental disclosures (Simmons, Neu and Ruff 1993, Buhr 1994, Deegan and Gordon 1996, Bewley and Li 1998). Test results in numerous studies (Freedman and Jaggi 1988, Buhr 1994, Deegan and Gordon 1996, Fekrat, Inclan and Petroni 1996, Bewley and Li 1998) distinguished companies in one or more of the following sectors - pulp and paper, chemicals, mining, and oil and gas - from companies in industries with less obvious environmental impacts.

Research question 3 (RQ3) stated in null hypothesis form, is:

there is no time dependent change in a stock's beta associated with an environmental incident.

Research question 4 (RQ4) stated in null hypothesis form, is:

there is no industry dependent change in a stock's beta associated with an environmental incident.

Research question 5 (RQ5) stated in null hypothesis form, is:

there is no size dependent change in a stock's beta associated with an environmental incident.

The small size of the Canadian stock market, in comparison to that of the US, may play a role in the amount of attention paid to TSE traded stocks when an accident occurs. Stocks trading on the US exchanges such as the New York Stock Exchange, the American Stock Exchange, or the National Association of Securities Dealers Automated

Quotation (NASDAQ) are much larger and subject to greater media attention. Some Canadian stocks are cross-listed on a US exchange, and therefore subject to this additional scrutiny. Research question 6 (RQ6) is:

> *a stock's beta stability in the event of an environmental incident is not associated with whether or not the stock is cross-listed on a major US exchange.*

Research question 7 (RQ7) examines the significance of the direct impact on human life. Many environmental accidents, such as most oil spills, have no immediate impact on people, while others, such as the Union Carbide gas leak, cause considerable injuries and many deaths. Research question 7 is:

> *a stock's beta stability in the event of an environmental incident is not associated with the number of people directly affected.*

Finally, the location of the accident may be significant. The matter of jurisdictional differences, including differences in environmental protection legislation, may be a deciding factor in determining stock market reactions to an accident. This issue has not been explored in prior research. Research question 8 (RQ8) is designed to investigate this relationship:

> *a stock's beta stability in the event of an environmental incident does not depend on whether or not the incident occurred in North America.*

The model proposed for examining RQ3 through RQ8 is:

$$\beta_{2i} = \beta_0 + \beta_1 Size_{it} + \beta_2 XL_{it} + \beta_3 People_t + \beta_4 NorAmer_t + \beta_5 OG_t + \beta_6 M_t + \beta_7 Time_t + \varepsilon_{it} \quad (8)$$

In this model, the dependent variable is the incremental beta (β_{2i}) obtained from equation (7). $Size_{it}$ is the size of company i at the time of the accident (t). There are several dummy variables:

XL_{it}	= 1 if stock i is cross-listed on a major US exchange, zero otherwise,
$NorAmer_t$	= 1 if the accident at time t occurred in North America, zero otherwise,
OG_t	= 1 for an oil and gas company, 0 otherwise, and
M_t	= 1 for a mining company, 0 otherwise.

$People_t$ is a quantitative variable measuring the number of people seriously affected by the event at time t. $Time_t$ is a trend variable, included in the model to test whether or not societal concern for the environmental impacts of business activity shifted at some point in time. The coefficients β_1 through β_7 are their associated coefficients, β_0 is the intercept, and ε_{it} is the error term.

Similar hypotheses can be explored using a model designed to test the factors associated with the CAR's. Research question 9 (RQ9) is:

> *there is no time dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

Research question 10 (RQ10) is:

> *there is no industry dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

Research question 11 (RQ11) is:

> *there is no size dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

Research question 12 (RQ12) is:

there is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the stock is cross-listed on a major US exchange.

Research question 13 (RQ13) is:

there is no association between a company's cumulative abnormal returns following an environmental incident, and the number of people directly affected by the incident.

Research question 14 (RQ14) is:

there is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the incident occurred in North America.

The model for examining RQ9 through RQ14:

$$CAR_{it}=\beta_0+\beta_1 Size_{it}+\beta_2 XL_{it}+\beta_3 People_t+\beta_4 NorAmer_t+\beta_5 OG_t+\beta_6 M_t+\beta_7 Time_t+\varepsilon_{it} \quad (9)$$

is identical to (8) except the dependent variable is the cumulative abnormal returns obtained for each stock through the application of equations (5) and (12) as discussed in 4.3.1. As this model uses the abnormal returns of individual stocks rather than the average returns of a portfolio, the issue of cross-sectional dependence arises once again. However this data is pooled, with stock returns from various industries and periods of time. While this should reduce the threat considerably, tests for cross-sectional correlation are still conducted.

Chapter 4

Data Collection, Statistical Results and Review of Hypotheses

4.0 Introduction

For the purposes of this paper, environmental events are defined to be large liquid spills, abnormal gaseous discharges or other unanticipated environmental disruptions. Discharges that result in penalties levied by provincial ministries or Environment Canada which did not result in serious disruption of human life are excluded. This is because the effectiveness of event study methodology is enhanced when the timing of the event can be precisely identified. In the case of environment related offences, the processing of charges through the court system is a lengthy process. Partial information is made public at various points along the way, but full information is often not publicized until a final judgement is made. This may occur months or even years after the initial event. The events included in this analysis are all well publicized, unexpected incidents, and in each case the date of the occurrence can be precisely determined.

With the exception of the Hagarsville tire fire, all environmental events included in this study were accidents. In all cases, the repercussions, both actual and anticipated, included a substantial impact on environmental quality (i.e. water table or land contamination), environmental degradation (i.e. decline in air quality) or a threat to human health (i.e. a cancer risk). While the analysis is restricted to stocks in Canadian companies, the accident need not have directly involved a Canadian company. Furthermore, the event itself need not have occurred in Canada. Neither restriction is required for an industry to be affected. For example, two days after the Mississauga train derailment occurred, triggering an evacuation of 250,000 people, a new directive was announced at British Rail. This directive, banning freight trains from carrying toxic chemicals and inflammables together, was prompted by the accident in Canada (Globe & Mail November 14, 1979).

A preliminary list of events was obtained using the news clippings files of the Canadian Environmental Law Association. Cross-referencing these items using the Canadian Business and Current Affairs database and daily newspapers yielded sufficient information to qualify 33 events for inclusion in the analysis. These events spanned a 22-year period, from May 1976 to July 1997. A brief description of each event is provided in Appendix D. In event 19, four accidents are combined into a single event study. This is because each of these four incidents was similar. Each involved the oil and gas industry, and the day the information became public knowledge (Day 0) was the same.

A sample of TSE traded companies was identified for each event. Where possible, compustat was used for this purpose. Compustat is a database of business data including historical financial statements, business descriptions, standard industrial codes (SIC), and other business information data. Compustat is a US database, however, and for many of the events this approach was unsuccessful in identifying groups of Canadian TSE traded companies with common SIC codes. For some events, the issue of *TSE Review,* published in the event month, was used to compile a list of companies. The number of stocks identified depended on the industry. For example, for the oil spill events the number varied from six to nine (Table Ia).

Where possible, the companies identified for each event participate in the same industry as the one directly involved in the incident. For example, with an oil spill event, the common shares of companies such as Imperial Oil, Texaco Canada, Parkland Industries, and other companies with refining operations were included. As there were 19 oil spill events, some of these names appear in numerous samples. For example, Shell Canada Class A common stock appears in 22 different samples, each corresponding to a separate event. The Shell Canada time series information in each of the 22 samples is from a different period in time. In order to avoid confusion, each time a company appears in a sample, it is referred to as a separate event-company. In other words, Shell Canada alone accounts for 22 event-companies. With the exception of events number 9 and 10, 13 and 14, and 18 and 19, the events are spread out over time and/or industry (Appendix D). In an efficient market, where information is rapidly digested into prices, the event windows may be assumed to be discreet and independent.

Every attempt was made to identify industrial sectors and firms likely to be affected by the event. However, precise identification of the industry was difficult in some cases. For example, the company directly involved in the Hagarsville tire fire (event #22) was ostensibly a tire recycling company. No TSE traded companies in this industry were found using compustat or TSE Review. Rubber and Tire manufacturing was a possible industry alternative, as the tires, though themselves not a hazardous waste, can create a toxic product if not properly stored or disposed of. Two such

Table Ia: Beta Stability Test Results - Oil Spill Events

Events are listed in chronological order.

All t-tests are conducted at the $\alpha = 0.05$ level of significance.

The two-tailed tests assess the likelihood of a beta shift in either direction.
The one-tailed tests assess the likelihood of an upward shift.

		# Beta shifts using equal weighted market index		# Beta shifts using value weighted market index	
Event Name	No. Stocks tested	2-tailed	1-tailed	2-tailed	1-tailed
Urquoila	8	2	0	1	1
Amoco Cadiz	8	1	1	1	0
Kurdistan	8	3	1	4	2
Star Luzon	8	1	1	0	1
Castillo de Bellver	8	0	0	2	0
Pointe Levy	8	1	1	0	0
ARCO	9	1	2	0	0
Imperial Oil Railcar	9	0	0	1	1
Shell Oil	7	0	0	0	0
Ultramar	7	0	0	0	0
Nestucca	6	1	0	0	0
Exxon Valdez	7	1	0	0	0
Nova Scotia tanker	6	0	0	0	0
Uruguayan tanker	6	1	0	0	0
American Trader	6	2	0	1	0
Eastern Shell	7	0	0	2	3
Coast of Spain	9	1	1	1	1
Braer	9	1	1	1	1
Sea Empress	8	3	0	1	2
Total	144	19	8	15	12

companies were identified, but infrequent trading ruled them out of the sample. Hazardous waste management (SIC #4955) was another industry alternative. Four such stocks were included in the analysis. Another industry considered for inclusion was chemical manufacturing, as this sort of operation has the capacity to release large quantities of airborne toxins. Unfortunately, stocks in industrial inorganic (SIC #2810) and organic (SIC #2860) chemicals were too thinly traded to use in the analysis, as were stocks in the agricultural chemicals industry (SIC #2870). The final resort was the integrated oils, because of their petrochemical operations. This is the reason companies such as Shell Canada appear so often in this study.

The toxic waste management, chemicals, and petrochemicals industries were used to draw a sample of stocks for each of the St. Basile le Grand and Sydney Steel PCB fires (events #15 and #28 respectively). For the Plastimet PCB fire (event #33) the industries considered were waste management, and plastics. The plastics industry was chosen because the company was directly involved in recycling defective plastic products. For the Bhopal accident (event #8), the chemicals and petrochemicals industries were used.

The Three Mile Island (event #4) and Chernobyl (event #12) accidents also presented an industry identification problem. There are no publicly traded nuclear powered electrical utilities in Canada. For this reason, shares in the uranium mining industry were used as proxies to study the impact, if any, on investor sentiment following the accidents. Both samples were very small, with only five companies identified for the Three Mile Island study, and three for the Chernobyl event.

Another event for which very few companies could be found was the Canadian Pacific train derailment in Mississauga (event #5), where only five companies were identified, including Canadian Pacific itself. Compustat was used to identify other TSE traded freight hauling companies, but with the exception of Greyhound Bus Lines, no others were found. Two waste transportation companies, Laidlaw Inc. and Trimac Corp., however, were included in the sample.

Industry and company identification was a relatively simple matter for events involving oil spills and mining accidents, although thin trading more or less restricted the samples to integrated oils for the former. In addition to the integrated oils, a small number of companies with operations restricted to oil refining (SIC #2911) were included. For three of the mining accidents, compustat was used to identify companies in the gold and silver ores industry (SIC #1040). This procedure identified 31 companies for the Rabbit Lake mine leak (event #20), 44 for the Omai dam failure (event #29), and 40 for the Marcopper dam failure (event #32). *TSE Review* was used to identify companies with smelting operations for the Inco gas leak (event #30), and six companies with such operations were found.

Once event and sample identification were complete, the *Canadian Financial Markets Research Centre* database was used to obtain a time series of daily stock returns for each event-company for a period of time starting 200 business days prior to Day 0, and ending 250 days after Day 0. Day 0 defines the date the market learned of the event. Assuming the stock traded on each day over the time period, a full data set consisted of 451 observations, including Day 0 itself. Information on daily trading volume and monthly shares outstanding was obtained from the CFMRC database for each event-company over the same period of time.

Thin trading presented a problem for both the abnormal returns tests and the beta stability tests. For example, the testing of abnormal portfolio returns required each individual stock within the portfolio to trade on each of the 451 days concerned, otherwise a daily average could not be computed. One way to deal with a no-trade day is to estimate a two-day return for both the stock and the market. For example, if a stock did not trade on Day 5, a two-day return can be calculated over the Day 4-6 period, with a similar two-day return calculated for the market itself. Once again, however, this approach would not support the daily averaging, for that stock would be left with only 450 return observations while the others would have 451.

With regard to the beta stability tests, neither the Scholes Williams nor Dimson techniques were found to effectively address the problems associated with beta measurement in the presence of thin trading (Fowler, Rorke and Jog, 1980). Since none of these approaches could be adequately defended, no adjustment was made for thin trading. Stocks with fewer than 451 observations were noted as being thin, but the beta stability tests were conducted with no adjustment to the data as long as the observations were adequately spaced on either side of Day 0. Where trading was significantly unbalanced over time, or where thin trading was extreme (more than 50% days with no trade), the stock was deleted from the analysis. For the purpose of the abnormal return tests on portfolio returns, stocks with less than a full data set (less than 451 trading observations) were usually excluded from the portfolio. Exceptions to this guideline are discussed in subsection 4.2.

4.1 Beta Stability tests

For each event-company the residuals arising from the time series regressions were tested for normality using the chi-test (α=0.01) or a Jarque-Bera (1987) test (α=0.01). For the majority of the event-companies, the normality hypothesis was rejected. Similar tests using arithmetic or geometric mean returns in the regressions in place of raw daily returns showed some improvement, but with an associated loss of accuracy. Adding the daily trading volume into the regression model, as suggested by Lamoureux and Lastrapes (1990), did not normalize the distributions. As these efforts were ineffective, the beta stability analysis proceeded using a single index model applied to raw daily returns. The beta tests were first conducted using the equal weighted total TSE return as the market index. Results were also obtained using a value weighted market return index.

For each event, the beta tests were conducted on each individual stock. The initial tests used a dummy variable as in equation (7) from chapter 3, and tested for an increase or decrease in beta at Day 0. A maximum of 451 daily observations were used. For the thinly traded stocks, those days when a stock did not trade were eliminated for that particular stock. A 51-day period (Day 0 through Day 50) was then omitted from the time series, and the beta stability tests were repeated for each stock. The statistic used to test for a beta shift after the settling period was the standardized change in beta (SCB):

$$SCB = [Beta\ (2) - Beta(1)] / [Var(1) + Var(2) - Cov.\ (1)(2)]^{1/2} \quad (10)$$

For the first 54 event-companies analysed, the results of testing for beta shifts using the above-described methods were corroborated using an alternative method discussed by Davidson and MacKinnon (1993). Using this procedure, the daily returns were first regressed over the entire 451 (maximum) day period. Residuals obtained from that model were then regressed in a two-factor model incorporating the dummy (D):

$$Residual_{it} = \beta_{0i} + \beta_{1i} R_{Mt} + \beta_{2i} R_{Mt} D + \varepsilon_{it} \qquad (11)$$

where D takes a value of zero for data recorded prior to Day 0, and 1 for data recorded on and after Day 0. R_{Mt} is the daily return for the market at time t, β_{0i} is the intercept term for Company i, β_{1i} is the beta for the company i prior to Day 0, and β_{2i} is the estimated incremental slope coefficient. The statistical significance of β_{2i} was assessed using a t-test at the α=0.05 level of significance. In this manner, the existence of a short-term beta shift was investigated.

The purpose of duplicating the beta test with an alternative procedure was twofold. The Davidson-MacKinnon approach is simpler to apply. Furthermore, unlike the method employed in equation (7), or other methods based on analysis of variance (such as the Chow test), the Davidson-MacKinnon approach does not depend on the assumption of homoscedasticity (Davidson and MacKinnon 1993).

In summary, for the first 54 event-companies, as many as eight regressions were used to test for a change in beta. The first four of these tests were as follows:

1. using an incremental slope dummy (equation 7) at Day 0;
2. using the Davidson-MacKinnon method (equation 11) testing for slope change at Day 0;
3. using a standardized change in beta (equation 10) calculated after allowing for a 51 day settling period; and
4. using the Davidson-MacKinnon method allowing for a 51 day settling period.

Each of these regressions was conducted using, first, the equally weighted market index, and then the value weighted index. This brought the maximum number of beta test regressions per event-company to eight.

After testing 54 event-companies, the results using equation (7) and the standard beta change (equation 10) were compared to results obtained using the Davidson-MacKinnon approach. In all cases the Davidson-MacKinnon method produced the same conclusions. Beta stability tests on the remaining 325 event-companies used the Davidson-MacKinnon method alone. This brought the maximum number of regressions per event-company down to four.

4.1.1 Results - Oil Spill events (Table Ia – page 46)

The oil spill events were spaced over a 21 year time frame, with the earliest in May 1976 (event #1) and the latest in February 1996 (event #31). They ranged in severity from the relatively minor Nestucca event (#16) when 220,000 gallons of oil were spilled, to a 28 million gallon spill in the Urquoila event (#1). Many of these spills were in the ocean. Some occurred in inland rivers or bays (event #19, and #24), and in one (event #11) the oil was spilled on the ground. While a substantial oil spill has potential long-term effects on human lifestyle through the destruction of fish and wildlife, and through negative effects on tourism, these spills seldom posed a direct, immediate threat to human life or health. An exception was the Imperial Oil railcar oil spill event (event #11) in Timmins, when oil seeping into the sewers led to the evacuation of 5,000 people and damage to 21 homes.

Despite the variety of circumstances associated with these spills, the results did not vary substantially across events. Table I(a) shows the total number of companies tested for each oil spill event, the number of stocks that had a statistically significant shift in beta (two-tailed test), and the number that had a statistically significant increase in beta (one-tailed test). Results are reported for both the equal and value weighted market indices. A shift is reported only where a change occurring at Day 0 was maintained when the test was conducted at Day 51.

The events in Table I(a) are shown in chronological order. There does not appear to be a time trend associated with the number of stocks with statistically significant beta shifts. For example, in the 1976 Urquoila event, a maximum of only two shifts were found among the eight stocks tested. In 1979 the Kurdistan event had a maximum of six beta shifts. For the 1996 Sea Empress spill, a maximum of three shifts were observed. The presence of a trend component is statistically tested in a pooled time series cross-sectional model discussed in subsection 4.3.

Using either equal or value weighted market index, both downward and upward shifts were observed. For example, a maximum of 27 beta shifts occurred in total. When a one-tailed test was applied, signifying a beta increase, significant results were obtained for only eight companies when an equal weighted market index was used, or 12 when the value weighted index was used. In none of the oil spill events was a statistically significant decline in beta, measured at Day 0, followed by a statistically significant increase in the beta parameter when measured after the 51-day settling period. Similarly, there was no case of a significant rise followed by a fall in the value of the beta parameter. This rules out the concern that estimates of systematic risk can be misleading, if consecutive beta shifts occur in opposite directions, as could sometimes happen when there is a substantial change in company risk at the time of a major shift in the overall market (Brigham and Crum 1977).

4.1.2 Results - Mining Company Events (Table Ib)

Results of beta stability tests for the four events involving mining companies are provided in Table I(b). The sample size for three of these events was relatively large, as there are many TSE traded mining companies. In the earliest of these events, the Rabbit Lake Mine leak (event #20), and the Omai Mine dam failure (event #29), very few beta shifts were observed. For example, of the 44 companies studied in the Omai Mine event, using a value weighted market index, a maximum of six statistically significant beta shifts were observed, some upward, others downward. The results changed considerably with the later events. Of the six companies studied in the Inco gas leak

Table Ib: Beta Stability Test Results - Mining Company Events

Events are listed in chronological order.

All t-tests are conducted at the $\alpha = 0.05$ level of significance.

The two-tailed tests assess the likelihood of a beta shift in either direction.
The one-tailed tests assess the likelihood of an upward shift.

		# Beta shifts using equal weighted market index		# Beta shifts using value weighted market index	
Event Name	No. stocks tested	2-tailed	1-tailed	2-tailed	1-tailed
Rabbit Lake Mine Leak	31	3	0	4	4
Omai Dam Failure	44	2	0	4	2
Inco Gas Leak	6	6	0	3	0
Marcopper Dam Failure	40	30	0	10	0
Total	121	41	0	21	6

(event #30), all six experienced beta shifts when the equally weighted market index was used. In the Marcopper Dam event, 40 stocks were studied, of which 30 experienced beta shifts (equal weighted index). In Table I(b), downward shifts far outnumbered upward shifts. For example, using an equal weighted market index in the regression model, there were 41 statistically significant beta shifts (two-tailed test), and no upward shifts (one-tailed test). In none of the mining events was a statistically significant decline in beta, measured at Day 0, followed by a statistically significant increase in the beta parameter when measured after the 51 day settling period. Similarly, there were no cases of a significant rise followed by a fall in the value of the beta parameter.

4.1.3 Results - Nuclear Accidents (Table Ic)

There were only two events involving nuclear facilities (Table Ic). Both the Three Mile Island and Chernobyl accidents (event #4 and #12) had direct impact on human life. While there were no deaths associated with the Three Mile Island event, the accident triggered precautionary measures including plans for a mass evacuation. Although the feared health repercussions never occurred, the threat of long-term health impacts was significant. The sample size was restricted in both events, making it difficult to contrast results or comment on possible trends. In each event, a maximum of two stocks experienced a statistically significant beta shift. In neither event was a statistically significant decline in beta, measured at Day 0, followed by a statistically

Table Ic: Beta Stability Test Results - Nuclear Accident Events

Events are listed in chronological order.

All t-tests are conducted at the $\alpha = 0.05$ level of significance.

The two-tailed tests assess the likelihood of a beta shift in either direction.
The one-tailed tests assess the likelihood of an upward shift.

		# Beta shifts using equal weighted market index		# Beta shifts using value weighted market index	
Event Name	No. stocks tested	2-tailed	1-tailed	2-tailed	1-tailed
Three Mile Island	5	1	1	1	1
Chernobyl	3	1	1	0	0
Total	8	2	2	1	1

significant increase in the beta parameter when measured after the 51 day settling period. Nor were there any cases of a significant rise followed by a fall in the value of the beta parameter.

4.1.4 Results - PCB fires (Table Id)

Like the nuclear accidents, the PCB fires had a direct impact on human life. All three events in Table Id involved the evacuation of residents because of the threat of exposure to airborne toxins. Of the three fires, the Plastimet event (#33) stands out for the number of statistically significant beta shifts. In contrast to the oil, mining, and nuclear events there is a clear tendency with the PCB fires for betas to rise. For example, in the Plastimet event, of the 13 stocks tested, there were 11 increases when the equal weighted market index was employed. In none of these events was a statistically significant decline in beta, measured at Day 0, followed by a statistically significant increase in the beta parameter when measured after the 51 day settling period. Similarly, there were no cases of a significant rise followed by a fall in the value of the beta parameter.

Table Id: Beta Stability Test Results - PCB Fire Events

Events are listed in chronological order.

All t-tests are conducted at the $\alpha = 0.05$ level of significance.

The two-tailed tests assess the likelihood of a beta shift in either direction.
The one-tailed tests assess the likelihood of an upward shift.

		# Beta shifts using equal weighted market index		# Beta shifts using value weighted market index	
Event Name	No. stocks tested	2-tailed	1-tailed	2-tailed	1-tailed
St. Basil le Grand	11	3	1	2	1
Sydney Steel Fire	13	1	2	2	2
Plastimet	13	10	11	2	3
Total	37	14	14	6	6

4.1.5 Results – Miscellaneous events (Table Ie)

The five miscellaneous events in Table Ie ranged considerably in nature. Both the Mississauga Train Derailment (event #5) and the Hagarsville fire (event #22) occurred near major North American cities. Both triggered mass evacuation of residents. However, the problems associated with the derailment were cleared up over six days, while uncertainty over the extent of ground water contamination after the tire fire meant that environmental testing was required for several years. Both events posed direct and long-term health problems, however both events ended without injury or substantial damage to the environment.

