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THE IMPACT OF POLLUTION ABATEMENT EXPENDITURES ON THE MARKET RISK OF SECURITIES: AN EMPIRICAL ANALYSIS

By

KENNETH JOHN MARTIN

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Oklahoma State University

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Name: Kenneth John Martin Date of Degree: May, 1980

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Scope and Method of Study: This study, utilizing the Capital Asset Pricing Model, uses two separate, yet related, approaches to analyze the effects of pollution abatement expenditures on the risk of securities. The first approach, using data from the CRSP Investment Performance File, tests for any changes in systematic risk (beta) and in unsystematic risk (standard error) each for three portfolios in three consecutive, nonoverlapping periods. The first portfolio consists of 40 firms which are in industries generally thought of as polluters while the other two are randomly generated control portfolios. The total time interval in this approach is from January 1953-December 1978. The second approach differs in the construction of the portfolios and the time interval. All industries with pollution abatement expenditures are divided into three portfolios; high, medium, and low expenditures. Yearly beta and standard error values are calculated for the firms in these industries for the years 1973-1978. Changes in the risk factors across this time period are examined.

Findings and Conclusions: The empirical results of this paper do not provide support for the hypothesis that pollution control legislation has adversely affected market risk of securities. The results of the first technique of analysis show no significant change in beta values for the polluting portfolio between any of the periods of time under consideration while the betas for the control portfolios did change significantly. All three of the portfolios showed a significant increase in nonmarket risk (standard error) between periods two and three. The results of the second technique of analysis support the first insofar as the relative magnitudes of the high, medium, and low categories of polluters are concerned. Contrary to the hypothesis, the high category of polluters experienced the lowest betas and standard deviations while the low polluters had the highest values for the sample time period 1973-1978. Thus, it appears that market risk is unaffected by pollution control legislation over the long run.

ADVISER'S APPROVAL ___[signature]___

THE IMPACT OF POLLUTION ABATEMENT EXPENDITURES

ON THE MARKET RISK OF SECURITIES:

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Report Approved:

Janet Jackson
Advisor

Z. Lee Man
Director of Graduate Studies

Gerald M Sage
Head, Department of Administrative Sciences

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CHAPTER I

INTRODUCTION AND OVERVIEW OF PROBLEM

Introduction

With the passage of the Employment Act of 1946, the United States Congress first established the economic objectives of full employment, stable prices, continued economic expansion, and a positive balance of trade. While these have been met with varying degrees of success, the past ten years have seen the addition of a fifth goal concerning the "quality of life". However, as more legislation and regulations regarding the quality of manufactured products and by-products are imposed upon the business community, the more conflicting become the economic goals of the government. In other words, the goals of continued economic growth and effective environmental control may involve tradeoffs between these goals. The objective of this paper is to examine one aspect of these tradeoffs as the environmental goals influence the perceived risks of companies coming under pollution control standards which surpass those previously experienced.

Problem Definition

As one delves into this area, he discovers that the ultimate problem concerns the productivity of industry in the United States. For years, economists, politicians, and businessmen have decried the decline of output per unit of input for reasons including changing attitudes among the work force, aging plant and equipment, and an increase in the service and white collar sectors of the economy. Another factor that should be considered is investment in pollution abatement equipment, an essentially nonproductive, cash draining asset. While this study will not examine productivity per se, it will explore the implications that mandatory investment in pollution control assets have on an industry basis. In the normal process of investment analysis, a company should properly estimate the cash inflows and outflows produced by the investment, discount these back to the present time period, and base the decision on whether this net present value is positive or negative. A crucial element in this analysis is the risk perceived by the firm as reflected in the required rate of return for, the greater the risk, the higher the rate.

The required rate of return is affected by several factors, notably the firm's cost of capital, of which cost of equity and debt are a part, and the riskiness of the cash flows involved with a project. In the case of pollution control equipment, one may assume that only cash outflows will result from the investment, that is, virtually no new capacity or revenue will be generated due to the project. However, the investments are still made because of the mandates of environmental legislation. Considering this, a new type of risk evolves which supplements the riskiness of cash outflows in that a future change in legislation may require more cash outflows thus restricting use of funds for productive assets.