The Union Carbide gas leak (event #8) happened in India, and resulted in thousands of deaths and injuries. The Southern Pacific train derailment (event #25) resulted in several cases of skin and eye irritations and respiratory problems, and 3,000 people were asked to evacuate their homes. As was the case with the oil spill events, despite the diverse nature of the events, the results of the beta tests do not reveal much reaction. Of the 39 event-companies studied, when an equal weighted index was used, there was a maximum of six statistically significant beta shifts. In none of these events was a statistically significant decline in beta, measured at Day 0, followed by a statistically significant increase in the beta parameter when measured after the 51 day settling period. Similarly, there were no cases of significant rises followed by a fall in the value of the beta parameter.

Table Ie: Beta Stability Test Results - Miscellaneous Events

Events are listed in chronological order.

All t-tests are conducted at the $\alpha = 0.05$ level of significance.

The two-tailed tests assess the likelihood of a beta shift in either direction.
The one-tailed tests assess the likelihood of an upward shift.

		# Beta shifts using equal weighted market index		# Beta shifts using value weighted market index	
Event Name	No. stocks tested	2-tailed	1-tailed	2-tailed	1-tailed
Mississauga Train Derailment	5	2	1	2	1
Bhopal Gas Leak	13	1	0	0	1
Algoma Central	5	0	0	0	0
Hagarsville Tire Fire	11	2	0	0	0
Southern Pacific	5	0	0	0	0
Total	39	5	1	2	2

4.1.6 Review of Beta stability hypothesis (Research Question 2)

Research question 2 was stated in null hypothesis form as:

> *there is no change in a* stock's *beta associated with environmental incidents.*

This hypothesis was tested using a regression model that focused on the significance of the β_{2i} coefficient of the dummy variable in the model:

$$Residual_{it} = \beta_{0i} + \beta_{1i}R_{Mt} + \beta_{2i}R_{Mt}D + \varepsilon_{it}$$

Of the 33 event studies conducted, 30 showed little evidence to reject the null hypothesis. In the remaining three events, there was significant evidence that betas shifted in a uniform direction. Two of these events were in the mining industry, in 1995 and 1996. The third was a PCB fire in 1997. For these three events only, the null hypothesis is rejected. Additional enquiry into the factors associated with these shifts is reviewed in section 4.3.3.

4.2 Abnormal returns analysis

In order to test for abnormal returns, a sample portfolio was constructed for each event. The decision to test the average portfolio returns, rather than individual stock returns, meant that for most of the events one or more of the stocks had to be eliminated from the sample due to thin trading. For this reason, the portfolio size (shown in Tables IIa through IIe) was often less than the number of stocks tested (Tables Ia through Ie) for the corresponding event. In 12 portfolios, (11 events) some of the stocks exhibited minor thin trading. These were the American Trader, ARCO, Bhopal, Castillo de Bellver, Kurdistan, Plastimet plastics, Plastimet waste management, Shell, St. Basile le Grand, Sydney Steel, Star Luzon, and Four Spills portfolios. Despite the thin trading, these stocks were retained for use in the AR analysis, and returns on either side of the no-trade day were averaged to produce a figure for the missing day. This practice was necessary if a portfolio approach was to be used. The procedure was used sparingly, with a maximum of six percent of no trade days permitted as shown in Figure I. Stocks missing more than six percent of the trading days were excluded from the portfolio.

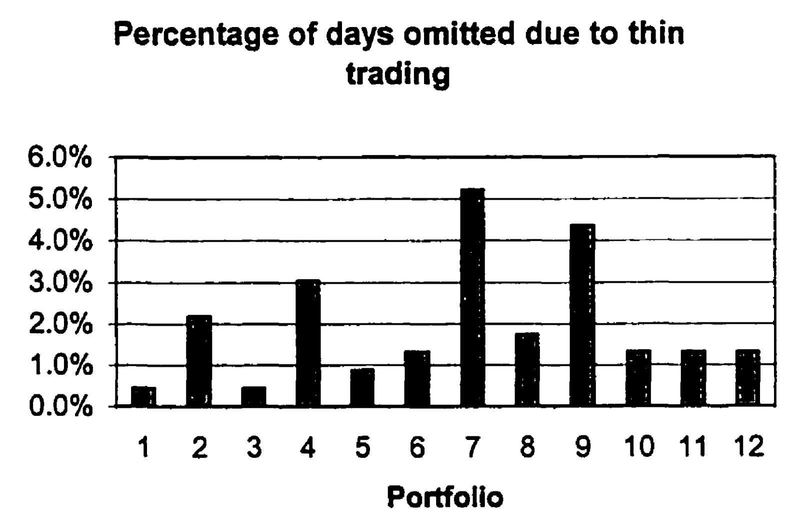

Figure I

Unlike the tests for beta stability, in which a full data set consisted of up to 451 days, a complete data set for the portfolio returns model was only 220 days. Returns from Day –200 to Day –11 inclusive were used to estimate model parameters. For each portfolio, the model parameters thus obtained were then used to forecast the next 30 daily returns for Days –10 through Day 19. Forecasted returns were then subtracted from actual returns to produce a series of residuals as in equation (5). The reasons for reviewing residuals prior to Day 0 were twofold. First, since a significant event could affect returns for time periods exceeding a single day, it was useful to look at the residuals leading into the event window for evidence that some prior, unidentified event was confounding analysis in the event window. Second, if residuals for any given portfolio were significantly large prior to Day 0, this suggests the portfolio returns may have been unusually volatile. In such a case, the finding of a statistically significant residual inside the event window lends less support to any conclusion as to the information content of the event in question.

Each residual was standardized using the standard error of the estimate. Sampling errors in the parameters were assumed to be zero as the number of observations used to estimate the parameters (190) was large (MacKinlay, 1997). The standardized residuals were then assessed for statistical significance using a two-tailed t-test, at an α=0.05 level of significance. Residuals were tested over the 30-day period, however Table II (a to e) focuses on the 10-day period, from Day 0 to Day 9 inclusive.

Up to four regressions per event were conducted, as follows:

1. using the equal weighted market index as the sole explanatory variable;
2. using the value weighted market index as the sole explanatory variable;
3. combining an industry index with the equal weighted market index; and,
4. combining an industry index with the value weighted market index.

The purpose of including industry indices is to capture variables operating in the industry which could confound the measured effects of the accident. For example, a sudden change in the price of gold at the time of a mining accident could affect mining company returns, making it difficult to establish a clear association of abnormal returns with the accident. The impact of adding the industry index is explored in Table III. For the earliest event (Urquoila – May 1976) no industry index was available. Table II(d), indicates multiple portfolio tests for the Plastimet and St. Basile le Grand events. This was necessary because of the difficulty associated with defining the industry.

Tables II(a) through II(e) report the findings of the portfolio tests using a single index model. Results are provided using both equal and value weighted market indices. The coefficient of determination (R^2) is provided for each portfolio. This is to provide further insight into any changes in the residuals when the industry indices are added later on.

Given the large number of event studies at hand, there were surprisingly few cases with negative abnormal residuals using both the equal and value-weighted indices. Table II(a) shows that among the oil spills, the Amoco Cadiz, Star Luzon, Exxon Valdez, Nova Scotia tanker, 4-spills, American Trader, and Braer incidents (event #s 2, 6, 17, 18, 19, 21 and 27) are the only ones that correspond to this restriction. Among the mining company events, only the Rabbit Lake (event #20) and Marcopper (event #32) accidents showed abnormally large negative residuals using both indices. Both nuclear accidents had large negative residuals. Among the PCB fires, only the Sydney Steel event (#28) had negative ARs using either index. Finally, among the

Table IIa: Presence of Statistically Significant Abnormal Returns (ARs)
*Oil Spill Events**

Events are listed in chronological order.

Symbols +/- indicate the sign, number, and sequence of ARs over the Day 0 to Day 9 period. Example: In the 4-spills event using the value weighted market factor, there were two positive ARs followed by one negative AR over the 10 day period.

Negative ARs are detected using a one-tailed test, corresponding to the wording of research question 1.

Positive ARs are detected using a two-tailed test. These will be discussed in a later section.

All t-statistics are evaluated at the $\alpha = 0.05$ level of significance.

		Equal Weighted		Value Weighted	
Event Name	Portfolio Size	R^2	AR	R^2	AR
Urquoila	4	0.249	none	0.480	none
Amoco Cadiz	4	0.252	-	0.494	-
Kurdistan	7	0.367	none	0.467	none
Star Luzon	8	0.373	-	0.529	-
Castillo de Bellver	8	0.400	+	0.528	+
Pointe Levy	7	0.217	none	0.365	-
ARCO	7	0.223	none	0.350	none
Shell Oil 88	4	0.590	none	0.716	none
Ultramar	3	0.606	none	0.729	none
Nestucca	2	0.187	+	0.346	+
Exxon Valdez	3	0.167	-	0.382	-
Nova Scotia tanker	4	0.124	-	0.216	-
4-spills	3	0.113	-	0.221	++-
American Trader	3	0.057	-	0.214	-
Eastern Shell	4	0.078	none	0.085	none
Coast of Spain	5	0.072	none	0.150	none
Braer	5	0.066	---	0.169	---
Sea Empress	7	0.081	none	0.112	none

*Imperial Oil Railcar event not shown here. Data problems eliminated this from the portfolio analysis.

Table IIb: Presence of Statistically Significant Abnormal Returns (ARs)
Mining Events

Events are listed in chronological order.

Symbols +/- indicate the sign, number, and sequence of ARs over the Day 0 to Day 9 period.

Example: In the Rabbit Lake event, there was one negative AR followed by two positive ARs over the 10 day period.

Negative ARs are detected using a one-tailed test, corresponding to the wording of research question 1.

Positive ARs are detected using a two-tailed test. These will be discussed in a later section.

All t-statistics are evaluated at the $\alpha = 0.05$ level of significance.

		Equal Weighted		Value Weighted	
Event Name	Portfolio Size	R^2	AR	R^2	AR
Rabbit Lake Mine Leak	8	0.002	- + +	0.005	- + +
Omai dam failure	19	0.289	none	0.288	none
Inco Gas Leak	4	0.208	+ +	0.432	+ + -
Marcopper dam failure	22	0.402	-	0.288	-

Table IIc: Presence of Statistically Significant Abnormal Returns (ARs) Nuclear Accident Events

Events are listed in chronological order.

Symbols +/- indicate the sign, number, and sequence of ARs over the Day 0 to Day 9 period.

Example: In the Chernobyl event, there was one negative AR followed by one positive AR, followed by one negative AR over the 10 day period.

Negative ARs are detected using a one-tailed test, corresponding to the wording of research question 1.

Positive ARs are detected using a two-tailed test. These will be discussed in a later section.

All t-statistics are evaluated at the $\alpha = 0.05$ level of significance.

		Equal Weighted		Value Weighted	
Event Name	Portfolio Size	R^2	AR	R^2	AR
Chernobyl	2	0.110	- + -	0.172	- + -
Three Mile Island	3	0.147	- -	0.157	- -

Table IId: Presence of Statistically Significant Abnormal Returns (ARs)
PCB Fire Events

Events are listed in chronological order.

Symbols +/- indicate the sign, number, and sequence of ARs over the Day 0 to Day 9 period.

Example: In the Plastimet event using the integrated oil portfolio with a value weighted market factor, there were two negative ARs followed by one positive AR over the 10 day period.

Negative ARs are detected using a one-tailed test, corresponding to the wording of research question 1.

Positive ARs are detected using a two-tailed test. These will be discussed in a later section.

All t-statistics are evaluated at the $\alpha = 0.05$ level of significance.

		Equal Weighted		Value Weighted	
Event Name	Portfolio Size	R^2	AR	R^2	AR
St. Basile le Grand (Waste Mgmt)	3	0.430	none	0.635	none
St. Basile le Grand (Integrated Oils)	2	0.376	none	0.436	none
Plastimet (Plastics)	4	0.000	none	0.067	none
Plastimet (Integrated Oils)	4	0.004	+	0.308	- - +
Plastimet (Waste Mgmt)	5	0.008	none	0.082	+
Sydney Steel (Waste Mgmt)	6	0.131	-	0.143	-

*Table IIe: Presence of Statistically Significant Abnormal Returns (ARs) Miscellaneous Events**

Events are listed in chronological order.

Symbols +/- indicate the sign, number, and sequence of ARs over the Day 0 to Day 9 period.

Example: In the Bhopal event using the integrated oil portfolio with an equal weighted market factor, there were two negative ARs over the 10 day period.

Negative ARs are detected using a one-tailed test, corresponding to the wording of research question 1.

Positive ARs are detected using a two-tailed test. These will be discussed in a later section.

All t-statistics are evaluated at the $\alpha = 0.05$ level of significance.

		Equal Weighted		Value Weighted	
Event Name	Portfolio Size	R^2	AR	R^2	AR
Bhopal (Integrated Oils)	5	0.272	- -	0.299	-
Hagarsville Tire Fire (To be revised)	5	0.095	-	0.444	- -
Algoma Central	3	0.051	none	0.398	+
Southern Pacific Train Derailment	2	0.028	none	0.323	none

*Mississauga Train Derailment is not shown here. With the exception of CP itself, all potentially eligible stocks were too thin for portfolio inclusion.

miscellaneous events, there were statistically significant negative residuals using both indices in the Bhopal study (event #8) and the Hagarsville fire (event #22).

These 14 portfolios are discussed in detail below.

The Amoco Cadiz (event #2) stocks produced a statistically significant residual on Day 7 only, regardless of whether the equal or value weighted index was used. These results are summarized in Table III. The regressions were repeated, this time adding the oil and gas index to the models to control for the effects of factors specific to the industry, such as the world supply of oil. The additional factor increased the R^2 from 0.252 to 0.565 for the equal weighted, and from 0.494 to 0.575 for the value weighted models respectively. In the model using the equal weighted market index, the statistical significance of the Day 7 residual disappeared when the oil and gas industry index was added. The Star Luzon (event #6) stocks produced a statistically significant residual on Day 6 only, using either the equal or value weighted index. When the industry index was added, the R^2 rose from 0.373 to 0.525 for the equal weighted, and from 0.529 to 0.557 for the value weighted models respectively. The statistical significance of the Day 6 residual disappeared in both models when the industry index was added. For the Exxon Valdez portfolio (event #17), only the Day 1 residual was significant in the single index model, regardless of whether the market index was equal or value weighted. When the industry index was added, the statistical significance of the residual derived from the model using the equal weighted market index disappeared. The R^2 increased from 0.167 to 0.658 (equal weighted) and from 0.382 to 0.670

Table III: Timing of Statistically Significant Negative Abnormal Returns (AR) in selected portfolios

Portfolios included in this table are those from Table II which have negative ARs over the 10 day period from Day 0 to Day 9 using BOTH equal and value weighted market factors in the regression models.

In the double index models, the industry factor was tested for incremental explanatory power using an F-test.
Where the industry factor was found to be significant, the Adjusted R^2 is italicized.

All t and F statistics are evaluated using a one-tailed test conducted at the $\alpha = 0.05$ level of significance.

	Equal Weighted				Value Weighted			
	Single Index Model		Add Industry Index		Single Index Model		Add Industry Index	
Event Name	R^2	AR	Adj. R^2	AR	R^2	AR	Adj. R^2	AR
Amoco Cadiz*	0.252	Day 7	*0.565*	none	0.494	Day 7	*0.575*	Day 7
Star Luzon*	0.373	Day 6	*0.525*	none	0.529	Day 6	*0.557*	none
Exxon Valdez*	0.167	Day 1	*0.658*	none	0.382	Day 1	*0.670*	Day 1
Nova Scotia tanker*	0.124	Day 7	*0.587*	Day 4	0.216	Day 7	*0.588*	Day 4
4-spills*	0.113	Day 4	*0.584*	none	0.221	Day 4	*0.580*	none
American Trader*	0.057	Day 9	*0.632*	none	0.214	Day 9	*0.603*	none
Braer*	0.066	Day 4, 6, 8	*0.391*	Day 6, 8	0.169	Day 4, 6, 8	*0.396*	Day 6, 8
Rabbit Lake Mine****	0.002	Da y 0	0.003	Day 0	0.005	Day 0	0.003	Day 0
Marcopper**	0.402	Day 1	*0.781*	Day 1	0.288	Day 1	*0.744*	Day 1
Three Mile Island**	0.147	Day 2, 3	0.150	Day 2, 3	0.157	Day 2, 3	0.154	Day 2, 3
Chernobyl**	0.110	Day 2, 8	0.247	Day 2, 8	0.172	Day 2, 8	0.246	Day 2, 8
Sydney Steel (Waste mgmt companies)***	0.131	Day 2	0.122	Day 2	0.143	Day 2	0.147	Day 2
Hagarsville Tire Fire***	0.095	Day 7	*0.262*	Day 3, 7	0.444	Day 3, 7	0.442	Day 3, 7
Bhopal***	0.272	Day 6, 8	0.268	Day 6, 8	0.299	Day 8	*0.385*	Day 6, 8

Industry Index: *Oil & Gas **Gold & Silver ***Industrial Products ****Metals & Minerals (value weighted) when the industry index was added. The results of additional tests, using the industry index as a dependent variable, are discussed in chapter 5.

For the Nova Scotia portfolio (event #18), the Day 7 residual was significant in both single index models. When the industry market index was added, the Day 4 residual was significant. The R^2 increased from 0.124 to 0.587 (equal weighted) and from 0.216 to 0.588 (value weighted) when the industry index was added. For the 4-spills portfolio (event #19), the Day 4 residual was significant in both single index models. When the industry market index added, there were no significant residuals over the 10 day window. The R^2 increased from 0.113 to 0.584 (equal weighted) and from 0.221 to 0.580 (value weighted) when the industry index was added. For the American Trader portfolio (event #21), the Day 9 residual was significant in both single index models. When the industry market index was added, there were no significant residuals over the 10 day window. The R^2 increased from 0.057 to 0.632 (equal weighted) and from 0.214 to 0.603 (value weighted) when the industry index was added. For the Braer oil spill (event #27), statistically significant abnormal returns were associated with Day 4, 6, and 8 using either the equal or value weighted market index in the market model. The explanatory power of the models is very low for this event, 0.066 for the model using the equal weighted index, and 0.169 for the model using the value weighted market index. When the industry index variable was added, the Day 6 and Day 8 residuals were both statistically significant, while the Day 4 residual was not. Results were the same using both the equal and value weighted index. The adjusted R^2

increased to 0.391 (equal weighted) and 0.396 (value weighted) when the industry index was added.

In the Rabbit Lake mine leak (event #20) the AR occurred on Day 0 in all four versions of the model. The explanatory power was very poor, however, at 0.002 using the equal weighted index, and 0.005 using the value weighted. The metals and minerals index was an insignificant factor in the double index models. In the Marcopper dam failure (event #32), the AR occurred on Day 1 in all four versions of the model. The explanatory power was much higher this time, and was substantially improved by the addition of the industry index, rising from 0.402 to 0.781 (equal weighted index) and from 0.288 to 0.744 (value weighted).

Portfolio residuals associated with the Three Mile Island accident (event #4) were statistically significant on Day 2 and Day 3. The explanatory power was 0.147 using the equal weighted index. When the value weighted index was used, the Day 2 and Day 3 residuals were significant again. The explanatory power was 0.157. The Chernobyl portfolio (event #12) had ARs on Day 2 and Day 8 in both the equal and value weighted versions of the model. The explanatory power was 0.110 and 0.172 respectively. In both of these events, the industry indices were insignificant.

In the Sydney Steel accident (event #28), the portfolio of waste management companies showed a significant abnormal residual on Day 2 for both the equal and value weighted versions of the regression model. The explanatory power was 0.131 and 0.143 respectively. The industry index was not significant.

The Hagarsville portfolio (event #22) had ARs on Day 7 using the single index market model with an equal weighted market factor. When the industry factor was added, the Day 3 residual was also significant. The R^2 rose from 0.095 to 0.262. ARs on Day 3 and Day 7 were also significant in the model using the value weighted market factor. The explanatory power was much higher this time, at 0.444. In this case, however, the industry index was not a significant factor.

The Bhopal accident (event #8) produced a statistically significant residual on Day 6 and Day 8 in the equal weighted market factor model, and in the value weighted model including the industry index. The single index value weighted model had a statistically significant residual on Day 8 only. Using the value weighted model, the R^2 rose from 0.299 to 0.385 when the industry factor was added. In the equal weighted model, the R^2 was 0.272, and the industry factor was not significant.

4.2.1 Review of Abnormal Returns Hypothesis (Research Question 1)

Research question 1, in null hypothesis form, stated:

> *there is no negative intra-industry abnormal return in response to environmental incidents among Canadian companies listed on the Toronto Stock Exchange.*

Statistically significant negative abnormal returns were found in seven of the oil spills events, two mining events, both nuclear accidents, one PCB fire, plus the Hagarsville and Bhopal events (Table III). For these 14 events, the null hypothesis is rejected. For the remaining 19 events, the null hypothesis is not rejected. The factors contributing to the ARs are explored in subsection 4.3.1. The presence of positive abnormal returns, and other issues that must be considered when interpreting the significance of these findings, will be discussed in chapter 5.

4.3 Pooled Time series Cross-sectional studies

4.3.1 Results - Cumulative Abnormal Returns (CARs)

For this part of the study, the single index market model parameters were estimated for each individual event-company using a 200 day time series of stock returns (dependent variable) and market returns (independent variable). Unlike the previous section, where tests were conducted using both the equal and value weighted market indices in turn, this time only the equal weighted index was employed. This choice was made because the equal weighted models produced more statistically significant results (Tables Ia – Ie). The parameter estimates were then used to forecast 20 daily returns for Days 0 to 19. Residuals were obtained by subtracting the actual from the forecast returns as in equation (5) from chapter 3, and cumulative residuals were calculated. For example, a two day cumulative abnormal residual was the raw residual for Day 0 added to the raw residual for Day 1 as shown below:

$$\begin{aligned}
&\text{2-day } CAR_{it} = CAR_{i0} + CAR_{i1} \\
&\text{3-day } CARit = CAR_{i0} + CAR_{i1} + CAR_{i2} \\
&. \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (12)\\
&. \\
&. \\
&\text{20-day } CAR_{it} = CAR_{i0} + CAR_{i1} + CAR_{i2} + \ldots\ldots + CAR_{i19}
\end{aligned}$$

This procedure produced a spreadsheet of 1-day to 20-day CARs for each event. A separate spreadsheet was then compiled, pooling the cross-sectional series of 5-Day

CARs for each of the 33 events. Additional data on company size, exchange listing, location of event, the number of people affected by each event, the industry, and the incremental betas for each event-company (obtained from the earlier part of this study) were also included in the spreadsheet.

The sample data included 379 observations. The sample was heavily dominated by two industries: oil and gas, which accounted for 171 observations, and mining, which accounted for 132 observations. Partial sample data are shown in Table IV. Summary statistics for the independent variables are shown in Appendix E. Because of the wide range in company size, natural logs of market value were calculated and used in the regression model (Blacconiere and Patten 1994). The correlation between the North America *($NorAmer_t$)* and Mining *(M_t)* variables, and between the Mining and Oil or Gas *(OG_t)* variables, was relatively high, suggesting a potential problem with multicollinearity. Appendix F provides a breakdown on an event-company, and an event basis, showing how the *$People_t$* factor, and two categorical variables - the geographical factor *($NorAmer_t$)* and the cross-listing factor *(XL_{it})* – are distributed throughout the data.