Bearers of Cost for Pollution Control

Regarding these risks, it is important to identify who ultimately pays for the investment, if the government bears part of the burden, then, the financial risk to the firm should not increase as much as it otherwise would and investors would value the firm accordingly. Through such means as tax credits, tax exempt bonds, direct subsidies, and accelerated depreciation, the government has been willing to absorb part of the cost of investment, yet the recurring costs of operations and the risk of more stringent regulations in the future will serve to increase an investor's perception of the likelihood that the firm will continue to function profitably and efficiently given the amount of human and physical resources committed to the analysis of the pollution problem. If the internalized costs could be passed on to the consumer in the form of higher prices, then it would appear that the firm could minimize the impact on profitability. Since business provides a service or product to an ultimate end user, it should recognize that the elasticity of the price upon the demand for the product will have a drastic effect on whether or not the price can be increased to recover the full cost of pollution control. Perhaps the only way a firm could raise its prices would be if all the firms in the industry were in the same stage of pollution abatement development, a case which is highly unlikely. The third possible impact of pollution control would be for the stockholders to assume the burden completely. The net effect would be to absorb the cost through cash flows from operations and in capital cost, thus reducing the return on investment and increasing the risk of earning an unacceptable return. Ultimately this will impact the investor (stockholder) who will, given an efficient market, act upon this information and value the stock lower relative to the rest of the market which is not exposed to this additional risk.

Viewpoints on Pollution Impacts

The impact of the pollution problem can be viewed in various contexts. At the macro level, environmental economists such as Mills (1) attempt to develop a cost/benefit basis upon which to value the environmental resources at our disposal and relate these values to the welfare of society as a whole. At this level, concern is upon policy and its effects on the well being of the general public. The studies concentrate most of their efforts on a determination of the costs of using such environmental resources as air and water and in developing some means by which a firm may internalize these costs as in any other expense. Since the data for such studies are in questionable form, other studies have approached the problem from an industry standpoint and looked at the inherent risks involved with this type of investment. Since the effects on risks should be fairly consistent within an industry, it is possible to study a sample of firms in various industries to determine any changes over time in their risk characteristics. Another possible analysis can be performed on the individual company basis and base the results on a study of financial indicators as well as its environmental track record. However, to properly perform this type of study, very detailed data, which is generally difficult to find, must be available. The expressed intent of this study is to develop a methodology to identify the magnitude of the pollution abatement impact on individual industries. From the industry level individual companies will be analyzed over a period of years to ascertain the nature and magnitude of the impact on risk as measured by the beta factor.

Greater demands have been placed upon the business community by external forces at all levels by government, environmental pressure groups, and consumer action groups. These demands reflect a growing interest in the social responsibility of the corporate entity and an increased awareness of the impact of corporate actions upon the community and the environment as a whole. As a result, changes in the manner of corporate decision making are resulting even though some businesses strive to reject these changes because they usually are not economically rational, that is, the resulting decisions may not be made based on profit-motivation. Consequently, in the light of the relatively new and increased emphasis on the quality of life, business may revise its overall goals to include a provision for environmental concern.

A direct result of the new activism in environmental matters was exemplified in the creation in 1970 of the Environmental Protection Agency. Since that time, the EPA has promulgated many reulations regarding by-products created by manufacturers and the disposal of those effluents. This added regulation has been the cause of great concern for many industries, most notably the steel, paper, chemical, and electric utility industries. Not only have large sums of money been spent to bring factories, mills, and plants within compliance of the regulations, but these capital outlays usually have produced no direct returns to the firms in the form of increased capacity, output, or productivity. In many cases, the investment in pollution abatement equipment results in increased operating costs. The adverse impact on the earnings stream whether due to decreased magnitude or greater variability results in a decline in the financial position as compared to firms not influenced directly by the higher costs and investments.

Risks of Investment

When contemplating investment in pollution control equipment, two types of risks are considered. The first involves the the timing of the investment, that is, whether or not the investment should be made now or postponed until a later date. Several factors are involved in this decision including the current and anticipated state of technology, the rate of change in prices for the ncessary equipment, the image of the firm, the incentives to invest, and the deadlines imposed by legislation. The second type of risk includes those which are inherent once the investment has been made, such as legislative, business, and financial risks.