Thin trading over the 200 day estimation period was essentially ignored. Days when the stock did not trade were deleted from the estimation period for that particular stock. This resulted in some event-companies having less than 200 observations in the estimation period, as was the case with the beta stability tests. Thin trading during the

Table IV: Sample Input data for Cross-sectional studies

Variables:

Time is the month the event occurred. Events are spread over a 22 year (264 month) period, with January 1976 as Month #1.
Price is the share price at the close of Day –1
OS is the number of shares of that class outstanding during the event month
MV is the market value, calculated by multiplying Price X OS
XL is a dummy variable: 1 if the stock is cross-listed on the NYSE, AMEX, or NASDAQ; zero otherwise
NorAmer is a dummy variable: 1 if the event occurred in North America; zero otherwise
People is the number of people killed, injured or evacuated during the event
OG is a dummy variable: 1 if the stock pertains to an oil and gas company; zero otherwise
M is a dummy variable: 1 if the stock pertains to a mining company; zero otherwise
ChgB is the increment/decrement in beta obtained using a full data set (max 451 observations) using cfmrce as an explanatory variable in the market model
5-CAR is the 5-day cumulative abnormal return, defined as $CAR_{t0} + CAR_{t1} + CAR_{t2} + CAR_{t3} + CAR_{t4}$

Event	Stock	Time	Price	OS	MV	XL	NorAmer	People	OG	M	ChgB	5-CAR
#3	Canadian Occidental	39	22.88	6,802,568	15,560,874	1	1	0	1	0	-2.335	-0.001
Kurdistan	Gulf Canada Corporation	39	44.38	45,497,406	20,189,473	1	1	0	1	0	0.290	0.017
(March 1979)	Gulfstream Resources	39	0.51	10,195,025	5,199,463	0	1	0	1	0	0.174	0.122
	.											
	.											
	.											
	.											
#4	Chancellor Mines	39	3.20	1,043,370	3,338,784	0	1	300,000	0	1	-0.188	-0.0014
Three Mile	Faraday Mines	39	3.55	3,421,300	12,145,615	0	1	300,000	0	1	-0.360	-0.062
Island	Denison Mines	39	23.00	18,272,884	42,027,633	1	1	300,000	0	1	0.526	-0.095
(March 1979)	.											
	.											
#8	Celanese	108	6.38	13,539,557	86,314,676	0	0	10,000	0	0	-0.194	-0.053
Bhopal	CIL	108	27.25	13,996,814	381,413,182	0	0	10,000	0	0	-0.042	-0.055
(Dec. 1984)	Dupont A	108	16.13	15,772,596	254,333,111	0	0	10,000	0	0	0.389	-0.054
	.											
	.											
	.											
	.											
	.											

event window resulted in the elimination of some of the event-companies from portions of the cross-sectional analyses. For example, for a company that traded on Days 0 to 2, missed day 3, then traded on Day 4, 3-day CARs were calculated, but not 5-day. Of the 379 observations initially available, thin trading eliminated 53 observations from the regressions using 5-day CARs. Four other observations were omitted as there was incomplete data available to calculate market value. This brought the number of observations available for the 5-Day CAR model to 322 (Table Va)

The CARs were run in the pooled cross-sectional time series model defined in equation (9). T-values are shown below (in italics) for the parameter estimates.

$$\text{5-day CAR}_{it} = \underset{\mathit{0.441}}{\beta_0} + \underset{\mathit{-0.257}}{\beta_1 \text{LogMV}_{it}} + \underset{\mathit{-1.461}}{\beta_2 \text{XL}_{it}} + \underset{\mathit{-2.501}}{\beta_3 \text{People}_t} + \underset{\mathit{2.422}}{\beta_4 \text{NorAmer}_t} + \underset{\mathit{-0.569}}{\beta_5 \text{OG}_t} + \underset{\mathit{-1.293}}{\beta_6 \text{M}_t} + \underset{\mathit{-0.800}}{\beta_7 \text{Time}_t} + \varepsilon_{it}$$

where: $LogMV_{it}$ is the natural log of the market value of company i at time t,

XL_{it}	= 1 if stock *i* is cross-listed on a major US exchange,
$NorAmer_t$	= 1 of the accident at time t occurred in North America,
OG_t	= 1 for an oil and gas company, 0 otherwise, and
M_t	= 1 for a mining company, 0 otherwise.

$People_t$ is a quantitative variable measuring the number of people seriously affected by the event at time *t*. $Time_t$ is a trend variable, included in the model to test whether or not societal concern for the environmental impacts of business activity shifted at some point in time. The coefficients β_1 through β_7 are their associated coefficients, β_0 is the intercept, and ε_{it} is the error term.

Market Value was measured by multiplying the price of the event-company stock on Day –1 by the number of shares outstanding during the event month. If the stock did not trade on Day –1, the closing price on the closest day prior to Day –1 was used. At the α=0.05 level of significance the $People_t$ and $NorAmer_t$ variables were significant. These tests were repeated using 3-Day, 7-Day and 10-Day CARs. Results of all four models are shown in Table V(a). The $People_t$ and $NorAmer_t$ factors were statistically significant in the 5, 7 and 10-Day CAR models, but not the 3-Day.

The sample was then split into subsamples, one restricted to data from the oil spill events, one restricted to mining event data, and finally, one with the data from the 10 remaining non oil/gas or mining events. Tests similar to those described above, using 3-Day, 5-Day, 7-Day and 10-Day CARs, were conducted on all three subsamples. Results are included in Tables V(b) to V(d).

Using oil and gas event data alone, (Table Vb) the size factor $(LogMV_{it})$ was statistically significant in the 3-day CAR model. There were no statistically significant factors in the 5, 7 or 10-Day CAR models.

When the mining subsample was analysed (Table Vc), only the cross-listing factor was significant. This was true for the 3,5 and 7-Day CAR models, but not the 10-Day.

In the 10 non-oil/gas or mining events, the size factor was statistically significant in the 5, 7 and 10 day CAR models. The cross-listing factor was significant in the 5 and 10-day models. Finally, the $People_t$ factor was significant in the 5, 7 and 10-day models. The Mining industry factor (M_t) was significant in the 3-day model.

Table Va: Cross-sectional studies – Cumulative Abnormal Returns (CARs) -All Events

$$CAR_{it} = B_0 + B_1 LogMV_{it} + B_2 XL_{it} + B_3 People_t + B_4 NorAmer_t + B_5 OG_t + B_6 M_t + B_7 Time_t + e_{it}$$

T-values for the parameter coefficients are shown in the table below.
Parameters are statistically significant if the absolute value of the t-statistic equals or exceeds 1.96.
Statistical significance of t-value was estimated using a two-tailed test.

Dependent Variable	n	Adj. R^2	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
3-Day CAR	333	0.025	1.084	-0.916	-1.418	-0.206	0.617	0.145	-1.762	-0.189
5-Day CAR	322	0.055	0.441	-0.257	-1.461	-2.501	2.422	-0.569	-1.293	-0.800
7-Day CAR	310	0.057	1.490	-1.521	-1.446	-2.631	2.366	-0.195	-0.941	-0.269
10-Day CAR	299	.040	0.816	-0.804	-0.652	-2.759	2.305	-0.610	-0.912	-0.606

Table Vb: Cross-sectional studies – Cumulative Abnormal Returns (CARs) - Oil & Gas Events

$$CAR_{it} = B_0 + B_1 LogMV_{it} + B_2 XL_{it} + B_3 People_t + B_4 NorAmer_t + B_5 OG_t + B_6 M_t + B_7 Time_t + e_{it}$$

T-values for the parameter coefficients are shown in the table below.
Parameters are statistically significant if the absolute value of the t-statistic equals or exceeds 1.96.
Statistical significance of t-value was estimated using a two-tailed test.

Dependent Variable	N	Adj. R^2	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
3-Day CAR	131	0.035	2.352	-2.042	-0.089	-0.307	-1.683	Not applic.	Not applic.	0.730
5-Day CAR	127	-0.013	1.439	-1.350	-0.298	-0.519	0.284	Not applic.	Not applic.	-0.060
7-Day CAR	123	-0.037	0.228	-0.240	0.102	-0.526	0.022	Not applic.	Not applic.	-0.431
10-Day CAR	118	-0.037	-0.660	0.608	-0.378	-0.670	0.193	Not applic.	Not applic.	-0.235

Table Vc: Cross-sectional studies – Cumulative Abnormal Returns (CARs) - Mining Subsample

$$CAR_{it} = B_0 + B_1 LogMV_{it} + B_2 XL_{it} + B_3 People_t + B_4 NorAmer_t + B_5 OG_t + B_6 M_t + B_7 Time_t + e_{it}$$

T-values for the parameter coefficients are shown in the table below.
Parameters are statistically significant if the absolute value of the t-statistic equals or exceeds 1.96.
Statistical significance of t-value was estimated using a two-tailed test.

Dependent Variable	N	Adj. R^2	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
3-Day CAR	113	0.071	-1.664	0.546	-2.074	-1.343	1.718	Not applic.	Not applic.	1.575
5-Day CAR	111	0.091	-0.617	1.058	-2.019	-0.210	0.642	Not applic.	Not applic.	0.440
7-Day CAR	106	0.118	0.027	-0.967	-2.498	0.139	0.259	Not applic.	Not applic.	0.103
10-Day CAR	102	0.072	-0.476	-0.426	-1.375	-0.423	0.737	Not applic.	Not applic.	0.515

Table Vd: Cross-sectional studies – Cumulative Abnormal Returns (CARs) - Non-oil/gas or Mining events

$$CAR_{it} = B_0 + B_1 LogMV_{it} + B_2 XL_{it} + B_3 People_t + B_4 NorAmer_t + B_5 OG_t + B_6 M_t + B_7 Time_t + e_{it}$$

T-values for the parameter coefficients are shown in the table below.
Parameters are statistically significant if the absolute value of the t-statistic equals or exceeds 1.96.
Statistical significance of t-value was estimated using a two-tailed test.

Dependent Variable	n	Adj. R^2	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
3-Day CAR	90	0.055	0.893	-0.735	1.089	0.141	1.201	-0.383	-2.417	-0.995
5-Day CAR	85	0.211	2.599	-2.555	2.313	-2.249	1.244	-0.536	-1.246	-0.898
7-Day CAR	82	0.185	3.177	-3.404	1.589	-2.807	1.521	1.259	0.273	-0.815
10-Day CAR	80	0.198	3.054	-3.176	2.074	-2.286	1.317	-0.237	-0.866	-0.957

4.3.2 *Review of hypotheses (Research Questions 9-14)*

Six hypotheses pertained to factors affecting the CARs. These were tested using pooled time series and cross-sectional data from all 33 events. Subsamples of the data from the oil and gas events, the mining events, and the non-oil/gas or mining events were also tested. Three, five, seven and ten-day CARs were used in alternative applications of the model:

$$CAR_{it} = \beta_0 + \beta_1 LogMV_{it} + \beta_2 XI_{it} + \beta_3 People_t + \beta_4 NorAmer_t + \beta_5 OG_{it} + \beta_6 M_{it} + \beta_7 Time_t + \varepsilon_{it}$$

Research question 9 was:

> *there is no time dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

There is no evidence to reject the null hypothesis using the all events sample, or any of the subsamples (Tables Va through Vd). Research question 10 was:

> *there is no industry dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

Using the non oil/gas or mining event data, the coefficient for the mining industry factor (β_6) was significant in the 3-day CAR model (Table Vd), so for this model and subsample, the null hypothesis is rejected. Research question 11 was:

> *there is no size dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

The coefficient for the size factor (β_1) was significant in the oil and gas event subsample using the 3-day CARs (Table Vb), and in the non-oil/gas or mining event subsample for the 5, 7 and 10-day CAR models (Table Vd). In these four cases the null hypothesis is rejected. Research question 12 was:

> *there is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the stock is cross-listed on a major US exchange.*

The coefficient for the cross-listing factor *(β_2)* is significant in the mining event subsample for each of the 3, 5 and 7-day CAR models (Table Vc), and in the non-oil/gas or mining subsample, in the 5 and 10-day CAR models (Table Vd). For these five versions of the model, the null hypothesis is rejected.

Research question 13 was:

> *there is no association between a company's cumulative abnormal returns following an environmental incident, and the number of people directly affected by the incident.*

The people factor coefficient *(β_3)* is significant in the all event sample (Table Va) and in the non-oil/gas or mining event subsample for the 5, 7 and 10-day models (Table Vd). In these six cases, the null hypothesis is rejected. Research question 14 was:

> *there is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the incident occurred in North America.*

Using the all event sample the $NorAmer_t$ coefficient *(β_4)* is statistically significant using the 5, 7 and 10-day CAR models (Table Va). In these three cases, the null hypothesis is rejected.

4.3.3 Results - Beta Stability: Review of hypotheses (Research Questions 3-8)

A pooled time series cross-sectional study was conducted using equation (8) from chapter 3 to identify potential factors affecting beta stability. This equation is repeated below:

$$Chg\beta_{it} = \beta_0 + \beta_1 LogMV_{it} + \beta_2 XL_{it} + \beta_3 People_t + \beta_4 NorAmer_t + \beta_5 OG_t + \beta_6 M_t + \beta_7 Time_t + \varepsilon_{it}$$

The dependent variable ($Chg\beta_{it}$) is the incremental beta (β_{2i}) obtained from the equation (11) model. All other factors and coefficients are as defined in section 4.3.1.

Results of this analysis are shown in Table VI. Using the full sample, only the mining companies make a significant contribution to a change in beta. In the oil and gas subsample, none of the factors are significant. This result is not surprising, given the overall stability illustrated by the betas of the stocks analysed in the oil and gas events as shown in Table I(a). Analysis of the mining event subsample showed the $People_t$ and $NorAmer_t$ factors to be significant, as well as the $Time_t$ factor.

Six hypotheses pertain to an examination of potential factors associated with beta shifts. Here again, the data consisted of pooled time series and cross-sectional data contained in an all event sample, as well as the three subsamples. These hypotheses are reviewed and discussed below.

Research question 3 was:

> *there is no time dependent change in a stock's beta associated with an environmental incident.*

The coefficient for the time factor (β_7) was statistically significant using the mining

Table VI: Results of Cross-sectional studies – Beta Stability

Model: $ChgB_{it} = B_0 + B_1 LogMV_{it} + B_2 XL_{it} + B_3 People_t + B_4 NorAmer_t + B_5 OG_t + B_6 M_t + B_7 Time_t + e_{it}$

T-values are provided below.

Parameters are statistically significant if the absolute value of the t-statistic equals or exceeds 1.96.

2-tailed test
Level of significance conducted at α = 0.05

		N	Adj. R^2	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
a	All event	374	0.132	-0.585	-0.058	-0.240	1.345	1.779	-0.078	-5.034	1.397
b	Oil & Gas events	146	0.005	-1.126	0.469	0.482	1.038	0.430	Not applic.	Not applic.	1.705
c	Mining events	121	0.361	7.473	0.282	-0.432	7.000	-7.420	Not applic.	Not applic.	-7.687
d	Other events	109	0.167	-0.872	-1.060	0.265	2.471	-2.920	-0.770	0.179	5.031

event, and the non-oil/gas or mining subsamples. For these two versions of the test, the null hypothesis is rejected.

Research question 4 was:

> *there is no industry dependent change in a stock's beta associated with an environmental incident.*

The coefficient for the mining industry factor *(β_6)* was statistically significant using the all events sample. The null hypothesis is rejected for this version of the test only.

Research question 5 was:

> *there is no size dependent change in a stock's beta associated with an environmental incident.*

There is no evidence to reject the null hypothesis.

Research question 6 was:

> *a stock's beta stability in the event of an environmental incident is not associated with whether or not the stock is cross-listed on a major US exchange.*

There is no evidence to reject the null hypothesis.

Research question 7 was:

> *a stock's beta stability in the event of an environmental incident is not associated with the number of people directly affected.*

The coefficient for the people factor *(β_3)* is significant using the mining events and the non-oil/gas or mining events subsamples. The null hypothesis is rejected in these two cases.

Research question 8 was:

a stock's beta stability in the event of an environmental incident does not depend on whether or not the accident occurred in North America.

The coefficient for the North America factor *(β_4)* is significant using the mining events and the non-oil/gas or mining event subsamples. The null hypothesis is rejected in these two cases.

All regression models that passed a test of overall statistical significance are provided in Appendix H, along with the results of their diagnostic tests. All model residuals were examined for conformity to the standard assumptions of linear regression (Gujarati 1995) using normality, heteroscadasticity and autocorrelation tests. For these tests, the 0.05 level of significance was used to test the null hypotheses. The assumption of normality was examined using probability plots and direct assessment of the symmetry of the residual distribution (D'Agostino 1986). Heteroscedasticity was examined using the Glejser test (Glejser 1969). Autocorrelation was assessed using the Durbin-Watson statistic (Durbin and Watson 1951) and Geary tests (Geary 1970). The models included in Appendix H include four applications using data from all the events combined, two using mining events data only, and four using data from the non oil spill or mining events. None of the models using oil spill event data were significant. These results are discussed in the following chapter.

Chapter 5
Interpretation of Results

5.0 Introduction

The statistical results of the study are reviewed and interpreted in this chapter. The tests were designed to examine stock reactions to environmental incidents. These incidents have potential negative cash flows associated with environmental cleanup liabilities and fines (Surma and Vondra 1992, Little, Muoghalu and Robison 1995), regulatory tightening (Slovic 1987, Blacconiere and Patten 1994), and potential restrictions in future financing (Scagnelli and Malloy 1987, Buhr 1991). These incidents should be associated, at minimum, with a loss in share value. This occurred in the Three Mile Island accident (Bowen, Castanias and Daley 1983), and in the Union Carbide accident at Bhopal (Blacconiere and Patten 1994). Alternatively, the uncertainties associated with potential legislative change, and other factors specific to companies in the affected industries, can affect the systematic risk of stock returns, as noted in the Three Mile Island study (Bowen, Castanias and Daley 1983). The results presented in chapter 4, however, were mixed. Some portfolios did indeed have negative ARs, but many companies had positive ones as well. Some betas declined while others rose, and many did not change at all.

One criticism of event study methodology is that its practitioners claim to be estimating the impact of an event on stock returns, when in fact they are measuring it (Frankfurter and McGoun 1993). The confusion stems from the data gathering process.

In the present study, the method used to collect sample data cannot be considered a random process, nor can the event-companies chosen be considered random samples. Efforts were made to identify all the events that satisfy the definition of an environmental accident provided in section 4.0. Fourteen hypotheses (summarized in Appendix C) were tested. The results cannot be used to estimate the effects of events not specifically included here. However, the purpose of this study is not to predict stock market responses to future events. Rather, it is to examine and identify past share sensitivities to past incidents, and to provide a foundation of knowledge so that further research can examine additional factors contributing to this sensitivity. The insights arising from this analysis, however, may be incorporated into future studies that will yield information for use in predictive models.

This study includes 33 events spanning a 22 year period. There were 379 event-companies. For reasons discussed in the literature review, earlier research in environmental accounting focused on companies in environmentally sensitive industries. The data used here is heavily concentrated in two such industries. Nineteen of the events were oil spills, and 171 event-companies were in the oil and gas sector (Appendix F). The number of companies tested in each individual oil spill event study ranged from six to nine. These events occurred from 1976 to 1996. The second area of concentration was the mining industry. There were four mining events, three of which had over 30 event-companies. In total, the mining industry accounted for 132 event-companies. The time frame covered by mining incidents was from 1989 to 1996. Most oil and gas event-companies were associated with oil spill events, and most mining event-companies with mining events. However, in some instances event-companies from either sector were associated with one of the 10 remaining events. This third subsample consisted of the non-oil spill or mining events. These events encompassed a variety of incidents over the 1976 to 1997 period, and included event-companies from the following industries: oil and gas, mining, industrial products, plastics, and transportation. The number of companies tested per individual event study ranged from three to 13.

5.1 Oil spills

Several of the oil stocks - Shell Canada, Canadian Occidental, Gulfstream Resources, Imperial Oil, and Total Petroleum North America – appeared in all 19 oil event studies. This facilitated additional analysis to identify common features or behaviours. Imperial Oil and Gulfstream Resources experienced a beta change once, while Total Petroleum's changed twice. Shell Canada and Canadian Occidental were relatively volatile, each changing five times. For Shell, one beta shift was upward and the remaining four downward. For Canadian Occidental, two shifts were downward and three upward. Both Shell and Canadian Occidental were examined more closely for common characteristics which might account for their relative sensitivity. Canadian Occidental was cross listed on the AMEX during the entire 21 year period covered by the oil spill events, while Shell stock was listed in Canada only. The market value of the two companies changed considerably over the years, but Canadian Occidental was always considerably smaller than Shell. For example, in the Urquoila event study (event

#1), the size of the eight companies tested ranged from 7.7 million to over 3 billion dollars. Canadian Occidental was at the low end of the range, with a value of 88 million dollars, while Shell's market value was one billion dollars. In the 1996 Sea Empress study (event #31), company size ranged from 200 million to nine billion dollars. Canadian Occidental's market value was by this time, three billion dollars, and Shell's was five billion. Frequency of trading was also considered. Thinly traded stocks tend to be less known, and receive less attention from analysts. As a result, they are often more volatile (Lev 1992). In the Urquoila study, Canadian Occidental was thinly traded, with only 371 observations. Shell, on the other hand, traded on each of the 451 days under consideration. For the 1996 study, both stocks had a full data set consisting of 451 days. Overall, efforts to identify an overriding theme in beta behaviour in the oil spill events were unsuccessful.

Autocorrelation was a problem in a large proportion of the individual stock regressions used to conduct the beta tests. Autocorrelation inflates the variances of the parameter estimates, thus raising the likelihood of Type II errors. In other words, in the absence of autocorrelation, more statistically significant incremental betas (β_{2i} from equation 11) may have been found. However, there was no clear directional theme to the beta shifts, as both upward and downward shifts occurred. Furthermore, in some cases the companies with beta shifts differed depending on whether the equal or value weighted index was used as a market factor. Other factors such as company size, listing, frequency of trading, and the location of the accident, all failed to provide evidence to support a claim of beta sensitivity in the case of oil spill events. For these reasons, no effort was made to rerun the tests with adjustments for autocorrelation.

The null hypothesis for research question one was:

> *there is no negative intra-industry abnormal return in response to environmental incidents among Canadian companies listed on the Toronto Stock Exchange.*

This hypothesis was rejected for the seven oil spill events shown in Table III. However, some words of caution concerning event studies are warranted. Practitioners of this methodology have been accused of biasing the structure and interpretation of their research so as to obtain evidence to support whatever theory they espouse (Frankfurter and McGoun 1993). For example, when statistically significant abnormal returns which are in line with the economic logic of the event occur within the event window, they are discussed in papers authored by proponents of the methodology. In many event studies, however, statistically significant error terms occur outside the event window. These abnormal returns are often ignored (Franfurter and McGoun 1993). The present study used a 10-day event window (Day 0 to Day 9) for the purpose of identifying negative ARs, and an additional 10-day study window on either side of the event window. These additional windows, from Day –10 to Day –1, and from Day 10 to Day 19, were used to look for problems such as those discussed by Frankfurter and McGoun. The 4-spills portfolio (event #19) had both positive and negative ARs over the event window. Positive ARs are not consistent with the economic logic of the event. Furthermore, all seven of the oil spill events shown in Table III had ARs outside the event window. This makes it difficult to attribute a particularly large residual in the event window to the actual event, since in the absence of an event, the likelihood of seeing statistically large residuals still remains.

There are three possible explanations for the occurrence of positive ARs inside the event window. The first is that the portfolio returns are volatile, hence subject to large shifts in either direction. If this is the case, then again it is difficult to attribute ARs inside the event window to the actual event, since abnormal returns are not that abnormal at all. The second is that there is some unidentified event (defined in terms other than those used in this paper) affecting the returns. While an exploration of all possible events is beyond the scope of this paper, the financial news was examined closely over each entire 30-day period, and no such other events were found. The third is that they are the result of random occurrences, unrelated to any event at all. This explanation cannot be entirely ruled out. It implies, however, that any statistically significant negative ARs are also random occurrences, not necessarily related to the environmental incident.

The Imperial Oil railcar leak (event #11) was the only oil spill event in which the company directly involved was itself, a TSE traded Canadian company. A study of Imperial Oil returns over the event period showed a statistically significant negative AR on Day 0 using either the equal or value weighted index as a market factor. There was no affect on beta. There were statistically significant ARs before the event on Day –8, Day –6 and Day-5, and after the event window on Day 14 and Day 15. In other words, the results do not support a clear, consistent interpretation of stock behaviour even for the company directly involved.

Data problems prevented a test of portfolio returns for this event. For this reason, a different approach was needed to test for an intra-industry effect. The Imperial Oil returns were regressed against the market again, with the oil and gas index used as an additional explanatory variable. Controlling for industry effects in this manner did not eliminate the Day 0 abnormal return, suggesting the industry itself did not reflect the impact of the accident. When the oil and gas index was regressed against each of the equal and value weighted market indices, however, in both cases the Day 0 abnormal return remained. This suggested the industry did indeed have a Day 0 reaction. The results were therefore inconclusive.

With regard to the CAR models, the pooled data were used to test the statistical significance of time, company size, listing, the number of people affected by the event, and the geographical location of the accident. Using the oil spill subsample there was little evidence to suggest that any of these factors are important, with the exception of the size factor in the 3-Day CAR model (Table Vb). None of the models using oil spills event data, however, were significant. The failure to obtain statistically significant results suggests that different or additional explanatory factors may have been required. For example, there was no variable in the model to represent the magnitude of the accident. Court established damages are one alternative measurement of magnitude. However, it is not possible to determine a dollar figure until long after the accident has occurred. The fact that it is difficult to control for assumptions the market may make about the outcome of court proceedings makes this a poor choice of metrics. Possibly the $People_t$ factor was a proxy for accident magnitude. In the oil spill events, however, it is clearly not a useful one, for with the exception of the Imperial Oil Railcar leak (event #11) the value of this factor was zero (Appendix F). The failure to include a relevant variable in the model can bias the parameter estimates (Gujarati 1995), which could explain why all regressions using the oil spills event data failed the test for overall significance.

In the 3-day CAR model the company size factor was significant. A cross-sectional study that focuses on a single oil spill event, where accident magnitude is controlled, might shed further light on how the company size factor correlates with the CARs. However, the size factor needs to be more appropriately defined. Thin trading characterized many of the stocks in the oil and gas industry. This more or less restricted portfolio participation to the integrated oils. The size factor was based on market value. For each integrated oil, however, some portion of the market value is related to explorations and recovery, petrochemicals, and retailing, as well as refining. This means the economic significance of regulatory changes resulting from the accident would depend on the extent of each company's participation in the refining segment. These two issues - the lack of a factor that effectively measures the magnitude of the spill, and the inappropriate measurement of the company size factor - means the cross-sectional models may be poor because of an omitted variable problem (Thompson and Schipper 1983).

It has been suggested that public recognition and defence of environmental assets stems from an increased awareness of both the use value and existence value of natural resources (Krutilla 1967, Attfield 1998). For example, after the Nestucca event

(#16), and the American Trader event (#21), lobby efforts to restrict the transportation of oil through the Strait of Juan de Fuca were intensified (Globe and Mail October 1, 1989, February 9, 1990). Public anger in the wake of the Exxon Valdez accident resulted in the company being fined five billion dollars in excess of reclamation and economic restitution costs. Such occurrences are evidence of the existence of bequest value (Krutilla 1967). The statistical results, however, do not support this assertion. Changes in societal attitude and legislative regime have not affected the results in the oil spill events, as the trend factor ($Time_t$) was not significant. More will be said on the meaning of the $Time_t$ factor in section 5.2.

The final test on the oil and gas events looked at factors affecting beta stability. None of the factors examined were significant. The need for different or additional factors applies as much to the pooled time series cross-sectional beta stability models as to the CAR models. It is also possible the difficulty identifying factors affecting beta shifts, and the lack of evidence that beta shifts even occur, may stem from the very frequency of this type of accident. Accidents that are common and well understood have low signal potential (Slovic 1987). Low signal potential accidents are not associated with impacts that go beyond the company immediately affected. This issue, discussed further in section 5.3, raises the question of how ARs as late as Day 7 (Amoco Cadiz - event #2), Day 6 (Star Luzon – event #6) and Day 9 (American Trader – event #21) can be related to the accidents (Table III). This final observation suggests that despite the rejection of the hypothesis for research question one for seven oil spill events, the only feasible explanation for the negative ARs is that they are the result of chance occurrence.

5.2 Mining events

Numerous beta shifts were observed in response to the Inco gas leak and Marcopper dam failure events (#30 and #32). The null hypothesis for research question 2 was :

there is no change in a firm's beta associated with environmental incidents.

This hypothesis was rejected for these two events. In both events, beta shifts were downward. Downward shifts are contrary to the results obtained by Bowen, Castanias and Daley (1983) in their Three Mile Island study of companies in the electrical utilities industry. On the other hand, Moreschi (1988) anticipated upward shifts in his analysis of pulp and paper companies, and was surprised to find that most shifts were in fact, downward. Brigham and Crum (1977) hypothesized that an increase (decrease) in beta could be temporarily masked by a preceding decrease (increase) because of the statistical consequences of a sudden shift upward (downward) of the overall market. The present study is sensitive to this possibility, however. Shifts were tested at Day 0, and again at Day 51. In none of the tests was a statistically significant beta shift in one direction followed by a statistically significant shift in the opposite direction. This suggests the Brigham and Crum explanation either does not apply in the Canadian market, or else the conditions under which their explanation would have applied, did not arise in the Canadian market over the time periods in question.

The covariance of the stock with the market, and the variance of the market itself determine a stock's beta as shown in equation (2). In both the Inco and Marcopper events, the variance of the market rose in the 200-day post event period. This factor alone would account for beta declines: the downward shifts would be driven by an overall change in market volatility, with no necessary relationship to the events at all. Moreschi (1988) suggested the beta declines were driven by a decrease in the covariance of the stock with the market, possibly in association with an increase in the covariance of the stock with some other factor. The covariance of several event-companies with the market was calculated over a 200 day period immediately before the event, and again immediately after (Appendix G) in order to test part of this explanation. Five (of six) Inco event stocks experienced a decrease in covariance, as did 12 (of 15) Marcopper event stocks. This test is evidence of a relationship between the events and the beta shifts. However the question of whether some factor, other than the market, began playing a greater role in explaining the overall variance of the stock returns is beyond the purview of this research, and was therefore not explored.

Beta is a stock's systematic risk, that portion of the total variance in returns which is triggered by sensitivity to general economic issues that affect the overall capital market. The standard deviation (sd), and coefficient of variation (cv), which relates the standard deviation to the stock's mean return in the formula:

$$cv = sd/mean \qquad (13)$$

have also been employed in to assess total risk (Spicer 1978, Halpern,Weston, and Brigham 1994). Moreschi suggested that while the systematic risk of the stocks in his study declined, the total risk may actually have increased. In five of the Inco event-companies, the *cv* increased, or switched from positive to negative, while the standard deviation declined (Appendix G) In other words, these two alternative measures of total risk give conflicting signals. In 12 of 15 Marcopper stocks, an initially positive *cv* increased, or became negative, while the standard deviation declined. Since standard deviation declined, these changes in *cv* must have been driven by a decline in the mean return. The impact on total risk was not an issue targetted for investigation in this study. For this reason, this observation is not pursued any further. However, these preliminary findings suggest that an investigation of the mean return over a period of time following an event may be an area for future research.

As was the case with the oil spill event studies, the portfolio analyses of the mining sector events had problems with positive ARs, and with ARs outside the 10-day event window. The Rabbit Lake Mine dam failure (event #20) had positive ARs on Day 4 and Day 8, as well as on Day 11 and Day 16, and a large negative AR on Day –6. No statistically significant ARs were found outside the 10-day event window for the Inco gas leak portfolio (event #30). Inside the event window, however, there was a statistically significant positive AR on Day 2 and Day 3. In the Marcopper dam failure (event #32), a statistically significant negative AR occurred two days before the accident.

Fama (1970) suggested that positive ARs are adjustments to earlier, negative ARs which reflected an over reaction of the market when there was insufficient information available to assess the full significance of the event. In the Rabbit Lake mine leak (event #20) a large negative AR on Day 0 was followed by large positive ARs on Day 4 and Day 8. In an efficient market, positive adjustments (if that is indeed what they are) are not likely to be delayed several days. The presence of these ARs frustrates the development of a coherent explanation of the behaviour of portfolio returns. To acknowledge those ARs which are consistent with the assumed economic logic of the event, while ignoring those which are not, is to employ the same faulty argument of which Franfurter and McGoun (1993, 1995) are so critical.

Event study methodology benefits considerably from the inclusion of an industry index if there is a noticeable improvement in R^2 (MacKinlay 1997). This is because the affect of industry wide factors, such as a fluctuation in commodity prices which could trigger ARs of either sign, are controlled. When the industry factors were added to the oil spills, and to one of the mining events, the explanatory power improved (Table III). However, the problem of these "misplaced" large residuals outside the event window persisted. This means there were unidentified non-industry factors displacing the residuals, the portfolios were volatile, or else the residuals were the product of chance alone. Whatever the cause, a consistent interpretation of the behaviour of returns over the event window remains difficult. Because of these difficulties, the rejection of the null hypothesis for research question 1 for two of the mining events (Table III) is likely the result of chance alone.

In three of the four mining events, the companies directly involved in the accidents were themselves, TSE traded Canadian companies. These companies were specifically excluded from the portfolio studies because the cash flow ramifications are more onerous for the companies directly involved than for other companies in the industry. While they are excluded from the discussion of intra-industry effects, a separate study of the behaviour of their shares was conducted and is discussed below.

The Omai Mine (event #29) in Guyana was jointly owned by Cambior and Golden Star Resources, with Cambior being the major owner. Neither Cambior's nor Golden Star's betas were affected by the accident. A test for abnormal returns applied to each company alone, however, showed a highly significant negative Day 0 residual using the single index model ($t = -11.28$ for Cambior, and -8.04 for Golden Star). Results were similar using either the equal or value weighted versions of the market index. Cambior also had a large negative Day 3 residual. For Cambior, when the industry index was added, large positive ARs on Day 1 and Day 4 immediately followed both negative ARs. Golden Star had large positive ARs on Day 1 regardless of whether or not the industry factor was added. The daily returns of a portfolio which excluded these two companies showed no statistically significant ARs over the entire 30-day period for which ARs were measured. This suggests there was no industry impact.

The addition of the gold and silver index to the market model is another way to test for an intra-industry effect. When the industry index was included, the Day 0 ARs remained ($t = -15.18$ for Cambior, and -7.86 for Golden Star). This means the industry returns did not reflect the impact of the accident. Furthermore, regressing the gold and silver index itself against the market produced no statistically significant ARs, once again supporting the conclusion of no contagion effect. Clearly, the impact of this accident, to the extent that it affected stock behaviour at all, was confined to the companies directly involved, and consisted of changes in return rather than beta.

The owner of the Marcopper mine (event #32) was Placer Dome. The beta of Placer Dome's common stock declined along with those of many of the other stocks tested. Abnormal returns for Placer Dome, however, were positive on Day 7 in the single index model, and on Day 1 when the gold and silver index was added. The results were the same using either the equal or value weighted index. While there were no negative ARs for Placer Dome itself, the portfolio had a negative AR on Day 1, suggesting there was an intra-industry reaction to the event. However, this Day 1 AR persisted when the gold and silver index was added, contradicting this initial conclusion. When the index itself was regressed against the market, the Day 1 AR remained. Results of testing for a contagion effect for this event are therefore inconclusive. These results contrast those of the Omai dam failure, where the effect was clearly restricted to the companies directly involved, and where beta was unaffected.

In the Inco event, the betas of all companies tested declined, including that of Inco itself. Inco had a single, positive return on Day 2 in the single index model, but no statistically significant residuals at all when the industry index was added. Results did not differ between models using the equal versus value weighted indices. Regressing the portfolio on the value weighted market index produced a negative AR on Day 8. When the industry index was added, this Day 8 AR remained, suggesting the industry itself did not react to the event. A regression of the metals and minerals index on either equal or value weighted index showed no negative ARs. In this event, the company shared the industry impact, but this impact was on beta alone.

As was the case with the oil spill events, the cumulative abnormal returns for the mining events were examined using pooled time series cross sectional data. The mining events subsample (Table Vc) shows the cross-listing variable (XL_{it}) as the only factor with statistically significant explanatory power in the 3, 5, and 7-day CAR models. Given the additional attention companies trading on a major US exchange receive on a normal basis, let alone when there is an accident, the importance of the XL_{it} factor is understandable. Furthermore, the environmental liability disclosure requirements of the US Securities Exchange Commission are more stringent than those of the Ontario Securities Commission. For example, item 303 of SEC Regulation SK requires the Management Discussion and Analysis (MD&A) section of the annual report to include forward looking disclosures of known trends, demands, events or uncertainties that are likely to have a material effect on operating results or financial condition. More specifically, item 101 requires disclosure of the material effects of compliance with environmental laws on earnings, capital expenditures, and competitive position. Item 103 requires the disclosure of the material effects of legal proceedings arising from environment related infractions.

The SEC disclosure requirements discussed above were introduced in 1989 (with adjustments and refinements in later years). In contrast, the Ontario Securities Commission policy statement 5.10 (also issued in 1989) directs registrants to disclose information on risks and uncertainties that would cause reported financial information "not necessarily to be indicative of future operating results or future financial condition". There is no specific direction to discuss environmental issues or regulations. This difference in disclosure requirements reflects the greater role of professional judgement in the accounting profession in Canada (Martin-Sidey 1999). However, companies must abide by the rules of each exchange on which their shares trade. This means that cross-listed companies must provide better environmental disclosure information, both historic and future oriented. The significance of the XL_{it} factor is therefore explained. The higher US disclosure standard means investors can better appreciate the cash flow impacts associated with environmental accidents if the stock is cross-listed. The null hypothesis for Research question 12 was:

> *there is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the stock is cross-listed on a major US exchange.*

This hypothesis was rejected.

The statistical significance of the XL_{it} factor, as explained above, is in keeping with the findings of Freedman and Stagliano (1991), and Blacconiere and Patten (1994). The negative sign on the coefficient, however, contradicts the findings of both these earlier studies. The conflicting results may be the product of research design. Each of the earlier studies included a company specific disclosure factor. Each was a single incident event study, so inter-temporal issues were excluded from consideration. The present study is designed to reflect inter-temporal changes. However, the subjectivity associated with the quantification of a disclosure factor was considered inappropriate, and for this reason no such factor was included. The use of a disclosure variable tailored to reflect the nuances of Canadian accounting standards is, however, another possible avenue for future research.

The negative coefficient for the XL_{it} factor also conflicts with voluntary disclosure theory. This theory purports that when investors believe management is deliberately withholding information, they discount their uncertainty into stock price (Richardson 1998). If cross-listed companies truly disclose more information, the XL_{it} coefficient should therefore be positive. However, the proprietary costs associated with the release of that information must also be taken into consideration when disclosure decisions are made (Verrecchia 1983). No effort was made to include proprietary costs in this study because of the difficulties associated with quantifying such a variable.

Another issue that confounds the interpretation of the explanatory power of the cross-listing variable is the difference between the trading systems of Canada and the United States. These differences were inspired by the growth of institutional trading. The inability of brokers to satisfy large institutional orders raised concerns that market illiquidity would trigger price fluctuations unrelated to the intrinsic value of the stocks. In the US, institutional investors have been able to bypass brokers and exchanges since 1979, using electronic trading sytems. This raised concerns about reduced market transparency, because information on pre-trade orders and post trade transactions was no longer available to all market participants on a real-time basis. In order to allay these concerns, the SEC established the *National Market System* to ensure that all market participants had access to information across markets, and the ability to access those markets. In Canada, the need to fill large block orders has also resulted in the migration of orders away from the exchange. Electronic trading systems, however, are not as yet permitted. Instead, brokers seeking to fill large orders accumulate stock by purchasing directly from their smaller clients, and then selling directly to the institutional buyer in "off-exchange" transactions (Ontario Securities Commission 1999). The ultimate objective of the brokers therefore remains hidden from the sellers. This contributes to inefficiency in the Canadian market, so that shares trading on the Canadian exchanges may not adjust as rapidly to new information as those trading on the US exchanges. This systems based explanation for trading differences may account for the inconsistent behaviour of the XL_{it} factor, for both the Freedman and Staglino (1991) and Blacconiere and Patten (1994) studies focused on NYSE trading, while the present study is restricted to TSE trading.

Table VIa shows that when all the event data is pooled, companies in the mining industry are associated with statistically significant beta shifts. When the mining data was split out and analysed separately (Table VIc), three statistically significant factors emerged. These were the $People_t$ factor (positive), the $Time_t$ factor (negative), and the $NorAmer_t$ place factor (negative). The associated null hypotheses rejected were those for research questions three, seven and eight. Respectively, these hypotheses were:

> *there is no time dependent change in a stock's beta associated with an environmental incident;*
>
> *a stock's beta stability in the event of an environmental incident is not associated with the number of people directly affected; and,*
>
> *a stock's beta stability in the event of an environmental incident does not depend on whether or not the accident occurred in North America.*

The positive coefficient for the *People*$_t$ factor coincides with economic logic. Accidents in which a large number of people are injured, displaced, or otherwise affected, are often followed by protracted law suits, and extensive media coverage which creates social pressure for regulatory tightening, possibly even business closure. Both of these factors – prospective lawsuits and regulatory tightening – contribute to higher cash flow uncertainties. Additional uncertainty means higher risk. Higher risk can be reflected in higher standard deviation of returns, higher beta, or both. More will be said on this shortly.

Some additional comments concerning event study methodology and the issue of time are warranted at this point. Event studies may be defined in terms of calendar time, or economic time. In a calendar time event, the companies studied experience the event on the same date. The Inco event, plus each of the time series studies reported in Tables I, II, and III, are examples of calendar time event studies. An example of an economic time event study would be the analysis of the effects of stock splits on company value, where each company studied experienced the event on a different date. When the observations are taken from different dates, however, fewer factors are held constant. An unrealistic assumption is made that even though the events occurred on different dates, all other market conditions are statistically independent and offset each other in the aggregate (Frankfurter and McGoun 1993). The cross-sectional studies included in this paper are a hybrid of the two, for some of the CARs and beta shifts (y-values) are taken from a common point in calendar time, while others are taken from different points in time. Including $Time_t$ as a trend factor is one way to capture the impact of many of these unidentified factors (Gujarati 1995). For this reason, it is important to realize that $Time_t$ is a proxy for many factors.

In 1995, the CICA added s5136 *(Misstatements – Illegal Acts)* to the auditing handbook, specifically requiring auditors to investigate compliance with environmental regulation. Audit guideline 19 *Audit of Financial Statements Affected by Environmental Matters* (introduced in January 1994, then revised to reflect the release of s5136) provides guidance for the application of auditing standards in light of environmental matters. Financial accounting standards address the precision of accounting information in terms of measurement uncertainty and serve, in the financial market, to reduce investor bias. In this paper, $Time_t$ was statistically significant and negative (Table VIc). Bewley (1998) suggested a tightening in the US Financial Accounting Standards Board's disclosure requirements in 1993 triggered a reduction in investor bias. She focused on the uncertainties associated with environmental liabilities already reflected in financial statements. A second source of uncertainty concerns the occurrence of the liability in the first place. In a study of real estate investment trusts, securities in which the unit holders do not have limited liability protection, the underpricing of initial public offerings is reduced when a higher quality auditor is used (Anderson 1998). This is because the uncertainty associated with the accounting information is reduced by the additional diligence such an auditor is expected to bring to the task. These studies suggest there is an impact on the equity markets when accounting standards are tightened and rigorously applied. The CICA amendments to the auditing handbook are evidence that this sort of regulatory tightening has occurred in Canada in recent years.

A company's total risk is reflected through its standard deviation of returns. There are two elements to total risk. The first is business risk, which affects both the equity beta, and the non-beta portion of total risk. Business risk is largely driven by industry specific factors such as strikes, and the cost of raw materials, and by company specific factors such as the quality of management. Environmental performance, as an element of business risk (Cormier, Magnan and Morard 1993) can affect company cash flows in numerous ways. The first is through efforts to sustain environmental assets through recycling or reduction in use, and through the inclusion of environmental protection strategies as part of an investment project such as a new mine development. These efforts are directly reflected in cash flows, and are also reported to users of accounting information to the extent that they are detailed in the annual report through social responsibility disclosures. Cash flows can also be affected by penalties resulting from non-compliance with regulatory standards. Through Audit Guideline 19, however, environmental risk is implicitly conveyed to external users. Another way in which cash flows are affected pertains to the likelihood that an accident will occur. With the exception of companies that self-insure, the quantification and monetization of a low probability/high cost accident is left to the insurance company, but is reflected in cash flows through insurance premiums.

Evidence of a benefit from tighter environmental regulation can be found in Pashigan's analysis of US manufacturing firms (Pashigan 1984), and in the Maloney and McCormick study of the textile industry (Maloney and McCormick 1982). There is also anecdotal evidence that in some industries, companies have actually lobbied for stricter environmental standards (The Economist 1994), and that other companies have participated in voluntary initiatives in order to show that new legislation is not required (LaBarr 1988). Regardless of whether the regulation is legislated or self-imposed, the results benefit some companies by imposing costs which others cannot bear. Furthermore, additional economic barriers block the entry of new competitors. This has the effect of reducing the uncertainties in the company's external business environment. Tighter environmental regulation also reduces the range of operating behaviours available for management to choose from, thereby reducing management's cash flow uncertainties. On the other hand, investors' uncertainties are addressed, at least in part, by increases in both the implicit assurance provided by the auditor, and the explicit assurance provided through social responsibility disclosures. These three impacts - the reduction in management's choices, the decrease in the uncertainties of the external business environment, and the reduction in investors' perceived risk - reduces the dependence of a company's cash flows and stock returns on general economic factors. This ties in directly with the second element of total risk: a stock's beta, or systematic risk, reflects the dependence of its returns on those of the overall market.

A company derives its cash flows from its investment projects. The covariance of these cash flows with market returns is reflected in the asset beta, as discussed in Chapter 3. In the absence of a change in financial structure, a decrease in asset beta would trigger a decline in the equity beta, for β_A and β_E are directly related (see equation 4 in chapter 3). The increasing regulatory environment that is reflected in growing environmental control legislation, and eventually in accounting disclosure standards, is one of the factors affecting project cash flows, and is reflected in the $Time_t$ variable.

It is also possible that an increasing regulatory environment augments the explanatory power of an industry factor by increasing the role of industry specific legislation. Both of these explanations – a decline in asset beta, and an increase in the significance of an industry factor - would account for the beta declines observed in this study. They would also account for Moreschi's observation of downward beta shifts in the wake of more stringent water pollution legislation. Neither asset beta nor industry factor were specifically targeted for investigation in this study. Both lines of enquiry represent opportunities for future research.

The $NorAmer_t$ factor was also found to be statistically significant and negative in the mining company event subsample (Table VIc). If an accident occurs in a jurisdiction where environmental legislation is sufficiently clear that due diligence is easily established in court, there is a reduction in the likelihood of future law suits and the cash flow uncertainties these create. The uncertainties are especially reduced when management has directly participated in the development of the legislation. Furthermore, in an environment where the legislation is clearly defined, and where the remedies available to the government are established in the constitution, there is less uncertainty on the part of the investment community as to the outcome should legal action occur. This is in contrast to a situation in which the laws are less well defined, the remedies unclear, and the constitutional rights of societal participants less protected.

In summary, the results of the mining event studies were mixed. The number of beta changes in the two later incidents, and the clear directional theme, suggest there was an impact on systematic risk. Other aspects of risk were also affected. In the study of abnormal returns, however, efforts to address the shortcomings of earlier published event studies left too many ARs unaccounted for. The cross-sectional study of cumulative abnormal returns, while inconclusive in itself, points in the direction where future research may be profitable.