Regarding the timing of the investment in pollution abatement equipment, the constantly evolving state of technology makes this decision, at best, uncertain. Should the firm invest now or wait until a newer, more efficient technology has been developed? If it waits, the inflation factor comes into play and if the new technology is not developed, then higher prices will be paid for the same equipment. Changes in the incentives to invest which are provided by the government can also affect the timing decision. A change from direct controls of emmissions to taxes or subsidies or a combination could reduce the costs borne by the firm. Of course, the most important consideration in this group is the deadline imposed by legislation. If the firm delays too long in its investment decision, fines for noncompliance may result. Despite these risks, it is assumed that the sample firms in this study have invested in pollution control equipment in an amount consistent with that of the rest of the firms in their respective industries.

The decision to invest in any earning asset always involves some business risk regarding the future returns from the asset. These returns are influenced by such factors as the general economy, competition, and consumer demand for the end product. However, there is a fundamental difference between investment in typical assets and investment in pollution abatement equipment. While the former is expected to earn a future return, though uncertain, the latter, in general, will earn no direct return and will even subject the firm to a reduction of income in the future. There is also the risk that existing laws and regulations will be changed and possibly strengthened in the future. This would involve investment in new, updated and, more than likely, more expensive equipment.

After the decision is made to invest, the firm must decide whether it will be financed through debt, equity, or internal sources. Special pollution bonds have been developed but, even so, the increase in fixed costs, with little, if any, economic return will adversely affect the firm's profitability as well as increase the variability in earnings. Whatever the nature of the financing, it influences the capital structure by the addition of debt or equity. If a firm has achieved its optimal capital structure, additional financing could force it to deviate from the optimal resulting in a decline in the value of its stock. Additions to debt affect credit ratings and the present and future cost of this capital source. It is clear that the magnitude of the incremental investment and financing requirements for pollution control vary from year to year depending upon the rate of reduction of pollution discharge within an industry or company. Measurement of the risk related to affected and nonaffected firms is achieved through examination of differences in systematic risk, the beta factor.

Summary of Approaches to the Problem

The hypothesis of this study can be formulated and tested utilizing the capital asset pricing model by calculating beta values across three nonoverlapping time periods. The three periods characterize three different periods regarding the risk that a firm faces when investing in pollution control equipment. The first period is that time before the clear inception of legislative risk, that is, firms did not have to consider the risk of changed and strengthened environmental laws when making their investment decisions. During the second time period, polluting firms faced the risk of investing in pollution control equipment only to have the laws strengthened after the equipment is operational. This period also marked the beginning of major investment and large expenditures to comply with mandated standards. The third time period is marked by stringent deadlines and improvement in investment to the "best available technology". This period served to drastically increase the risk a firm faced in view of major investment in nonproductive assets. In order to examine the problems, two separate techniques were developed to analyze the problem. One approach uses firms in industries usually associated with significant pollution problems. The other approach uses specific industry pollution control capital expenditures to ascertain groups based upon the level of these historical capital expenditures.

In the first approach three portfolios, one designated as polluting[1] plus two control portfolios, are identified and mean beta and standard

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[1]While the firms included in this portfolio are designated as "polluting", it should be made clear that this is only a designation scheme and in no way should it imply a value judgment on those firms.

deviation values are calculated to measure market and nonmarket risk in the three nonoverlapping time periods. It is expected that changes in risk will be observed thus lending support to the hypothesis. The second approach identifies industries influenced by pollution control investments with data generated by the Department of Commerce (2,3). After placing the sample companies into groups of high, medium, or low relative investment, yearly beta values are calculated to determine the effect that the investments have made regarding the perception of risk. Hypothetically, one should expect to see an increase in risk throughout the entire period as firms are forced to invest in assets that generally yield little or no financial or productive return.

The remaining chapters will develop this concept more fully and empirically test these ideas. Chapter II will provide a history of the lankmark dates in the evolving legislation regarding pollution. Chapter III will review previous empirical studies and develop the model which will be used to test the hypothesis while Chapter IV will present these findings and any implications which the findings may have on risk measurement or additional studies.