5.3 Non-Oil Spill or Mining events

The 10 remaining events not covered by the mining or oil spills analyses include the PCB fires, the nuclear and transportation accidents, plus the Bhopal and Hagarsville events. Special problems arose in the analyses of these occurrences. First of all, company identification was difficult, leading to a problem with sample size. Second, industry identification was a problem, and the stocks selected were sometimes drawn from an industry other than the one which experienced the accident. For example, in the absence of a publicly traded nuclear power electrical utilities industry in Canada, shares in uranium mining companies were used to study the two nuclear accidents (events #4 and #12). It was assumed that disruptions in the demand for nuclear powered utilities would likely affect the demand for uranium. In other cases, such as the Hagarsville fire (event #22), proxy industries were used because of difficulty defining the industry involved. The failure to target the appropriate stocks and the correct industry make it difficult to draw conclusions regarding intra-industry effects.

The outcomes of the beta stability tests on the nuclear events (events #4 and #12) were similar to the results of the oil spill events. There were very few significant beta shifts (Table Ic). This contrasts with the findings of Bowen, Castanias and Daley (1983), where betas showed a marked tendency to rise following the Three Mile Island accident. This US study had 83 companies to consider, whereas the present study had only five for the Three Mile Island event, and three for the Chernobyl event. Furthermore, in the earlier paper, the companies studied were direct participants in the nuclear utilities industry. Caution should be used, therefore, when attempting to draw comparisons between the US study and this one, and when drawing conclusions as to intra-industry impacts.

Results of the beta stability tests of the five events listed in Table Ie are also inconclusive. Stock selection was either severely limited in terms of number of companies, or else the industry was difficult to define.

While industry identification was a problem for the PCB events, the availability of a greater amount of data allowed more latitude in the interpretation of the results. The Plastimet fire (event #33) was the only one to show significant changes in beta stability, and to support a rejection of the null hypothesis for research question 2. The variance of the market declined after the event. This alone, would drive betas upward. A comparison was made between the standard deviations, coefficients of variation, and covariances of each stock on a pre-event and post-event basis (Appendix G). Of the 13 event-companies studied, 11 had statistically significant upward beta shifts. The standard deviations rose for 10 of the stocks following the event. The coefficients of variation rose in 10 cases, and for 12 of the stocks the covariance with the market rose. This contrasts with the findings in the Inco and Marcopper events, where the standard deviations and covariances declined, and the coefficient of variation, the only risk metric that increased, was driven upward by a declining mean. Overall, the event-companies studied in these two mining events became less risky, while those studied in the Plastimet event became more risky.

Societal anxiety pertaining to the handling of toxic substances is particularly acute (Slovic 1987). This has resulted in tangled regulation and confusion on the part of both business and the public alike (Bradford 1990). Even companies that comply with international standards for environmental management cannot rest assured that they could prove due diligence in the case of legal action (Griffiths and Clairman 1996). It has also made the remediation of accident sites particularly costly and difficult because of concern over the moving, storage and disposal of PCB's. For example, the costs of containment, soil sampling, excavation, removal and disposal can cost up to four million dollars for even a small PCB fire (Machin and Ehreshmann 1990). The St. Basile le Grand fire in 1988 (event #15) was a large one. The final barrel of contaminated earth did not leave the site until 1998, and the cost to the Quebec government was over 60 million dollars (Block 1998).

In the portfolio studies of abnormal returns, the Chernobyl portfolio was volatile, with large ARs outside the event window on Day -5 and Day –3. The Three Mile Island portfolio had a large AR on Day 16. The only PCB event with a negative AR inside the event window was the Sydney Steel fire (event #28) waste management company portfolio, which had a negative AR on Day 2 (Table III). Large ARs also occurred on Day -1 and on Day 17. In all three portfolios – Chernobyl, TMI, and the Sydney Steel waste management portfolio - the negative ARs persisted when the industry index was added. This suggests the portfolios tested were indeed affected by the events in question, and not some other industry factor. On the other hand, the explanatory power was low for all three portfolios, and was not greatly improved by the addition of the industry factor. While the null hypothesis for research question 1 was rejected for these three events, the link between the accidents and the stock responses is tenuous at best.

The two remaining events that provided evidence of a correlation between the accident and share returns were the Hagarsville Tire fire (event #22) and Bhopal (event #8). There were no statistically significant ARs outside the event window in the Hagarsville portfolio using the equal weighted market factor. When the value weighted factor was used, however, a large (positive) AR occurred on Day –2. Within the event window, statistically significant negative ARs occurred on Day 3 and Day 7 (Table III). The first evacuation of people occurred on Day 1. By Day 2, discussions of an expansion of the evacuation area were publicized, along with warnings of the health threats associated with exposure to the airborne toxins in the smoke. These news items explain a reaction on Day 3, however the Day 7 AR remains unexplained.

In the Bhopal accident (event #8), large negative ARs occurred on Day 6 and Day 8 (Table III). These findings coincide with the findings of Blacconiere and Patten (1994) whose cumulative abnormal returns declined substantially between Day 5 and Day 10. On the other hand, over the Day 0 to Day 3 period, their CARs became increasingly negative. This was in keeping with the incremental release of bad news over the four day period. However, it contrasts with the results of the Canadian portfolio used in this study, in which an initial Day 0 positive AR was immediately followed by one negative AR, and then by 4 positive ARs. Possibly the difference in results between the two studies is explained by the choice of companies. The US sample was drawn from the industrial gases, industrial inorganic chemicals, and industrial organic chemicals industries. TSE traded stocks in these industries were too thinly traded for use in the analysis. Furthermore, the authors of the US research had access to a much larger stock exchange, and were able to gather data on 47 companies, whereas in this paper the sample size was only five.

A further inspection of the Mississauga Train derailment (event #5) highlights a potential problem when employing event study methodology in the Canadian market. All candidates for inclusion in the portfolio were excluded because of thin trading. Analysis of Canadian Pacific, the company directly involved in the accident, showed there were statistically significant negative abnormal returns on Day 4 and Day 5. These disappeared, however, when the transportation index was added. To conclude that CP returns were unaffected by the accident, however, would be premature. In 1979, the TSE transportation index was itself, dominated by CP. In other words, controlling for factors specific to the transportation index was in effect, controlling for factors affecting CP, including the effects, if any, of the event. Caution is therefore required when adding industry indices in attempt to enhance the sensitivity of event study methodology without first considering the composition of the indices. In the smaller markets, the index itself can be dominated by one or two stocks.

When data from the All Events sample were analysed in the cross-sectional CAR models (Table Va) the $People_t$ factor was significant. When the data were divided according to the nature of the event, this significance appeared in the non-oil spill or mining subsample only (Table Vd). The $People_t$ factor was significant in the 5, 7 and 10-day CAR models, resulting in a rejection of the null hypothesis for research question 13:

> *there is no association between a company's cumulative abnormal returns following an environmental incident, and the number of people directly affected by the incident.*

The greater the number of people affected, the lower the CAR. This result is in keeping with economic logic, for the greater the human impact, the greater the demand for legislative change, with whatever cash flow ramifications that may entail.

Company size was statistically significant (Table Vd). For the non-oil spill or mining companies the null hypothesis for research question 11 was rejected:

> *there is no size dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

This result coincides with the economic consequences theory of accounting which purports that companies that are large, profitable, or in high profile industries, attract more attention and are therefore more likely to be subject to investor scrutiny (Watts and Zimmerman 1990). A question arises as to why the size factor was not significant in the mining events. The fact that the non-oil spill or mining events include the "high signal potential" accidents (Slovic 1987) may be the explanation. Psychometric profiling shows the lay person associates accidents involving the nuclear industry (including uranium mining), PCBs and other chemicals, with higher order impacts. Higher order impacts are those which go beyond the company directly involved, to include the industry or even an entire technology (Slovic 1987).

The statistical significance of the mining industry factor *(M_i)* in the 3-day CAR model is further evidence of the role that signal potential plays in investor reactions. Of the 90 observations used in this model, only eight were from the mining industry. These eight observations are the uranium event-companies identified in the Three Mile Island and Chernobyl accidents. These observations create an industry effect, leading to a rejection of the null hypothesis in research question 10:

> *there is no industry dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

The signal potential explanation, however, suggests the effect is more likely the impact of uranium mining specifically, rather than the mining industry in general.

Considering that both mining and oil and gas accidents can have a devastating impact on natural resources, the above discussion suggests that investors are only concerned with issues that directly affect people, and that shareholders beyond a narrow segment of "ethical" investors have no real concern for environmental assets. On the other hand, Feltmate and Schofield (1999) claim that companies that practice sustainable development have higher rates of share appreciation. If these shares truly perform better than those of competing companies, it is unlikely that just a narrow segment of the market is driving them. The Feltmate and Schofield definition of sustainable development, however, includes economic and social initiatives such as providing opportunities for academic upgrading in communities where the companies operate (Feltmate 1999). This suggests that it really is a large segment of the market that rewards company efforts toward sustainability, however, environmental considerations are just one facet of the laudable behaviour, perhaps even a minor one.

The market impact of an environmental accident could also be associated with the publicity the accident attracts. The extent of publicity is often driven by the impact the accident has on the human population. The inclusion of a variable measuring the number of accident related news items in the regression model is another possible avenue for future investigation. However, major oil spills such as the Exxon Valdez (event #17), Braer (event #27), and Sea Empress (event #31) also attracted considerable front page news coverage. This suggests the extent of publicity is not in itself driving the stock market response. On the other hand, since it is only through this sort of publicity that the market learns of the human impact, news coverage might be investigated as an explanatory factor in the high signal potential events. Given the difficulties associated with stock selection, however, such a study would best be pursued using US data.

The cross-listing factor *(XL_{it})* was significant in the 5 and 10-day CARs. The positive sign is in keeping with the view that fuller disclosures are favoured by the market. These results contrast those obtained when the mining event subsample was analysed, however, in which case the XL_{it} coefficient was negative. In the discussion in section 5.2, the absence of factors representing company specific disclosures and proprietary costs were cited as possible confounding issues. These same issues apply to the discussion at hand, although this time the statistical result is in keeping with voluntary disclosure theory, and with the findings of Freedman and Stagliano (1991) and Blacconiere and Patten (1994). The time periods from which the data for the two subsamples were drawn differed considerably. The observations in the non-oil spill or mining subsample spanned the full 22 year time frame, while the mining events data were concentrated in the 1989 to 1996 period. This difference should be borne in mind when contrasting the results of model application to the two subsamples.

In the cross-sectional analysis of beta stability, the $People_t$ factor was significant and positive, while the geographic factor $NorAmer_t$ was significant and negative. These results coincide with results in the mining event subsample. The $Time_t$ factor, however, was positive, whereas in the mining events subsample it was negative.

The negative $Time_t$ factor in the mining events subsample was explained in terms of:

1. the reduction in perceived risk, associated with the higher accounting disclosure standards; and,
2. the reduction in the dependence of individual stock return distributions on market returns, associated with increased environmental protection regulation.

In the high signal potential events, however, the trends and uncertainties that have emerged over time have had the opposite effect. First, the industry experts who participate in the development of regulation tend to measure risk in terms of technical estimates of annual fatalities, while ignoring the broader context in which risk is viewed by the lay person (Slovic 1987). This means the regulation has failed to reduce the risks perceived by the market.

Over the past 22 years, two changes in the way civil liability cases are treated by the courts in the US have had a profound impact on business activity and on the public's perception of business responsibility. First, the courts no longer require the plaintiff to prove cause and effect. This paved the way for a myriad of law suits for damages not necessarily related to the named event. Second, the courts extended the concept of injury to include the "fear damages" for "cancerphobia" (Knight 1990), the "brooding uncertainty" (Huber 1987) that one may have been injured. Furthermore, the courts extended the concept of damages to include the cost of ongoing diagnostic monitoring needed to establish whether one has suffered ill effects or not (Knight 1990). The key impact on business activity was the withdrawal of many private insurance companies from the environmental liability business, because they could no longer define the risks associated with operating activities that involved toxic substances (Huber 1987). Other insurance companies restricted their comprehensive general liability coverage to include accidents, but not the effects of long-term or deliberate spills or discharges such as those associated with a radioactive or hazardous waste site (Little, Muoghalu and Robison 1995).

The withdrawal of the insurance companies has left many businesses the double burden of defining the risks for themselves, and of reporting their level of preparedness to the market (Surma and Vondra 1992). However, with a limited understanding of how the lay person perceives risk, companies are at a loss to know how to effectively allay public fears. By way of contrast, in the mining sector (with the exception of uranium mining), the nature of the industry and the effects of a mining accident do not rate high in terms of signal potential. This could well be the explanation for the different results of the beta tests on the two subsamples. In the mining events, stock returns after an accident became less sensitive to general market concerns. This is because the industry is perceived to be subject to greater control when standards - both accounting and regulatory – are increased. When the industry is not perceived to be subject to increasing control, accidents trigger increases in market risk. These increases are muted when the accident occurs in a jurisdiction in which management is free to participate in the development of legislation, the remedies in the case of legal action are clear, and the constitutional rights of societal participants are protected.

Chapter 6

Summary, Conclusions, & Significance of this Study

Two issues have had a major influence on the development of external reporting theory. These are the extension of the stakeholder concept, and the proliferation of corporate responsibilities. Once narrowly defined as shareholders and creditors, stakeholders today are defined to include insurers, suppliers, consumers, industry associations, governments and their agencies, communities, environmental groups, the media and the general public, in addition to investor and lender groups. This change expanded reporting objectives from a singular emphasis on managers' stewardship responsibility for financial assets, to include a range of objectives that acknowledges the broad societal implications of business activity. One need only compare annual reports from the 1960's to those of the 1990's to see how this change has increased both the volume and diversity of information disclosed.

These changes have been driven, at least in part, by growing concern for the externalities associated with environmental degradation. While externalities are not captured in accounting records, there is a concern that with the expanded view of corporate responsibility, they will one day be reflected in the balance sheet. If these items are to be disclosed in financial statements today, however, they must be measured and monetized. This is an area in which economic research has made considerable progress. Using valuation methodologies such as hedonic pricing, travel cost and contingent valuation, dollar values have been assigned to natural resources, and to changes in value arising from business activity. Such values may be used in the development of a national accounting system that takes environmental quality into consideration. At the level of the individual company, however, where the results of techniques such as these could provide input into operating decisions, the research remains proprietary and company specific.

In capital markets parlance, news is considered to be "information" only if it affects share behaviour. Shares are affected by a myriad of factors, some subject to management influence, others not. This thesis assessed the information content of some of these factors in the wake of environmental accidents. Changes in share return and systematic risk were studied in order to understand if, how, and why shares respond to such events. The goal was to provide a foundation of knowledge using Canadian data, upon which future research into disclosure and operating decisions can be based.

This study included 33 events. There were 19 oil spills. Oil spill accidents spanned a 21 year period and accounted for over one third of the data. These spills ranged considerably in terms of magnitude, location, environmental impact and media coverage. There were four mining events. Mining accidents accounted for almost a third of the data. The final group of events included 10 incidents including transportation accidents, and chemical or radioactive discharges.

The null hypothesis of no negative abnormal return was tested for 34 separate portfolios. The hypothesis was rejected for 14 portfolios. However, three problems complicated the interpretation of the statistical results:

1. the presence of statistically significant negative residuals late in the event window;

2. the presence of statistically significant positive residuals inside the event window; and,

3. the presence of statistically significant residuals of either sign outside the event window.

If it is true that capital markets rapidly discount information, news of each accident should be reflected on or close to the day of the accident. In some cases, news of the accident evolved over a period of days. In situations such as these, a protracted market reaction is understandable. It is also possible that a negative overreaction on one day was adjusted by a positive abnormal return the following day. However, the late timing of abnormal returns in many of the portfolios studied here cannot be explained within the context of an efficient market. The frequent occurrence of abnormal returns in the 10-day periods before and after the event window further confounded a consistent interpretation of the results. For this reason, despite the statistical support for an association between the accidents and portfolio returns, the relationship is attributed to chance alone until further compelling evidence is obtained. Further assessment of possible economic impacts of accidents is best pursued using a different methodology.

None of the oil spill events provided evidence to support an association between environmental accidents and beta shifts. When the data were pooled into a time series cross sectional model, the models failed the test for overall significance. Future work with this industry might benefit from including a variable to quantify the magnitude of the spill, and from refining the company size variable to account for the degree of vertical integration.

On the other hand, since oil spills are a relatively common type of environmental accident, their possible environmental consequences are relatively well understood, and the associated cleanup procedures are well developed. It is possible that investors do not associate this kind of accident with the same kind of dread accorded to accidents that are less understood. This suggests that future studies involving events as diverse as the ones included here, should include a variable recording the frequency of the accident.

Two of the mining events provided evidence of an impact on systematic risk across the industry. These were the Inco gas leak in 1995, and the dam failure at Placer Dome's Marcopper mine in 1996. However, this research was designed to test short-term beta impacts only. Given that previous research has found betas to be stable over a five year period, the long term impact on beta remains an as yet unexplored opportunity for future study. The same concern applies to the findings of the Plastimet event in 1997, the third (and last) event study in which an intra-industry beta impact was observed. While the equity beta was the only risk metric included in the research proposal, the results of each of these three event studies suggest that changes in total risk are also worth investigating in future research. However, beta changes are important in and of themselves, because they reflect a change in the stock's non-diversiable risk. To an investor concerned with managing portfolio risk, an increase or decrease in a stock's beta may shift the company's equity into a different investment category. To a manager concerned with attracting institutional investors, beta stability is also a concern.

The null hypotheses for research questions 3 to 8 were designed to identify factors contributing to beta instability. The factors examined included time, industry, company size, exchange listing, the number of people affected, and the location of the accident. The explanatory power of these variables was assessed by combining the results of the individual studies into a pooled time series cross-sectional study. The econometric model was used in four separate applications:

1) on all the event study data combined;
2) on the oil spill event data;
3) on the mining event data; and,
4) on the non-oil spill or mining event data.

The time factor was statistically significant and negative for the mining event data. Tighter standards in pollution control legislation and accounting disclosure requirements have reduced management discretion concerning operating activity, and also the uncertainties management faces in the external business environment. These changes may well have contributed to a reduced relationship between the returns of investment projects with those of the overall market. This is an area where additional work is warranted. Tighter standards, reflected in the time factor, have also reduced investors' perception of the relationship between the returns of the individual stock with those of the overall market.

The time factor was also statistically significant for the non-oil spill or mining event data, however the coefficient was positive. This subsample included the type of events that psychometric analyses associate with high signal potential. In these accidents, the risk assessments of the experts differ considerably from those of the layperson. It is the expert's assessment which is incorporated into regulation, however. This means that despite a growing regulatory environment, the layperson's fears often remain unaddressed. Furthermore, managers themselves find this legislation difficult to interpret, so the uncertainties they face when making decisions are not alleviated when further legislative restrictions are introduced, or threatened. Finally, some high profile American law suits have sharpened the layperson's sensitivity to these accidents. The positive coefficient of the trend variable in the non-oil spill or mining data reflects this growing uncertainty.

The industry factor was significant in the all events sample only. Holding all the other factors constant, beta shifts of companies in the mining sector were downward. There was no evidence, however, using the all events sample or any of the subsamples, of an association of beta shifts with company size, or with the cross-listing factor. Beta shifts were, however, correlated with the number of people affected by an accident, and by its location. These associations were observed using both the mining subsample, and the non-oil spill or mining subsample. For both subsamples, beta increased as the number of people affected rose. This is possibly a reflection of the greater publicity accorded an accident where many people are involved. This variable may also be a proxy for the magnitude of the accident. In any case, accidents in which people are seriously affected are threatened with protracted law suits, loss of business, and therefore higher uncertainty as to future cash flows.

For both subsamples, beta shifts were lower when the accident occurred in North America. If an accident occurs in a jurisdiction in which environmental legislation is sufficiently clear such that compliance can be both accomplished and proven in court, there is a reduction in the likelihood of future law suits and the cash flow uncertainties these create. Furthermore, in an environment where the legislation is clearly defined, where the remedies available to the government are established, and where the rights of litigants are constitutionally defined, an accident triggers less uncertainty on the part of the investment community.

The significance of the six explanatory factors (time, industry, company size, exchange listing, the number of people affected, and the location of the accident) were assessed again, this time in relation to cumulative abnormal returns. Again, the econometric models were applied to the all event sample, and the three subsamples discussed earlier.

Company size was statistically significant using the non-oil spill or mining subsample, in keeping with the view that large companies have a relatively high public profile. The fact that this size factor was only significant in the high signal potential events is not entirely unexpected, as these accidents are the ones most likely to receive attention.

The cross-listing factor was statistically significant in the mining, and the non-oil spill or mining event subsamples. The statistical significance of this factor is explained by the additional attention stocks receive by trading on the US exchanges. The coefficient of the cross-listing factor was negative using the mining event subsample, but positive using the non-oil spill or mining subsample. The higher disclosure standards of the US markets support a tentative conclusion that the additional information provided by the cross-listed companies puts investors in a better position to assess the negative cash flow consequences of the accident. This would explain the negative coefficient using the mining data, but not the positive coefficient using the non-oil spill or mining subsample. On the other hand, the positive coefficient using the non-oil spill or mining data is in keeping with voluntary disclosure theory, whereas the negative coefficient using the mining data is not. While this conflict can possibly be resolved through future research that takes company specific disclosure factors into consideration, and/or the magnitude of proprietary costs, it is also possible that differences in the trading systems of the two countries are confounding the interpretation of this variable.

The final hypothesis explored the association between the location of the accident, and the cumulative abnormal returns. The location factor was statistically significant in an application using the all events sample. The significance of this factor disappeared, however, once the data were split into subsamples. Using the models and variables as defined, there is insufficient information provided to yield insight into how these results may be explained.

The findings of this thesis have implications of significance to academics, business managers, and investors. At the academic level, practitioners of event study methodology are well advised to assess beta stability in light of the possible impact of the event on systematic risk, before assessing the significance of abnormal returns. There is evidence of beta instability in response to some accidents with environmental repercussions. Company managers, for their part, need to be cognizant of the impact of specific factors on beta stability. Some of these factors will be beyond their control, while others will be subject to management influence. For example, if shares of mining companies operating outside North America face an increase in systematic risk should an environmental accident occur, managers wishing to satisfy the institutional segment of the market should direct additional attention to the operating risks of these foreign endeavours. Also, while regulation entails limitations to management discretion, the results of this analysis suggest that reduced flexibility in operating and disclosure decisions is associated, in the mining industry at least, with a reduction in beta. This means that in their lobbyist role, companies seeking to appease the environmentally conscious segment of the market by supporting additional regulation, need not worry that they do so at the expense of the overall investment community. Finally, individual investors and fund managers alike are concerned with beta because it reflects the amount of non-diversifiable risk a single stock adds to their portfolios. Environmental accidents are an ongoing operating risk in many companies. The fact that the direction of a beta shift is dependent upon at least one factor within management control - location - provides the market with new information to incorporate into their analysis of the risk/return trade-off of an investment decision.

The results of this study point to the mining industry as a springboard for additional research into the information content of environmentally related operating and disclosure decisions. The abundance of TSE traded companies in this industry means that finding Canadian data is not a problem. Furthermore, the size of many of these companies means that thin trading does not detract from the usefulness of the data.

Also, the high profile of the mining industry makes these companies a target for activists demanding better performance relating to environmental matters. This suggests the mining sector offers considerable potential for future research into the relationship between disclosure and risk, and between disclosure and market value. Suggestions for future investigation into the factors affecting beta include a refinement of the models used in this study to include a company specific disclosure factor, a specific focus on total risk and/or business risk, an examination of changes (if any) in the explanatory power of an industry index, and the inclusion of a variable representing a measure of publicity. With regard to further investigation into market value fluctuations, a methodology other than the event study approach should be considered.

This study has also provided insight into investor reaction to accidents with high signal potential. The use of Canadian data has, in these events, presented considerable difficulties in terms of company identification and data collection. Future efforts in this area are therefore likely to be more successful using American data. Furthermore, the issue of psychometric profiling is beyond the purview of the finance or accounting practitioner. Future studies with this type of accident are best conducted with an interdisciplinary team.