ENDNOTES

1. Edwin S. Mills, _The Economics of Environmental Quality_. New York: W. W. Norton and Company, Inc., 1978.

2. Gary L. Rutledge, Fredrick J. Dreiling, and Betsy C. Dunlap, "Capital Expenditures by Business for Pollution Abatement, 1973-77 and Planned 1978." _Survey of Current Business_ (June, 1978), pp. 33-38.

3. Gary L. Rutledge, Fredrick J. Dreiling, and Betsy C. O'Connor, "Capital Expenditures by Business for Pollution Abatement, 1977, 1978, and Planned 1979." _Survey of Current Business_ (June, 1979), pp. 20-22.

CHAPTER II

A REVIEW OF POLLUTION LEGISLATION

Introduction

A review of pollution control legislation is provided with details on the major provisions of both air and water pollution control laws which developed along similar, yet independent, lines. The federal government's actions to regulate matters concerning conservation of natural resources have evolved slowly throughout the history of the United States. Through legislation, greater conscienceness about our environment is expressed.

Prior to 1948, pollution laws in the United States were based upon two acts, the Rivers and Harbors Act of 1899 and the Oil Pollution Act of 1924. The former prohibited the discharge of wastes into navigable waters unless a permit was obtained from the Corps of Engineers. Any violation of this law was punishable by fines or imprisonment. The Oil Pollution Act prohibited the dumping of oil into navigable waters except for emergencies or unavoidable accidents. The Secretary of the Interior, the Coast Guard, and the Secretary of the Army were given authority for enforcement. Although this act was limited to coastal waters and tide-waters, later sessions of Congress sought to extend it to cover inland waters.

Water Pollution Legislation

Modern water pollution control began on June 30, 1948, when President Harry S. Truman signed into law the Water Pollution Control Act. Congress recognized the harmful effects of pollution both upon the public health and on the environment. The states still maintained the primary responsibility of controlling water pollution, but the federal government played an increasingly important support role. Under the 1948 act, the Public Health Service was to develop a comprehensive program for the solution of water pollution problems and to coordinate its efforts with those of the states, municipalities, interstate agencies, and industry. Federal grants were authorized to help states and municipalities with their industrial waste studies, to finance engineering studies and other preliminary work in the construction of treatment works, and loans to municipalities for construction of abatement works. The 1948 act also provided for federal enforcement although it was only for matters concerning interstate waters, only after the efforts of the state had been exhausted, and only with state consent. Throughout the eight year period from 1948 to 1956, a total of $216 million was authorized, however, only $11 million was actually appropriated.

In July of 1956, an amendment to extend and strengthen the Water Pollution Control Act was signed into law. The law authorized continued federal-state cooperation in the development of comprehensive water pollution control programs while still recognizing that the primary responsibility lay with the states. Increased technical assistance and research were authorized as well as the collection and dissemination of basic data on water quality. Interstate compacts and uniform state laws were encouraged, and the veto power of the states over federal enforcement was removed. Funds were authorized for studies and construction of municipal treatment plants as well as a program to control pollution from federal installations.

The law was amended again in 1961 resulting in the administration of the law being handed to the Secretary of the Department of Health, Education, and Welfare. Other provisions established regional water pollution control laboratories, increased federal grants to states and municipalities, and strengthened federal enforcement authority. Also, the law provided for regulation of stream flow for water quality control purposes which meant that the federal flood control, navigation, and reclamation programs were tied to the water quality control program for the first time.

In 1965, another amendment was added to the original act. The purpose, as stated by Congress, was "to enhance the quality and value of our water resources and to establish a national policy for the prevention, control and abatement of water pollution." A major change in administration also occurred with the creation of the Federal Water Pollution Control Administration within the HEW. The states were also required to develop water quality standards for interstate navigable waters, subject to approval of the Secretary of the Interior. Any pollution reducing the quality below those standards would be subject to federal action. Grants to cities for the construction of treatment plants was increased from $100 million per year to $150 million.