Appendix A

List of Acronyms

CAR	Cumulative Average Residual
CFMRC	Canadian Financial Markets Research Centre
CICA	Canadian Institute of Chartered Accountants
CSR	Corporate Social Reporting
CVM	Contingent Valuation Method
EPEA	Environmental Protection Expenditure Accounts
ESL	Earth Sanctuaries Ltd.
FASB	Financial Accounting Standards Board
GPI	Genuine Progress Indicator
IRRC	Investors' Responsibility Research Centre
MEFA	Material and Energy Flow Accounts
NRA	Natural Resource Account
OLS	Ordinary Least Squares
OSC	Ontario Securities Commission
PEA	Political Economy Accounting
SEC	Securities Exchange Commission
SEEA	System of Environmental Economic Accounts
SERA	System of Environmental Resource Accounts
SFAS	Statement of Financial Accounting Standards
SNA	System of National Accounts
TCM	Travel Cost Method
VDT	Voluntary Disclosure Theory
WTA	Willingness to Accept
WTP	Willingness to Pay

Appendix B

National Accounting and Non-market Valuations

Statistical offices in numerous countries compiled natural resource stock accounts (NRA's) as early as the mid 70's. However, the real attention to environmental accounting at the national level began with the release of the Brundtland Report, *Our Common Future* (1987), with its call for new measures of national wealth. Conventional GNP, which focuses on "flows" of services from environmental resources rather than the standing asset value of natural resource "stocks" (Goodland and Ledec 1987), encourages the liquidation of natural resources into a measurable economic flow. The Brundtland Commission called for an annual report on environmental quality and capital, to permit assessment of the progress toward *sustainable development,* which generates non-declining per capita national income by replacing or conserving the sources of that income (Statistics Canada 1997). As most nations compile their System of National Accounts (SNA) using the same framework, it was believed that an adapted SNA would provide information that could be quickly integrated into an international decision making framework. For this reason, several international organizations cooperated under the auspices of the United Nations in 1993 to develop SNA93, which provides guidelines for the development of national balance sheet (stock) accounts. SNA93 also includes guidelines for the development of satellite accounts under the heading *System of Environmental Economic Accounts,* or SEEA. The major objectives of the SEEA are:

1. to reorganize the conventional SNA framework to make explicit the expenditures on environmental protection or restoration;

2. to capture economy-environmental linkages by comparing resource use and waste production to economic activity; and,

3. to calculate an environmentally adjusted Net Domestic Product, or conventional NDP adjusted for the depletion and/or degradation of natural resource stocks.

The definition of natural or environmental capital is a contentious issue, and one that profoundly affects policies directed toward sustainable development. Sustainability may be nothing more than a Hicksian definition of income and equivalent to the traditional notion of capital maintenance:

> *We ought to define a man's income (for one week period) as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning* (Hicks, 1946).

In other words, income should be *net* of any draw down of the capital stocks used to generate that income. However there is considerable disagreement as to whether sustainable development means sustaining the productive capacity of natural capital itself, or the productive capacity of the total complement of capital, including *produced* (manmade) capital. If the latter interpretation is accepted, it means one form of capital may be traded off against the other. This practice has been criticized (Daly 1998) for its failure to recognize that some aspects of environmental goods are limiting factors of production. The International Institute of Sustainable Development (1997) believes natural capital must be maintained in and of itself. Gray (1992) suggested a separate accounting treatment for three different types of capital: produced assets, critical non-renewable natural capital (such as the ozone layer), and renewable natural capital (such as timber, or fish). The World Bank (1997) also recognizes three categories of capital: natural capital, produced assets, and human resources. In addition, the World Bank acknowledges that *net financial assets* are important for assessing sustainable development potential, because a country's level of foreign indebtedness is linked to its capacity to invest in different types of capital for the benefit of future generations. One study assesses a value for natural resources only if they are scarce, regardless of their role in maintaining ecosystem integrity (Hecht and Peskin 1993). While economic theory states that value stems from scarcity (Hueting et al. 1998, Daly 1998), this approach to valuing natural resources paradoxically leads to a valuation of the environment based on what has been lost, rather than on what wealth as been created, or is available (Daly 1998).

Statistics Canada's *System of Environmental Resource Accounts* (SERA) aims to expand the analytical capacity of the national accounts through a set of satellite accounts including natural resource stock accounts (NRA), material and energy flow accounts (MEFA), and environmental protection expenditure accounts (EPEA). In that environmental protection expenditures are a cost of maintaining natural capital, the EPEA (in dollars) are split out so that economic activity can be assessed separately. In this regard, SERA's objectives match those of the SEEA. However SERA does not at this time, include modification of the SNA among its objectives, and so retains the flexibility to measure the NRA's in either dollars or physical units.

Despite disagreements over definitions and scope, in 1989 the UN Statistical Division developed a handbook on Integrated Economic and Environmental Accounting, parts of which have been applied in developing countries. Natural resource accounts were introduced in Indonesia in 1989. These accounts, in both physical and monetary terms, were used to develop a "green GDP", and studies concluded that over the years 1971-84, the annual growth rate of the economy, when adjusted for the NRA's, was about four percent lower than that of conventional GDP (Suparmoko 1993). The valuation method consisted of calculating beginning and year end balances of resources at current market prices, with adjustments for additions/deletions throughout the year using the average price. This approach opens the way for wide swings in GDP, however, and is only applicable when market prices are available. A broader perspective of the benefits to be gained from environmental resources was applied in the Philippines in 1991 (Hecht and Peskin 1993), where environmental amenities were viewed not as a distinct resource defined by location and physical feature, but as a set of assets defined by the services provided (Hueting et al. 1998). For example, a lake is a set of assets providing waste disposal, transportation, commercial fishing and recreational services. Valuing the services separately permits the use of a variety of valuation techniques. For example the cost of building a waste treatment facility was used as a proxy for the value of waste disposal services, and the travel cost approach (discussed below) was used to assess recreational services. The use of different techniques facilitates the calculation of separate depreciation schedules. If economic depreciation - the decline in present value of the future income stream associated with the capital – can be assessed, this may help to devise some notion of sustainable income.

While many environmental stocks such as timber and minerals have market prices, others, such as fresh air, or a smog free view, have no such market based price. However, economists have attempted to measure opportunity cost, or what an individual is prepared to give up in order to acquire an amenity (Wildavsky 1994), believing this to be a proxy for the amenity's value.

The term "value" is not the same as "price". Price is determined in part by value, but also by a variety of mechanisms such as cost, and competition. While the price of a market good can be easily observed, this does not mean people would not be willing to pay *more*. Given this distinction between value and price, economic research uses a variety of methods to assess value specifically.

One such approach, based initially on a suggestion by Hotelling in 1947, is the *travel cost* method (TCM), which relates the number of visits to a site to the costs associated with those trips. In its crudest applications, the TCM measures only the direct costs associated with travel, and makes several strict assumptions, the most contentious of which is that time itself has no value. In truth, TC models are sensitive to assumptions concerning time (Bishop and Heberlein 1979, Fletcher et al. 1990). However, it is not clear that one way of integrating time into the models is superior to any other (Fletcher et al. 1990). Also, the divergence between perceptions of site availability, distance, and cost, from actual measures affects the reliability of TC models. Perceptions play a significant role in decision making (Fletcher et al. 1990).

Economists, however, have tended to work with real measures (Fletcher et al. 1990), thus introducing measurement error into the model. Nevertheless, the TCM has been used to estimate the values of environmental amenities such as the Louisiana wetlands (Costanza and Wainger 1991) and fishing opportunities in the Adirondacks (Mullen and Menz 1985).

Clawson and Knetch (1966) said that once a TC model has been devised to estimate demand for a recreational experience, it is simple to adapt it to measure the value of the resource area itself. However, any problems or errors in the recreational experience model will transfer into the resource value model. Nevertheless the TC method has been used extensively to measure demand for national parks in the US (Clawson and Knetch 1966). A simplified version of TC uses tourist expenditures to measure the value of wilderness (The World Bank 1997, Earth Sanctuaries Limited Annual Report 1996). Statistics Canada, however, in its valuation of the NRA, has chosen to avoid non-consumptive use based methods such as travel cost, choosing instead to rely on market based costs, and prices associated with extracting and selling resources (Statistics Canada 1997).

The TCM has been criticized for its focus on use values alone (Freeman 1993). There is a learning process associated with the use of environmental resources (Krutilla 1967) which limits the ability of use measures to capture all facets of value. Economists now recognize a host of value categories which are unrelated to immediate consumption or enjoyment. For example, *option value* is associated with the preservation of environmental resources now for possible future use (Krutilla 1967), and varies directly with the costs of recreating those resources should future decisions call for their restoration (Weisbrod 1964). Arrow and Fisher (1974) showed that uncertainty of costs and benefits leads to a reduction in the expected value of commercial development involving irreversible losses of environmental amenities. *Bequest value*, a related concept, supports the preservation of resources today should future generations discover new uses (Krutilla 1967), such as the medicinal value of some existing plant species, or even the value in leaving ecosystems intact for the potential evolution of new species with such uses (Attfield 1998). These findings argue that an efficient environmental policy, one that maximizes value (including non-use value), will normally involve some restriction on development. Both the World Bank and Statistics Canada acknowledge that non-use values exist. Difficulties associated with their measurement, however, have resulted in their exclusion from national wealth and NRA estimates, and both organizations acknowledge that the omission of non-use values leaves their estimates incomplete (The World Bank 1997, Statistics Canada 1997).

The United Nations' SEEA has, in addition to objectives discussed earlier, the intention to include in its measurements the environmental impacts on human welfare such as changes in health, recreational opportunities, or aesthetics. Such assessments are complicated by the interrelationship of diverse disciplines. For example, an estimation (in dollars) of the impact of air pollution on humans depends upon three functional relationships involving a combination of scientific and behavioural analyses to determine:

1) the rate of discharge into the environment, and a change in environmental quality;

2) a change in environmental quality, and a change in the flows of environmental services such as the loss of a clear view, or a change in health; and,

3) a change in environmental services and a change in utility (Freeman 1993).

Hedonic pricing, as applied to real estate values, is one approach designed to capture the net effect of these relationships.

The hedonic method estimates the implicit prices of characteristics which differentiate closely related products. For example, if the value of a piece of real estate can be viewed as the discounted stream of costs and benefits associated with its attributes, then a change in any of those attributes, such as neighbourhood air quality, should be reflected in a change in price. Complications associated with this method pertain to the quality of the data (Freeman 1993). Imprecision in the parameter estimates arises from the inability to "mix and match" the independent variables, such as house size, and number of rooms (Freeman 1993). Furthermore the stochastic nature of some of the measurements (such as pollution in the example above) creates serious problems with this estimation procedure (Freeman 1993).

The hedonic approach assumes that individuals have complete information about the asset being valued (Freeman 1993). For example in the real estate market it is assumed individuals know the availability of houses for sale. In reality, buyers/sellers of houses accept or reject offers as they are received. The seller sets an asking price without knowing if there are buyers who would pay more, and a buyer makes an offer to purchase, not knowing if the seller would have accepted less. This means it is incorrect to assume the transaction price reflects minimum willingness to accept, or maximum willingness to pay for any of the attributes of the house (Freeman 1993).

The hedonic method was first used to estimate the value of an environmental amenity when Ridker (1967) analyzed the relationship between residential housing prices and air quality in St. Louis. His use of housing values obtained from owners' estimates meant input data may have been unreliable (Freeman 1993). However, the method was used again, this time in Los Angeles, using real market data (Brookshire, Thayer, Schulze and D'Arge 1982).

The advantage of hedonic pricing over other methods (including travel cost) to assign value to natural resources, lies in its ability to capture a wider variety of value categories. For example, if the damage associated with air pollution were limited to corrosion, the damage repair costs could be as low as the cost of an extra coat of paint. A damage function, providing a quantifiable relationship between the level of air pollution and the amount of metal corrosion, would provide sufficient information to derive a monetary assessment. For example, in 1959 the incremental laundering costs associated with air pollution in Pittsburgh were estimated to be $20 per year per person (Estes 1972), and in 1963 the US aggregate costs of respiratory illness alone, measured in terms of hospital costs and lost wages, were two billion dollars (Estes 1972). However, there might also be a loss in utility that goes beyond the cost of a paint job, the laundering and medical expenditures, which would not be reflected in the estimate. For example, the nuisance associated with having to repeat the paint job, or a reduced sense of well-being associated with declining health, would be captured by the hedonic method. Furthermore, hedonic pricing would reflect the value associated with proximity to an environmental amenity such as a national park, whereas the TCM, in its focus on use value, would miss this entirely. Nevertheless the US Department of the Interior, delegated the task of promulgating regulations pertaining to natural resource damage assessments, accepts the use of both methods (Federal Register 59).

A third valuation technique is the *contingent valuation method* (CVM). As opposed to TCM and hedonic pricing, CVM attempts to establish non-market values directly, rather than indirectly. CVM is a survey technique, which asks economic agents about their willingness to pay (WTP) for an increment in environmental quality, or willingness to accept (WTA) a decrement. Over the years this method has attracted considerable attention, and numerous studies have tested for the presence and/or seriousness of biases in the responses. For example, an embedding effect (Cummings, Brookshire, and Schulze 1986, Kahneman and Knetsch 1992) was found to influence the responses. Brookshire, Thayer, Schulze, and D'Arge (1982) tested the relationship between the initial prompt and final bid, or *starting point bias*, and found no significant relationship. Mitchell and Carson (1989), despite their overall defense of the CV technique, found starting point bias to be quite strong. Brookshire, Randall and Stoll (1980) tested for *vehicle bias*, with inconclusive results. Furthermore, a study of air quality in Los Angeles found no evidence of such a bias (Brookshire, Thayer, Schulze and D'Arge 1982). However Greenley, Walsh and Young (1981) found a significant difference in willingness to pay using a sales tax versus a sewer fee as a method of payment. Here the free rider effect highlights the importance of careful survey design, for the non-excludability of public goods can lead to respondents feeling some payment vehicles are inequitable. Bohm (1972) found evidence of *hypothetical bias,* suggesting that respondents may not respond truthfully. Bishop and Heberlein (1979) found willingness to pay in a hypothetical transaction to be significantly less than amounts offered in a real cash transaction. The introduction of repetitive bidding, in an effort to more closely mimic a real market experience, did not result in material changes in the final values (Bishop and Heberlein 1979). However careful handling of extreme bids can reconcile the difference between real and hypothetical cash offers in some studies (Mitchell and Carson 1989).

Other concerns as to the reliability of values obtained using CVM stem from persistent differences between willingness to pay for an increase in quality, and willingness to accept a decrease (Cummings, Brookshire and Schulze 1986). These differences could not be explained by income alone (Brookshire and Coursey 1987, Cummings, Brookshire and Schulze 1986). Evidence of "loss aversion" behaviour (Kahneman and Tversky 1979) has been offered as one explanation, and in controlled experiments where respondents were able to assess their own bids in light of other peoples' bids, these discrepancies were substantially reduced (Brookshire and Coursey 1987).

In a comparison of hedonic pricing and CV methods, Brookshire, Thayer, Schulze and D'Arge (1982) found hedonic values were substantially higher. This is possibly explained by the fact that a CV survey can be designed to elicit use values and non-use values in isolation, while hedonic pricing catches the net sum of all value classifications. This is an important advantage of the CVM. The contingent valuation method has attracted considerable attention from regulatory standard setters following the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980, and the Oil Pollution Act of 1990. Most US Federal and State regulatory agencies responsible for environmental assessments use this technique (Epstein 1996). However, while the US Department of the Interior also accepts the CVM, ongoing concern as to the reliability of non-use value measurements has meant their estimation is attempted only where use values cannot be obtained (Federal Register 59). Furthermore, in view of the limitations of human knowledge as to potential or future uses, the likelihood of any willingness to pay assessment capturing true, total, non-use value is questionable (Attfield 1998).

Another valuation method involves estimating the shadow price for an environmental amenity (Costanza et al. 1997). Items with positive shadow prices are often valued using market values as a proxy (Ayres 1998). For example, natural processes are estimated to provide 70 percent of the fixed nitrogen and about 60 percent of the phosphorus for US agriculture. Based on 1993 farmers' expenditures on fertilizer, these services have been valued at 30 billion in 1993 dollars (Ayres 1998). Where shadow prices are negative, such as occurs when the released volume of nutrients exceeds the assimilative capacity of the planet, the *cost of control* has been suggested as a suitable proxy for shadow price (Ayres 1998). This method is inappropriate for environmental impacts which cannot be controlled, however. Furthermore, environmental impacts are site specific. For example, acid rain damage to a cornfield differs from its affect on a city. The cost of control approach ignores this.

Just as accounting theory has been accused of incorporating assumptions, for example, as to the relative importance of certain groups in society, economic theory also incorporates value laden assumptions (Goodland and Ledec 1987). For example, when the social costs and benefits associated with a development proposal are estimated, the discount rate employed reflects judgments as to the relative value of inter-temporal concerns. The discount rates are high, often equal to those applied to cash flows as discussed in chapter 2. This has the effect of attributing greater recognition to current day economic agents than to future generations.

The accounting profession is concerned with a loss of objectivity (Cooper 1980). Arguments against the mixing of market with non-market valuations in financial statements claim that additional disclosures will befuddle and confuse the investor (Gonedes 1976, CICA 1997, Willis 1997). On the other hand, in an efficient market, where at least the majority of buy/sell decisions are made by sophisticated investors (Scott 1997), a paternalistic attitude such as this is unwarranted, and is more likely to result in the protection of management than the investor (Gonedes 1976). This attitude possibly accounts for efforts to record environmental impacts at the company level being few and far between.

Appendix C

Summary of Null Hypotheses

There were 14 research questions, each associated with a null hypothesis. These hypotheses are reviewed below.

RQ1: *There is no negative intra-industry abnormal return in response to environmental incidents among Canadian companies listed on the Toronto Stock Exchange.*

RQ2: *There is no change in a stock's beta associated with environmental incidents.*

RQ3: *There is no time dependent change in a stock's beta associated with an environmental incident.*

RQ4: *There is no industry dependent change in a stock's beta associated with an environmental incident.*

RQ5: *There is no size dependent change in a stock's beta associated with an environmental incident.*

RQ6: *A stock's beta stability in the event of an environmental incident is not associated with whether or not the stock is cross-listed on a major US exchange.*

RQ7: *A stock's beta stability in the event of an environmental incident is not associated with the number of people directly affected.*

RQ8: *A stock's beta stability in the event of an environmental incident does not depend on whether or not the incident occurred in North America.*

Appendix C

Summary of Null Hypotheses continued

RQ9: *There is no time dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

RQ10: *There is no industry dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

RQ11: *There is no size dependent factor associated with a company's cumulative abnormal returns following an environmental incident.*

RQ12: *There is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the stock is cross-listed on a major US exchange.*

RQ13: *There is no association between a company's cumulative abnormal returns following an environmental incident, and the number of people directly affected by the incident.*

RQ14: *There is no association between a company's cumulative abnormal returns following an environmental incident, and whether or not the incident occurred in North America.*

Appendix D

List of events – chronological order

Information below was obtained from newspapers such as the Globe & Mail, Toronto Star, Halifax Chronicle Herald, Montreal Gazette, Calgary Herald, Vancouver Sun, Washington Post.

#1-Urquoila (May 1976) Industry index unavailable

The tanker Urquoila, carrying over 100,000 tonnes of crude oil from the Persian Gulf to La Coruna harbour in Spain, was swept by fire and explosion after hitting the rocks during its entry into the harbour on May 12, 1976. It spilled 28 million gallons of oil, threatening the shellfish industry and other sea life.

#2-Amoco Cadiz (March 1978) Industry: Oil & Gas

The tanker Amoco Cadiz lost 223,000 gallons in the English Channel off the coast of France.

#3-Kurdistan (March 1979) Industry: Oil & Gas

The British oil tanker, on route to Sept Isles Quebec, split into two, spilling 2.3 million gallons of bunker oil into Cabot Strait.

#4-Three Mile Island (March 1979) Industry: Gold & Silver

A malfunctioning valve in a nuclear power plant in Pennsylvania released radioactive water into the Susquehanna River. Plans were made to evacuate 300,000 people from a 25-mile radius around the plant, in case technical difficulties suggested the situation would worsen. Widespread fears raised the issue that nuclear reactors were not safe.

Appendix D

List of events – chronological order

#5 -Mississauga Train Derailment (November 1979) Industry: Transportation

Twenty-four cars in a CP train derailed while passing through Mississauga, Ontario. Fear of a chlorine gas leak, and explosions of propane tanks, led to the evacuation of 250,000 people from the area. The provincial transportation minister called existing regulation concerning the transportation of hazardous waste ineffective, and called for renewed legislation. Repercussions in the industry reached the United Kingdom, where a British Rail spokesman said they would escalate new directives banning freight trains from carrying both toxic chemicals and inflammables together.

#6-Star Luzon (January 1983) Industry: Oil & Gas

A Philippine registered freighter docked in North Vancouver, leaking bunker oil from a hole it its fuel tank. Between 1,575 and 3,150 gallons of oil leaked into the harbour in what was reported as the worst Vancouver spill since 1973. Reports claim that 200 sea birds died as a result of the spill. Sailboat owners were also affect, as there were 40-50 boats in need of cleaning.

#7-Castillo de Bellver (August 1983) Industry: Oil & Gas

Supper tanker Castillo de Bellver, carrying 64 million gallons of crude oil, broke in two off the coast of South Africa.

#8-Bhopal (December 1984) Industry: Industrial Products

Methyl isocyanate gas escaped from an underground tank at a US owned Union Carbide pesticide plant in Bhopal, India. The gas spread over a 65 km square area in central India with a population of 700,000. Residents up to 10 km from the factory woke up with violent choking and vomiting. Approximately 2,000 people died. Decomposing human and animal corpses triggered fears of a disease epidemic. Local authorities closed the plant, and the Prime Minister of India said the government would review its policy on the location of factories manufacturing potentially hazardous products. Union Carbide closed a similar plant located in Virginia as a precaution.

Appendix D

List of events – chronological order

#9-Pointe Levy ***(December 1985)*** Industry: Oil & Gas

An Ultramar Canada Ltd. barge ran aground near Matane harbour, 300 km east of Quebec City, while being towed from Montreal to Bathurst N.S. It spilled 32,000 gallons of bunker oil into the Gulf of the St. Lawrence before the leaks were stopped. Ecologists said they would not know the extent of the damage until the next salmon spawning season.

#10-ARCO ***(December 1985)*** Industry: Oil & Gas

The tanker ARCO Anchorage ran aground in Port Angeles harbour spilling 837,000 gallons of crude oil near Dungeness National Wildlife refuge. Port Angeles is a wintering station for waterfowl. Winds and tidal waves kept most of the oil contained in the harbour.

#11-Imperial Oil Railcar ***(March 1986)*** Industry: Oil & Gas

A railway car in an Esso Petroleum storage yard leaked 2,000 gallons of gasoline into the sewers in Timmins, Ontario. Two homes were destroyed, 19 others were damaged by explosions and fires, and 5,000 people had to evacuate the affected area. This case was notable as it became the first to face a new Ontario law making the polluter liable for damage caused by a spill.

#12-Chernobyl ***(April 1986)*** Industry: Gold & Silver

An accident at a Soviet nuclear plant resulted in radiation leaks that spread over Sweden, Finland, Denmark, Norway, and western Europe. Scientists in Europe predicted that up to 10,000 lung cancer deaths could occur within a 500 km radius of the immediately affected area over the next 10 years. In the US, stock prices of utilities fell sharply, especially for companies with incomplete or unlicensed reactors.

Appendix D

List of events – chronological order

#13-Shell Oil Storage tank leak *(April 1988)* Industry: Oil & Gas

The drainpipe on a Shell Oil storage tank in Martinez California ruptured, spilling 416,000 gallons of oil near a wildlife marsh. The company incurred total costs of $19.75 million US including the cost of cleanup, penalties, and restitution to the affected communities.

#14-Ultramar tanker spill *(May 1988)* Industry: Oil & Gas

An oil tanker struck a pier at an Ultramar refinery near Quebec City, spilling 644,000 gallons of crude near a bird sanctuary.

#15-St. Basile le Grand *(August 1988)* Industry: Industrial Products

Fire in a warehouse containing 90,000 litres of oil contaminated with polychlorinated biphenyls resulted in the evacuation of 3,000 people from their homes, and created widespread fear that skin, eye, gall bladder, liver or kidney disorders would surface in the coming weeks. An embargo was placed on meat and produce grown within 1500 acres of the evacuation area.

#16-Nestucca *(December 1988)* Industry: Oil & Gas

A barge, the Nestucca, collided with a US barge off the coast of Vancouver Island, leaking 220,000 gallons of fuel.

#17-Exxon Valdez *(March 1989)* Industry: Oil & Gas

The Exxon Oil tanker Valdez struck rock near Prince William Sound, spilling 11 million gallons of crude oil near a tourist area, with a salmon industry valued at $84 million dollars a year. The cleanup bill for this accident was $1.2 billion, only a third of which was covered by insurance. In 1994, a civil litigation jury ordered Exxon to pay $287 million in compensation to commercial salmon and herring fisherman. Damages of $5 billion were also assessed. The captain of the ship was also fined.

Appendix D

List of events – chronological order

#18-Nova Scotia tanker ***(June 1989)*** Industry: Oil & Gas

A barge spilled 155,000 gallons of oil while pumping fuel oil into a tanker in the Bay of Fundy. The spill happened near several salmon farms.

#19-4 oil spills ***(June 1989)*** Industry: Oil & Gas

On Friday, June 23, 1989, a Greek tanker carrying 7.2 million gallons of heating oil hit the rocks at Newport Island, spilling 350,000 gallons of oil near a vital spawning ground for fish and crustaceans. Rhode Island shellfish beds, an important part of the state economy, were immediately closed. Over the weekend of June 24/5, a Uruguayan tanker spilled 1.6 million gallons of heavy heating oil into Delaware Bay near Philadelphia, fouling beaches in three states. Over that same weekend, a barge collision resulted in a 966,000 gallon oil spill into Galveston Bay, Texas. Finally, on the same weekend, at the Irving Oil refinery, 37,000 gallons of crude oil were spilled onto the ground and about 100,000 into Little River in East Saint John.

Day 0 for all four of these events was Monday June 26, 1989.

#20-Rabbit Lake Mine Leak ***(November 1989)*** Industry: Metals & Minerals

A leak of 2 million litres of contaminated water at the Cameco Rabbit Lake Mine continued for over 14 hours.

#21-American Trader ***(February 1990)*** Industry: Oil & Gas

A tanker owned and operated by American Trading Transportation Co. of New York ruptured itself with its own anchor, spilling 275,000 gallons of Alaskan crude, threatening beaches and estuaries. As a result, protesters escalated efforts to prevent tankers from navigating the Strait of Juan de Fuca.

Appendix D

List of events – chronological order

#22-Hagarsville Tire Fire ***(February 1990)*** Industry: Industrial Products

Fire among 13 million tires at Tyre King Recycling triggered an initial evacuation order covering a 3 km radius. About 2,000 people left to escape airborne toxins such as benzene, toluene, and other chemicals that posed a threat to kidney, liver, and respiratory function. Shifting winds resulted in the evacuation zone being expanded to cover a 10 km radius.

#23-Algoma Central ***(April 1990)*** Industry: Transportation

A train owned by Algoma Central Railway derailed, spilling 2,000 gallons of fuel into Achigan Creek, north of Sault Ste. Marie.

#24-Eastern Shell ***(May 1991)*** Industry: Transportation

The tanker Eastern Shell owned by Soconav Inc. of Montreal, carrying fuel from Shell's Sarnia refinery, ran aground, spilling 240,000 gallons of diesel fuel and gasoline into Georgian Bay. Greenpeace spokespersons renewed urgings to the government to pass legislation that would prevent oil spills.

#25-Southern Pacific ***(July 1991)*** Industry: Transportation

A Southern Pacific Train derailed in California, spilling 19,000 gallons of the weed killer metam-sodium, into the Sacramento River, in what was then known as the state's worst inland disaster. The spill triggered a ban on drinking water, and fishing was banned indefinitely. Highways and campgrounds were closed. Three thousand people were asked to evacuate their homes, and about 300 were treated for skin and eye irritation. A congressional representative said she would push the federal government to adopt special rules pertaining to the transportation of pesticide.

Appendix D

List of events – chronological order

#26-Aegean Sea ***(December 1992)*** Industry: Oil & Gas

A tanker carrying 90 million litres of crude oil to a refinery in La Corunna, struck rock off the coast of Spain, spilling 22 million gallons. Over 100 km of coastline was affected by the slick, threatening sea life and the shellfish industry.

#27-Braer ***(January 1993)*** Industry: Oil & Gas

The tanker Braer, transporting oil from Norway to an Ultramar refinery in Quebec, ran aground off the coast of Scotland, spilling 26 million gallons of crude near an internationally famous seabird colony and nature reserve. On the day the accident occurred, Ultramar claimed it was suing the operators of the ship to ensure they took action to limit the impact on the Scottish environment. The opposition party and lobby groups renewed calls for the mandatory use of double hulled vessels.

#28-Sydney Steel PCB fire ***(May 1994)*** Industry: Industrial Products

Fire in a Sydney Steel electrical substation vapourized 180 litres of PCB laden liquid from three transformers. The fire triggered an evacuation of local residents.

#29- Omai dam failure ***(August 1995)*** Industry index: Gold & Silver

A tailings dam failure at a mine owned by Cambior in Guyana spilled 3.2 billion litres of water contaminated with cyanide and copper sludge into a large river system. The government declared a state of emergency. The mine was closed for five months. A lobby group, *Recerches Internationales Quebec,* filed a class action law suit against the company. In the ensuing months, this group started a letter writing campaign directed at financial institutions in both Canada and the US, discouraging the banks from providing capital to Cambior.

Appendix D

List of events – chronological order

#30-Inco Gas Leak *(November 1995)* Industry: Metals & Minerals

Equipment failure at Inco's Copper Clif smelter in Sudbury triggered a leak of sulphur dioxide. About 100 people went to hospital, and fumes affected staff and patients already in hospital.

#31-Sea Empress *(February 1996)* Industry: Oil & Gas

The tanker Sea Empress carrying crude from the North Sea oil fields to a Texaco refinery ran aground off the coast of Wales, spilling 1.9 million gallons. An environmental emergency was declared.

#32-Marcropper dam failure *(March 1996)* Industry: Gold & Silver

A tailings dam failure at a mine owned by Placer Dome in the Philippines spilled 4 million tons of tailings into the Boac River. The Philippine government revoked the Environmental Certificate of Compliance and operations at the mine were suspended.

#33-Plastimet PCB fire *(July 1997)* Industry: Industrial Products

Fire at a scrap recycling plant operated by Plastimet Inc. triggered an official state of emergency, and the evacuation of 4000 people.

Appendix E

Summary statistics of independent variables used in pooled time series cross-sectional analysis

(Total number of observations was 379. Four are missing as there was incomplete data to calculate Market Value)

Variable Name	No.	Minimum value	Maximum value	Mean value	Standard Deviation
Market value (LogMV)	375	14.617	23.454	19.717	2.05
Location of Incident (NorAmer)	375	0	1	NA	NA
Industry: Mining (M)	375	0	1	NA	NA
Industry: Oil & Gas (OG)	375	0	1	NA	NA
No. of People Affected (People)	375	0	300,000	6,989	40,810
Cross-listing variable (XL)	375	0	1	NA	NA
Time of Incident (Time)	375	5	253	172.36	64.26

CORRELATION MATRIX OF VARIABLES - 375 OBSERVATIONS

LogMV	1.000						
NorAmer	0.352×10^{-1}	1.000					
Mining	-0.155	-0.407	1.000				
OilGas	0.168	0.130	-0.667	1.000			
People	-0.129	0.114	0.917×10^{-1}	-0.139	1.000		
XL	0.480	-0.988×10^{-1}	-0.240×10^{-1}	0.200	-0.172×10^{-1}	1.000	
Time	0.678×10^{-1}	-0.229	0.447	-0.474	-0.314	-0.495×10^{-1}	1.000
	LogMV	*NorAmer*	*Mining*	*OilGas*	*People*	*XL*	*Time*

Appendix F

Distribution of Event-Companies

Industry	*No. of event-companies in industry*	*No of event-companies cross-listed on AMEX, NYSE or NASDAQ*
Oil & Gas	171	91
Mining	132	55
Other	76	15
Total	379	161

Distribution of Events

Industry	*No.*	*No. events in North America*	*No. events in which people are affected*
Oil & Gas	19	13	1
Mining	4	2	1
Other	10	8	10
Total	33	23	12

Appendix G

Standard Deviation, Coefficient of Variation & Covariance For selected Event-companies

Event:	**Inco gas leak**						
		Day -200 to Day -1			*Day 1 to Day 200*		
Company name	*Beta shift*	*Std dev*	*CV_i*	*Cov_{iM}*	*Std dev*	*CV_i*	*Cov_{iM}*
Alcan	Down	0.016	12.92	0.247×10^{-4}	0.014	59.94	0.203×10^{-4}
Cominco	Down	0.014	11.42	0.264×10^{-4}	0.012	18.32	0.194×10^{-4}
Inmet Mining	Down	0.022	-46.59	-0.269×10^{-4}	0.017	-58.12	-0.133×10^{-4}
Inco	Down	0.018	14.42	0.190×10^{-4}	0.016	-115.7	-0.197×10^{-4}
Noranda	Down	0.013	14.64	0.252×10^{-4}	0.012	23.6	0.181×10^{-4}
Westmin Mining	Down	0.028	10.51	0.423×10^{-4}	0.021	43.22	0.336×10^{-4}

Event:	**Marcopper dam failure**						
		Day -200 to Day -1			*Day 1 to Day 200*		
Company name	*Beta shift*	*Std dev*	*CV_i*	*Cov_{iM}*	*Std dev*	*CV_i*	*Cov_{iM}*
Aber Resources	Down	0.031	8.60	0.500×10^{-4}	0.029	14.52	0.599×10^{-4}
Agnico-Eagle	Down	0.029	10.07	0.270×10^{-4}	0.022	-14.47	-0.264×10^{-5}
Aur	Down	0.030	6.66	0.611×10^{-4}	0.021	-17.03	-0.176×10^{-4}
Barrick	Down	0.020	14.77	0.242×10^{-4}	0.018	-29.10	-0.101×10^{-4}
Bema Gold	No change	0.029	9.05	0.406×10^{-4}	0.024	16.07	0.143×10^{-4}
Breakwater Resources	Down	0.034	67.86	0.413×10^{-4}	0.033	117.65	0.292×10^{-4}
Caledonia	No change	0.033	-80.44	0.184×10^{-4}	0.045	187.31	0.145×10^{-4}
Cambior	Down	0.025	22.28	0.461×10^{-4}	0.018	307.45	0.415×10^{-4}
Cameco	Down	0.016	5.65	0.367×10^{-4}	0.011	-10.14	0.192×10^{-4}
Cominco	Down	0.015	9.73	0.326×10^{-4}	0.014	22.60	0.204×10^{-4}
Cusac Gold	No change	0.044	-39.68	0.240×10^{-4}	0.053	-82.25	0.135×10^{-5}
Pegasus	Down	0.025	12.18	0.346×10^{-4}	0.022	-5.96	0.578
Princeton Mining	Down	0.046	-83.39	0.465×10^{-4}	0.043	55.18	0.255
Prime Resources	Down	0.026	12.12	0.342	0.023	-14.71	-0.769×10^{-4}
Pioneer Metals	No change	0.083	12.61	0.460×10^{-4}	0.068	-1524.51	0.302×10^{-4}

Appendix G continued

Standard Deviation, Coefficient of Variation & Covariance
For selected Event-companies

Event:	Plastimet						
		Day -200 to Day -1			*Day 1 to Day 200*		
Company name	*Beta shift*	*Std dev*	CV_i	Cov_{iM}	*Std dev*	CV_i	Cov_{iM}
AT Plastics	Up	0.016	-179.51	0.309×10^{-4}	0.023	-43.19	0.394×10^{-4}
Bovar	No change	0.047	-51.49	0.101×10^{-3}	0.057	28.04	0.830×10^{-4}
Celanese	Up	0.015	-45.33	0.973×10^{-5}	0.016	20.51	0.336×10^{-4}
Dupont	No change	0.016	19.19	-0.253×10^{-4}	0.012	10.78	0.113×10^{-4}
Harrowston	Up	0.032	13.47	0.272×10^{-4}	0.033	24.69	0.566×10^{-4}
Imperial Oil	Up	0.010	7.62	-0.183×10^{-4}	0.014	6.67	0.478×10^{-4}
Laidlaw	Up	0.014	9.77	0.476×10^{-4}	0.019	66.79	0.883×10^{-4}
Newalta	Up	0.023	8.66	-0.184×10^{-4}	0.023	24.51	0.579×10^{-4}
Petro Canada	Up	0.015	8.37	0.513×10^{-4}	0.021	23.39	0.968×10^{-4}
Pillips	Up	0.029	9.36	0.370×10^{-4}	0.028	65.82	0.110×10^{-3}
Royal	Up	0.016	6.65	-0.322×10^{-5}	0.020	-242.14	0.627×10^{-4}
Shell	Up	0.013	7.08	0.145×10^{-4}	0.020	10.04	0.477×10^{-4}
Suncor	Up	0.014	6.39	0.152×10^{-4}	0.025	9.43	0.775×10^{-4}

Appendix H – Table I

Econometric models – All Event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from all 33 environmental events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

Each model was tested for heteroscedasticity with the SHAZAM HetCov command. There were no substantial changes in any of the t-values.

Probability plots indicated minor departures from normality in the tails. Symmetry of distributions was assessed and found to be acceptable. Based on these results, residuals distributions were considered to be normal. Unless otherwise indicated, each model was found to be homoscedastic and free from autocorrelation.

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
5-day CAR	0.018	-0.001	-0.011	-0.239×10^{-6}	0.018	-0.006	-0.014	-0.000
(T-value)	(0.441)	(-0.257)	(-1.461)	(-2.501)	(2.422)	(-0.569)	(-1.293)	(-0.800)

N = 322 Significance test: F = 3.681 Adjusted R^2 = .055

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
7-day CAR	0.065	-0.003	-0.012	-0.266×10^{-6}	0.019	-0.002	-0.011	-0.000
(T-value)	(1.490)	(-1.521)	(-1.446)	(-2.631)	(2.366)	(-0.195)	(-0.941)	(-0.269)

N = 310 Significance test: F = 3.646 Adjusted R^2 = 0.057

7-day CAR model failed Geary test

Appendix H – Table I continued

Econometric models – All Event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from all 33 environmental events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

Each model was tested for heteroscedasticity with the *SHAZAM* HetCov command. There were no substantial changes in any of the t-values.

Probability plots indicated minor departures from normality in the tails. Symmetry of distributions was assessed and found to be acceptable. Based on these results, residuals distributions were considered to be normal. Unless otherwise indicated, each model was found to be homoscedastic and free from autocorrelation.

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
10-day CAR	0.045	-0.002	-0.007	-0.339×10^{-6}	0.023	-0.009	-0.013	-0.000
(T-value)	(0.816)	(-0.804)	(-0.652)	(-2.759)	(2.305)	(-0.610)	(-0.912)	(-0.606)

N = 299 Significance test: F = 2.779 Adjusted R^2 = .040

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
Chgbeta	-0.231	-0.001	-0.020	0.128×10^{-5}	0.141	-0.008	-0.555	0.001
(T-value)	(-0.585)	(-0.058)	(-0.240)	(1.345)	(1.779)	(-0.078)	(-5.034)	(1.397)

N = 374 Significance test: F = 9.130 Adjusted R^2 = 0.132

Appendix H – Table II

Econometric models – Oil spill event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from the 19 oil spill events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

None of the models using oil spills data alone were statistically significant

Appendix H – Table III

Econometric models – Mining event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from the four mining events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

Each model was tested for heteroscedasticity with the SHAZAM HetCov command. There were no substantial changes in any of the t-values.

Probability plots indicated minor departures from normality in the tails. Symmetry of distributions was assessed and found to be acceptable. Based on these results, residuals distributions were considered to be normal. Unless otherwise indicated, each model was found to be homoscedastic and free from autocorrelation.

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_7
7-day CAR	0.158	-0.004	-.004	0.000	0.045	0.000
(T-value)	(0.027)	(-0.967)	(-2.498)	(0.139)	(0.259)	(0.103)

N = 106 Significance test: F = 3.809 Adjusted R^2 = 0.118

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_7
Chgbeta	33.752	0.010	-0.052	0.080	-10.110	-1.144
(T-value)	(7.473)	(0.282)	(-0.432)	(7.000)	(-7.420)	(-7.687)

N = 121 Significance test: F = 14.58 Adjusted R^2 = 0.361

Appendix H – Table IV

Econometric models – Non-oil spill or mining event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from the four mining events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

Each model was tested for heteroscedasticity with the SHAZAM HetCov command. There were no substantial changes in any of the t-values.

Probability plots indicated minor departures from normality in the tails. Symmetry of distributions was assessed and found to be acceptable. Based on these results, residuals distributions were considered to be normal. Unless otherwise indicated, each model was found to be homoscedastic and free from autocorrelation.

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
5-day CAR	0.124	-0.006	0.025	-0.297×10^{-6}	0.022	-0.006	-0.031	-0.000
(T-value)	(2.599)	(-2.555)	(2.313)	(-2.249)	(1.244)	(-0.536)	(-1.246)	(-0.898)

N = 85 Significance test: F = 4.216 Adjusted R^2 0.211

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
7-day CAR	0.213	-0.011	0.023	-0.509×10^{-6}	0.037	0.019	0.009	-0.000
(T-value)	(3.177)	(-3.404)	(1.589)	(-2.807)	(1.521)	(1.259)	0.273	(-0.815)

N = 82 Significance test: F = 3.627 Adjusted R^2 0.185

Appendix H – Table IV continued

Econometric models – Non-oil spill or mining event data

These tables report the parameter estimates obtained using ordinary least squares for models that included data from the four mining events listed in Appendix D. Models for 3-day, 5-day, 7-day and 10-day CARs were estimated using a full data set (max 451 observations) and using the equal weighted market index. Chgbeta is the incremental beta measured at Day 0, using a full data set (max 451 observations) and using the equal weighted market index. Those models that failed the F-test for overall regression significance have been excluded from the table.

Each model was tested for heteroscedasticity with the SHAZAM HetCov command. There were no substantial changes in any of the t-values.

Probability plots indicated minor departures from normality in the tails. Symmetry of distributions was assessed and found to be acceptable. Based on these results, residuals distributions were considered to be normal. Unless otherwise indicated, each model was found to be homoscedastic and free from autocorrelation.

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7
10-day CAR	0.238	-0.012	0.035	-0.480×10^{-6}	0.037	-0.004	-0.034	-0.000
(T-value)	(3.054)	(-3.176)	(2.074)	(-2.286)	(1.317)	(-0.237)	(-0.866)	(-0.957)

N = 80 Significance test: F = 3.789 Adjusted R^2 = 0.198

Dependent variable	*Constant*	*Company Size*	*Listing factor*	*People Affected*	*Location*	*Oil industry*	*Mining Industy*	*Time*
Chgbeta	-0.410	-0.024	0.034	0.326×10^{-5}	-0.581	-0.094	0.045	0.008
(T-value)	(-0.872)	(-1.060)	(0.265)	(2.471)	(-2.920)	(-0.770)	(0.179)	(5.031)

N = 109 Significance test: F = 4.108 Adjusted R^2 = 0.167

References

Anderson, S. 1998. *Unlimited Liability and Market Efficiency: Theory and Evidence from the Canadian Securities Markets*. Ph.D. Dissertation. York University.

Arrow, K. and A. Fisher. 1974. "Environmental Preservation, Uncertainty, and Irreversibility." *Quarterly Journal of Economics* 78:312-319.

Attfield, R. 1998. "Existence Value and Intrinsic Value." *Ecological Economics* 24:163-168.

Ayres, R. 1998. "The price-value paradox." *Ecological Economics* 25(1):17-19.

Ball, R., and P. Brown. 1968. "An Empirical Evaluation of Accounting Income Numbers." *Journal of Accounting Research* Autumn:159-178.

Barbash, F. 1996. "Grounded oil tanker freed." *Toronto Star*. Thursday February 22:A20.

Beams F. and P. Fertig. 1971. "Pollution Control Through Social Cost Conversion." *The Journal of Accountancy* (November):35-42.

Beaver, W. H. 1973. "What should be the FASB's objectives?" *The Journal of Accountancy* (August):49-56.

Beresford, D. "Financial Reporting: Comparability and Competition" (address at the Stern School of Business Administration, New York University, New York, October 1990) cited in Viper 1994.

Bernard, V. 1987. "Cross-sectional Dependence and Problems in Inference in Market Based Accounting Research." *Journal of Accounting Research* 25(1):1-48.

Bewley, K. 1998. *The Economic Consequences of Financial Reporting Standards: The Market Valuation of Environmental Liabilities*. Ph.D. Dissertation. The University of Waterloo.

Bewley, K. and Y. Li. 1998. "Disclosure of Environmental Information by Canadian Manufacturing Companies: A Voluntary Disclosure Perspective." Working paper.

Birnberg, F. 1980. "The Role of Accounting in Financial Disclosure." *Accounting, Organizations and Society* 5(1):71-80.

Bishop R., and T. Heberlein 1979. "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics* (December):926-930.

Blacconiere, W. and D. Patten. 1994. "Environmental disclosures, regulatory costs, and changes in firm value." *Journal of Accounting and Economics* 18:357-377.

Block, I. 1998. "PCB toxins finally cleared from Ste Basile fire site." *Finanacial Post*. Saturday, December 5:A10.

Blunn, R. 1992. "Content of Reports Growing." *Financial Post*. October 19: s31.

Bohm, P. 1972. "Estimated Demand for Public Goods: An Experiment." *European Economic Review* 3:111-130.

References

Bowen, R., R. Costanias and L. Daley. 1983. "Intra-Industry Effects of the Accident at Three Mile Island." *Journal of Financial and Quantitative Analysis* 18(1):87-111.

Bradford, M. 1990. "PCB cleanups lag as deadline nears." *Business Insurance* (March 19):3-36.

Brealey, R., S. Myers, G. Sick and R. Whaley. 1986. *Principles of Corporate Finance – First Canadian Edition.* McGraw-Hill Ryerson.

Brigham, E., and R. Crum. 1977. "On the Use of the CAPM in Public Utility Rate Cases." *Financial Management* 6:7-15.

Brookshire, D., A. Randall and J. Stoll. 1980. "Valuing Increments and Decrements in Natural Resource Service Flows." *American Journal of Agricultural Economics* 62(3):478-488.

Brookshire, D., and D. Coursey. 1987. "Measuring the Value of a Public Good: An Empirical Comparison of Elicitation Procedures" *American Economic Review* 77:554-566.

Brookshire, D., M. Thayer, W. Schulze, and R. D'Arge 1982. "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches." *American Economic Review* 72(1):165-177.

Brown, S. and J. Warner. 1980. "Measuring Security Price Performance." *Journal of Financial Economics* 8:205-258.

Brown, S. and J. Warner. 1985. "Using Daily Stock Returns: the Case of Event Studies." *Journal of Financial Economics* 13:3-32.

BSO/Origin Annual Reports for the years 1990 - 1994 inclusive.

Buhr, N. 1991. "The Environmental Audit: Who Needs It?" *Business Quarterly*. University of Western Ontario. (Winter).

Buhr, N. 1994. *Environmental Disclosures: An Empirical Study of Corporate Communication in Canada and the Role of Accounting.* Ph.D. Dissertation. University of Western Ontario.

Buzby, S. and H. Falk. 1978. "A Survey of the Interest in Social Responsibility Information by Mutual Funds." *Accounting, Organizations and Society.* 3(3/4):191-201.

Byrd, C., and I. Chen. 1997. *Financial Reporting in Canada.* 22nd edition. CICA Toronto.

Canadian Institute of Chartered Accountants 1993. *Environmental Costs and Liabilities: Accounting and Financial Reporting Issues.* Toronto.

Canadian Institute of Chartered Accountants 1997. *Full Cost Accounting from an Environmental Perspective.* Toronto.

Canadian Institute of Chartered Accountants 1997. Handbook.

Clawson, M., and J. Knetsch. 1966. *Economics of Outdoor Recreation.* Resources for the Future Inc. Baltimore.

References

Cobb, C. T. Halstead, and R. Rowe. 1994. *The Genuine Progress Indicator*. Redefining Progress. California.

Collins, D., M. Rozeff, and D. Dhaliwal. 1981. "The Economic Determinants of the Market Reaction to Proposed Mandatory Accounting Changes in the Oil and Gas Industry." *Journal of Accounting and Economics* 3:37-71.

Commissioner of the Environment and Sustainable Development. 1997. *Report of the Commissioner of Environment and Sustainable Development to the House of Commons.* Ottawa.

Cormier, D., M. Magnan and B. Morard. 1993. The impact of corporate pollution on market valuation: some empirical evidence." *Ecological Economics* 8:135-155.

Cooper, D. 1980. "Discussion of Towards a Political Economy of Accounting." *Accounting, Organizations and Society* 5:161-166.

Cooper, D. and M. Sherer. 1984. "The Value of Corporate Accounting Reports: Arguments for a Political Economy of Accounting." *Accounting, Organizations and Society* 9(3):207-232.

Costanza, R., and L. Wainger 1991. "Ecological Economics" *Business Economics* (October):45-48.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Brasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, P. Sutton, and M. van den Belt. 1997. "The value of the world's ecosystem services and natural capital." *Nature* Macmillan Magazines Ltd. London (May 15):253-260.

Cummings, R. G., D. S. Brookshire, and W. Schulze 1986. *Valuing Environmental Resources: An Assessment of the Contingent Valuation Method.* Rowman & Allanheld. New Jersey.

Curran, P, and E. Kalbfuss, "3000 kept from their homes a second night," *Montreal Gazette,* Thurs. Aug. 25: A1.

D'Agostino, R. 1986. Graphical analysis, in D'Agostino, R. and M. Stephens eds. *Goodness-of-fit-Techniques*. Marcel Dekker Inc., New York:7-62.

Daly, H. 1998. "The return of Lauderdale's paradox." *Ecological Economics* 25(1):21- 23.

Damsell, K. 1991. "Georgian Bay oil spill evaporates." *Globe and Mail.* Monday May 13: A3.

Davis, V. and K Frizzell. 1996. "Standard Progress." *CA Magazine* (June/July):34 - 35.

Davidson, R. and J. MacKinnon. 1993. *Estimation and Inference in econometrics.* Oxford University Press.

Deegan, C., and B. Gordon. 1996. "A Study of the Environmental Disclosure Practices of Australian Corporations." *Accounting and Business Research* 26(3):187-199.

Dimson, E. 1979. "Risk Measurement when Shares are Subject to Infrequent Trading. *Journal of Financial Economics* 7:197-226.

References

Dowdell, T., S. Govindaraj, and P. Jain. 1992. "The Tylenol Incident, Ensuing Regulation, and Stock Prices." *Journal of Financial and Quantitative Analysis* 27(2):283-301.

Durbin J. and G. Watson. 1951. "Testing for Serial Correlation in Least Squares Regression," *Biometrika* 38:159-171.

Earth Sanctuaries Limited Annual Report. June 30, 1996.

The Economist. 1994. "Regulate us please," January 8:69.

EPA742-R-95-004 May 1996. *Full Cost Accounting at Ontario Hydro.*

Epstein, M. 1996. *Measuring Corporate Environmental Performance.* The IMA Foundation for Applied Research Inc.

Epstein, M. and M. Freedman. 1994. "Social Disclosure and the Individual Investor." *Accounting Auditing and Accountability Journal* 7(4):94-109.

Estes, R. 1972. "Socio-Economic Accounting and External Diseconomies" *The Accounting Review*:284-290.

Fagan, D. 1989. "Bad weather slows efforts to contain oil." *Globe and Mail* Tuesday March 28: A1.

Fagan, D. 1989. "Alaska losing battle to recover spilled oil." *Globe and Mail* Wednesday March 29: A1.

Fama, E. 1965. "The Behaviour of Stock Market Prices." *Journal of Business* 38:34-105.

Fama, E. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* 25:383-417.

Fama, E., Fisher, L., C. Jensen, and R. Roll. 1969. "The adjustment of Stock Prices to New Information." *International Economic Review* 10(1):1-21.

Federal Register 59 (March 25, 1994) 14284.

Fekrat, M., C. Inclan and D. Petroni. 1996. "Corporate Environmental Disclosures: Competitive Disclosure Hypothesis Using 1991 Annual Report Data." *The International Journal of Accounting* 31(2):175-195.

Feltmate, B. 1999. "Sustainable Development and Environmental Reporting." Paper presented at the Canadian Academic Accounting Association Conference, Wyndham Bristol Hotel. June 3-6.

Feltmate, B., and B. Schofield. 1999. "Elevating shares and saving the planet." *CMA Management* (July-August):20-24.

Filsner, G. and M. Cooper. 1992. The Environment: A Question of Profit - The Ordinary Investor and Environmental Issues in Accounting. in *Green Reporting: Accountancy and the Challenge of the Nineties* ed. D. Owen, Chapman and Hall, London.

Fletcher, J., W. Adamowicz, and T. Graham-Tomasi 1990. "The Travel Cost Model of Recreation Demand" *Leisure Sciences* 12:119-147.

References

Fowler, D., C. Rorke, and V. Jog. 1980. "Thin Trading and Beta Estimation Problems on the Toronto Stock Exchange." *Journal of Business Administration* 12:77-90.

Frankfurter, G. and E. McGoun 1993. "The Event Study: An industrial Strength Method." *International Review of Financial Analysis*. 2(2):121-141.

Frankfurter, G. and E. McGoun 1995. "The Event Study: Is It Either?" *The Journal of Investing*. (Summer):8-16.

Freedman, M. and B. Jaggi. 1986. "An Analysis of the Impact of Corporate Pollution Disclosures Included in Annual Financial Statements on Investors' Decisions." *Advances in Public Interest Accounting* 1:193-212.

Freedman, M. and B. Jaggi. 1988. "An Analysis of the Association between Pollution Disclosures and Economic Performance." *Accounting, Auditing and Accounting Journal* 1(3):43-58.

Freedman, M. and A. Stagliano. 1991. "Differences in Social Cost Disclosures: A Market Test of Investor Reaction." *Accounting, Auditing and Accountability Journal* 4(1):68-83.

Freedman, M. and C. Wasley. 1990. "The Association Between Environmental Performance and Environmental Disclosures in Annual Reports and 10Ks." *Advances in Public Interest Accounting* 3:183-193.

Freeman, A. 1993. *The Measurement of Environmental and Resource Values - Theory and Method.* Resources for the Future.

Gamble, G., K. Hsu, D. Kite and R. Radtke. 1995 (September). "Environmental Disclosures in Annual Reports and 10Ks, An Examination." *Accounting Horizons* 9(3):34-54.

Geary, R. 1970. "Relative Efficiency of Count of Sign Changes for Assessing Residual Autoregression in Least Squares Regression." *Biometricka* 57:123-127.

Gibson, K. 1995. "National Pollutant Inventory." *Environmental Accountability Research Newsletter* 1(1) University of Tasmania:5-6.

Glejser, G. 1969. "A New Test for Heteroscedasticity." *Journal of the American Statistical Association* 64:316-323.

Glister, J., and C Linke. 1978. "More on the Estimation of Beta for Public Utilities: Biases Resulting from Structural Shifts in True Beta." *Financial Management* 7:60-65.

Globe and Mail. 1979. "British Rail changes policy." Wednesday November 14:A5.

Globe and Mail. 1984. "15 die, 2000 treated after factory gas leak." Monday December 3:8.

Globe and Mail. 1984. "Gas leak death toll in India tops 500." Tuesday December 4:1.

Globe and Mail. 1984. "Indian death toll from gas cloud placed at 1200." Wednesday December 5:1.

Globe and Mail. 1984. "Gas leak toll in Indian city put at 2000." Thursday December 6:1.

References

Globe and Mail. 1986. "Soviet A-leak hits Scandinavia." Tuesday April 29, 1986:A1.

Globe and Mail. 1986. "Soviet A-leak "world's worst." Wednesday April 30:A1.

Globe and Mail. 1986. "US utilities are dumped by investors." Wednesday April 30:B1.

Globe and Mail. 1989. "Oil tanker spills millions of litres off Alaska coast." Saturday March 25: A1.

Globe and Mail. 1989. "Oil ship's captain not on bridge, Exxon says." Monday March 27: A1.

Globe and Mail. 1989. "Cleanup of oil spill rife with bungling." October 1.

Globe and Mail. 1989. "Saskatchewan mine spill tainted: residents fear fishing may be hurt." Thursday, November 9: A89.

Globe & Mail. 1990. *"Oil slick a threat to beaches in California."* Friday February 9:A15.

Globe and Mail. 1991. "Oil tanker spills fuel into Georgian Bay." Saturday May 11: A6.

Globe and Mail. 1994. "PCBs vaporized in Sysco Mill fire." Friday, May 27: A1.

Gonedes, N. J. 1976. The Capital Market, The Market for Information and External Accounting." *Journal of Finance* 31:611-630.

Goodland, R. and G. Ledec. 1987. "Neoclassical Economics and Principles of Sustainable Development." *Ecological Modelling* 38:19-46.

Gray, R. 1992. "Accounting and Environmentalism: an Exploration of the Challenge of Gently Accounting for Accountability, Transparency and Sustainability." *Accounting Organizations and Society* 17(5):399-425.

Gray, R., R. Kouhy and S. Lavers. 1995. "Corporate social and environmental reporting: A review of the literature and a longitudinal study of UK disclosure." *Accounting, Auditing and Accountability Journal* 8(2):47-77.

Greenley, D., R. Walsh and R. Young. 1981. "Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality." *Quarterly Journal of Economics* 96:657-73.

Griffiths, L. and C. Clairman. 1996. "Exercising diligence." *CA Magazine* (November):25-29.

Gujarati, D. 1995. *Basic Econometrics.* McGraw Hill Inc.

Guthrie, J. and L. Parker. 1989. "Corporate Social Reporting: A Rebuttal of Legitimacy Theory." *Accounting and Business Research* 19(76):343-352.

Halifax Chronacle Herald. 1985. "Oil spill may hurt salmon." Tuesday December 10: 47.

Halifax Chronacle Herald. 1985. "Cleanup underway." Saturday December 7:15.

Halifax Chronical Herald. 1985. "Oil cleanup underway in Gaspe." Thursday December 5:14.

References

Halpern, P., J. Weston, and E. Brigham. 1994. *Canadian Managerial Finance – 4th edition.* Harcourt Brace and Company Canada.

Harper, R., W. Mister, and J. Strawser. 1987. "The Impact of New Pension Disclosure Rules on Perceptions of Debt." *Journal of Accounting Research* 25(2):327-330.

Harper, R., W. Mister, and J. Strawser. 1991. "The Effect of Recognition vs. Disclosure of Unfunded Post Retirement Benefits on Lenders' Perceptions of Debt." *Accounting Horizons* 5(3):50-56.

Harte, G. and D. Owen. 1991. "Environmental Disclosures in the Annual Reports of British Companies: A Research Note." *Accounting, Auditing and Accountability Journal* 4(3):51-61.

Hecht, J. and H. Peskin. 1993. "Natural Resource Accounting in the Developing World: A Neo-classical Approach: A Summary." UNEP Paper No. 8 eds. A. Markandya and C. Costanza. Harvard Institute for International Development.

Hicks, J. 1946. *Value and Capital.* Clarendon Press. pg. 172. quoted in Society of Management Accountants of Canada. 1987. Lesson Notes for Advanced Financial Accounting.

Hines, R. 1991. "On Valuing Nature." *Accounting, Auditing and Accountability Journal* 4(3):27-29.

Hinterberger, F., F. Luks, and F. Schmidt-Bleek. 1997. "Material flows vs. 'natural capital' What makes an economy sustainable?" *Ecological Economics* 23:1-14.

Hotelling, H. 1947. Unpublished letter to Director of National Park Service. US.

Huber, P. 1987. "The Environmental Liability Dilemma." *CPCU Journal* (December):206-216.

Hueting, R., L. Reijnders, B. de Boer, J. Lambooy and H. Jansen. 1998. "The concept of environmental function and its valuation." *Ecological Economics* 25(1):31-35.

Huizing. A. and H. Dekker. 1992. "Helping to pull our planet out of the red: an environmental report of BSO/Origin." *Accounting Organizations and Society* 17(5):449-458.

Hume, M. 1985. "Fog limits tracking of oil slick. " *Vancouver Sun.* Monday December 23: A1.

Ingram, R. and K. Frazier. 1980. "Environmental Performance and Corporate Disclosure." *Journal of Accounting Research* 18(2):614-622.

International Institute of Sustainable Development. 1997. *Measuring Sustainable Development: A Review of Current Practice.* Winnipeg.

Israelson, D. 1993. "Oil spill disaster looms in North Sea." *Toronto Star.* Wednesday January 6:A1.

Israelson, D. 1993. "Salvagers wait to board tanker." *Toronto Star.* Thursday January 7:A3.

Israelson, D. 1993. "Experts downplay health risks as tanker continues to gush." *Toronto Star.* Friday January 8:A14.

Jarque, D. and A. Bera. 1987. "A test for normality of observations and regression residuals," *International Statistical Review* 55:163-172.

References

Kahneman, D., and J. Knetsch 1992. "Valuing Public Goods: the Purchase of Moral Satisfaction." *Journal of Environmental Economics and Management* 22:57-70.

Kahneman, D., and A. Tversky. 1979. "Prospect Theory: An Analysis of Decision Under Risk." *Econometrica* 47(2):263-291.

Kalbfuss, E., 1986. "PCB fire forces 3000 to flee south shore," *Montreal Gazette*, Wednesday August 24: A1.

King, B. 1966. "Market and Industry Factors in Stock Price Behaviour." *Journal of Business*:139-190.

Knight, J. 1990. "Planning a Pollution Response to Trucking Spill Accidents." *Risk Management* (April):84-86.

Krutilla, J., 1967. "Conservation Reconsidered." *American Economic Review* 57:777-786.

LaBarr, G. 1988. "Chemical Industry: Regulatory Crunch Coming?" *Occupational Hazards* (November):36-39.

Lamoureux, C. and W. Lastrapes. 1990. "Heteroskedasticity in Stock Return Data: Volume versus GARCH Effects." *Journal of Finance* (March) 45(1):221-229.

Lev, B. 1992. "Information Disclosure Strategy." *California Management Review* (Summer):9-32.

Lev, B. 1974. "On the Association Between Operating Leverage and Risk." *Journal of Financial and Quantitative Analysis* 9:627-642.

Li, Y. and B. McConomy. 1998. "An Empirical Examination of Factors Affecting the Timing of Environmental Accounting Standard Adoption and the Impact on Corporate Valuation." Working paper.

Li, Y., G. Richardson, and D. Thornton. 1997. "Corporate Disclosure of Environmental Liability Information: Theory and Evidence. *Contemporary Accounting Research* 14(3):435-474.

Lindblom, C.K. 1994. "The implications of organizational legitimacy for corporate social performance and disclosure", paper presented at the Critical Perspectives on Accounting Conference, New York, N.Y. cited in Gray, Kouhy and Lavers 1995.

Little, P., M. Muoghalu, and H. Robison. 1995. "Hazardous Waste Lawsuits, Financial Disclosure, and Investors' Interests." *Journal of Accounting, Auditing and Finance* 10:385-397.

Machin, M. and J Ehreshmann. 1990. "Remediating a Fire Site." *Civil Engineering* (April) 60(4):55-56.

MacKinlay, A. C. 1997. "Event Studies in Economics and Finance." *Journal of Economic Literature.* (March) XXXV:13-39.

Maloney, M. and R. McCormick. 1982. A Positive Theory of Environmental Quality Regulation." *Journal of Law and Economics* (April) 25:99-123.

Martin-Sidey, D. Legal Council-Enquiries, *Ontario Securities Commission*. Private discussion December 23, 1999.

References

McKone, T. 1996. "Overview of the risk analysis approach and terminology: the merging of science, judgment and values." *Food Control* 7(2):69-76.

Milne, M. 1991. "Accounting, Environmental Resource Values and Non-market Valuation Techniques for Environmental Resources: A Review." *Accounting, Auditing and Accountability Journal* 4(3):81-109.

Mitchell, R., and R. Carson. 1989. *Using Surveys to Value Public Goods: the Contingent Valuation Method.* Resources of the Future.

Mobley, S. 1970. "The Challenge of Socio-economic Accounting." *The Accounting Review*:762-768.

Montreal Gazette. 1988. "Ship's oil spill threatens bird sanctuary." Monday May 9: A9.

Moreschi, R. 1988. *Tort Liability Standards and the Firm's Response to Regulation.* Ph. D. Dissertation. University of Illinois at Urbana-Champaign.

Mullen, J. and F. Menz. 1985. "The Effect of Acidification Damages on the Economic Value of the Adirondack Fishery to New York Anglers." *American Journal of Agricultural Economics.* February:112-119.

New York Times. 1988. "Oil spill affects wildlife." Wednesday April 27: A23.

Ontario Securities Commission 1999. *Automated Trading Systems proposal – Supplement to the OSC Bulletin* July 2, 1999.

Our Common Future. 1987. World Commission on Environment and Development. Oxford University Press, New York.

Owen, D. 1992. "The Implications of Current Trends in Green Awareness for the Accounting Function: An Introductory Analysis." Introduction to *Green Reporting: Accountancy and the Challenge of the Nineties*, ed. D. Owen. Chapman and Hall. London.

Pashigan, P. 1984. "The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares." *Journal of Law and Economics* 27:1-28.

Patten. D. 1992. "Intra-Industry Environmental Disclosures in Response to the Alaskan Oil Spill: A Note on Legitimacy Theory." *Accounting Organizations and Society 17*(5):471-475.

Ramanathan, K. 1976. "Toward a Theory of Corporate Social Accounting." *The Accounting Review* 11(3):516-527.

Reither, C. 1997. "How the FASB Approaches a Standard-Setting Issue." *Accounting Horizons* 11(4):91-104.

Richardson, G. 1998. "Signals and Signs." *CA Magazine* (March):37-39.

Ridker, R. 1967. *Economic Costs of Air Pollution: Studies in Measurement.* Praeger. New York.

Robinson, C. 1993. "A Deep Ecology Critique of Accounting." York University Faculty of Administrative Studies Research Papers #20-93.

References

Rockness, J. 1985. "An Assessment of the Relationship Between US Corporate Environmental Performance and Disclosure." *Journal of Business Finance and Accounting* 12(3):339-354.

Rockness, J., and P. Williams. 1988. "A Descriptive study of Social Responsibility Mutual Funds." *Accounting, Organizations & Society,* 13 (4):397-411.

Rosen, L. 1997. "GAAP, evaluation and decision-making." *CA Magazine* (April):40-52.

Rubenstein, D. 1989. "Black Oil Red Ink." *CA Magazine* (November):30-35.

Rubenstein, D. 1994. *Environmental Accounting for the Sustainable Corporation: Strategies and Techniques,* Quorum Books.

Scott, W. 1997. *Financial Accounting Theory.* Prentice-Hall Canada.

Scagnelli J. and B. Malloy. 1987. "Should Lenders Require Environmental Audits?" *The Journal of Commercial Bank Lending.* (1987):14-19.

Scholes, M. and J. Williams. 1977. "Estimating Betas from Non synchronous Data." *Journal of Financial Economics* 5:309-327.

Shane, P. and B. Spicer. July 1983. "Market Response to Environmental Information Produced Outside the Firm." *The Accounting Review*:521-538.

Sharpe, W. 1964. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *Journal of Finance* 19(3):425-442.

Sharpe, W. and G. Cooper. 1972. "Risk-Return Classes of New York Stock Exchange Common Stocks, 1931-1967." *Financial Analysts Journal* (March/April):46-54.

Simmons, C., D. Neu, and C. Ruff. 1993. "Socially Responsible Reporting." *CGA Magazine* (November):49-52.

Slovic, P. 1987. "Perception of Risk," *Science* 236:280-285.

Society of Management Accountants of Canada. 1997. *Accounting for Sustainable Development: A Business Perspective.* Management Accounting Issues Paper No. 14. Hamilton.

Solomon, K. 1996. "Overview of Recent Developments in Ecotoxicological Risk Assessment." *Risk Analysis* 16(5):627-633.

Spears, J. 1993. "Canada could still face similar catastrophe, oil spill experts fear." *Toronto Star.* Thursday January 7:A3.

Spicer, B. 1978. "Investors, Corporate Social Performance and Information Disclosure: an Empirical Study," *The Accounting Review* 53(1):94-111.

Statistics Canada 1997. *Econnections: Linking the Environment and the Economy.* Cat 16-200-XKE.

References

Suparmoko, M. 1993. "Problems and Methods of Natural Resource and Environmental Accounting. The Indonesian Case." UNEP Paper No. 8 eds. A. Markandya and C. Costanza. Harvard Institute for International Development.

Surma, J., and A. Vondra. 1992. "Accounting for Environmental Costs: A Hazardous Subject." *Journal of Accountancy* (March):51-55.

Thompson, R., and K. Schipper. 1983. "The impact of merger-related regulations on the shareholders of acquiring firms." Journal of Accounting Research. 21(1):184-221.

Toronto Star. 1976. "Spain fears disaster after huge oil spill." Thursday May 13: A4.

Toronto Star. 1976. *"Salvagers to pump tanker in bid to control oil spill."* Friday, May 14: A12.

Van Rijn, N. 1995. "Hundreds rush for help in Sudbury gas leak." *Toronto Star*. November 17:A3.

Trueman, B. 1986. "Voluntary Release of Earnings Forecasts." *Journal of Accounting and Economics* 8:53-71.

Vancouver Sun. 1983. "Biggest spill since 1973 fouls Vancouver harbour." Saturday January 22: A5.

Vancouver Sun. 1983. "Oil damage covered by insurance." Monday January 24: A3.

Vancouver Sun. 1985. "Leaked fuel oil washes ashore in Washington." Saturday December 24.

Verrechia, R. 1983. "Discretionary Disclosure." *Journal of Accounting and Economics* 5:179-194.

Vinten G. 1991. "The Greening of Audit." *Internal Auditor* (October):30-43.

Viper, R. V. 1994. *Setting Standards for Financial Reporting*. Quorum Books.

Wagmire, G. 1985. "Earnings Volatility and Voluntary Management Forecast Disclosure." *Journal of Accounting Research* (Spring):268-295.

Ward, B. 1994. "PCBs vaporized in fire." *Halifax Chronical Herald*. Friday, May 27: A1.

Watts, R. and J. Zimmerman. 1987. "Towards a Positive Theory of the Determination of Accounting Standards," *The Accounting Review* 65(1):112-134.

Watts, R. and J. Zimmerman. 1990. "Positive Accounting Theory: A Ten Year Perspective," *The Accounting Review* (January):131-156.

Weisbrod, B. 1964. "Collective-Consumption Services of Individual-Consumption Goods." *Quarterly Journal of Economics* 78:471-77.

Wildavsky, A. 1994. "Accounting for the Environment." *Accounting, Organizations and Society* 19(4/5):461-481.

Willis, A. 1997. "Counting the Costs." *CA Magazine* (April):48-50.

References

Willis, A. 1994. "For Good Measure." *CA Magazine* (December):16-27.

Wiseman, J. 1982. "An Evaluation of Environmental Disclosures Made in Corporate Annual Reports." *Accounting, Organizations and Society* 7(1):53-63.

The World Bank. 1997. *Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development.* Environmentally Sustainable Development Studies and Monographs Series #47. Washington DC.