The 1966 amendment increased federal financial assistance to $5- $10 million annually to be divided between the states and interstate agencies and $3.4 billion for assistance to cities for the period 1968-1971. The administration of the program was also transferred from HEW to the Department of the Interior. Other provisions included a study of the costs of pollution control, studies of estuaries along the coastlines, pollution by watercraft, financial assistance to industry, and strengthened control over oil pollution.

Air Pollution Legislation

The modern era regarding federal involvement in air pollution legislation began on July 14, 1955, when the Air Pollution Control Law was signed by President Dwight D. Eisenhower. The law established the basic policy that the prime responsibility for control of air pollution lay with the cities and states but that the federal government would provide financial and technical assistance to help coordinate efforts of the various entities involved. This included the collection and dissemination of information, research work to explore new means to reduce air pollution, perform surveys and research into any specific problem areas, and make grants to any state, city, or agency for surveys, studies, research, training, or demonstration projects. The law authorized a maximum appropriation of $5 million per year for each of five years.

The 1959 amendment extended the authorization for an additional four years. Also, it required all federal departments and agencies to cooperate with the Department of Health, Education, and Welfare and with interstate, state, and local air pollution control agencies to control pollution from facilities under their jurisdiction.

The amendment of 1960 authorized the Surgeon General to study the problem of motor vehicle exhausts and their effect on human health. The report was to be presented to Congress within two years. The 1962 amendment extended for two more years authorization for appropriations for the motor vehicle exhaust study and authorized that the studies be conducted on a continuing basis.

The Clean Air Act of 1963, an amendment of the 1955 act, resolved arguments between those who viewed the federal government's role as one of providing research and financial assistance and those who viewed it in stronger terms. This act provided the framework for the basic principles of federal enforcement and financial aid. Specifically, it provided for improved programs relating to the establishment of uniform state and local laws, research, investigation, training, and dissemination of information, grants to air pollution control agencies, enforcement of air pollution laws, limitation of automotive vehicle pollution, and cooperation of federal agencies to control air pollution from federal agencies.

The 1965 amendment to the Clean Air Act resulted from the continuing studies into the effects of motor vehicle exhausts on the air pollution problem. The act authorized the Secretary of HEW to set standards regarding emissions from motor vehicles, authorized new action regarding the effects of U. S. air pollution upon foreign countries, and included an increased role for the federal government in cases where significant air pollution could pose a threat to the public health.

The 1966 amendment authorized grants to air pollution control agencies to maintain existing programs as well as continuing authority to develop, establish, and implement new programs. The amount of funds authorized for 1967 was $46 million, for 1968, $66 million, and for 1969, $74 million.

In 1967, amendments to the Clean Air Act, known as the Air Quality Act, were enacted. This act established a new national objective very similar to that of the Water Pollution Control Act, that is, "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Specifically, with respect to stationary sources of pollution, it authorized the Secretary of HEW to prevent future sources of air pollution, to require states to set standards for air pollution under the Secretary's supervision, establish air quality regions within or between states in connection with setting the standards, and to study the possibilities of setting national standards for major industries.

Establishment of National Environmental Policy and Subsequent Acts

All of this legislation culminated in 1969 with the passage of the National Environmental Policy Act of 1969. The major provisions called for the establishment of a three man Council on Environmental Quality within the Executive Office of the President. An annual report would be submitted to Congress each year setting forth the status of the various environmental programs and review the impact of these on the environment and on the conservation, development, and use of natural resources. The act also provided that the Council was to assist in the development of the report, the development and recommendation of national policies regarding environmental protection, and the collection of data to monitor any changes or trends in the national environment.

After the landmark policy act of 1969, more stringent laws which set deadlines and mandates were enacted to deal with the pollution problem. The Federal Water Pollution Control Act Amendments of 1970 provided that the owner or operator of a vessel or offshore facility would be liable for the clean up costs of oil spills. The Resources Recovery Act of 1970 revised the 1965 Solid Waste Disposal Act and provided for a tenfold increase in federal funding to undertake basic research and development to improve methods of collection, transport, recycling, processing, and disposal of solid waste.

The Clean Air Act Amendments of 1970 revised the federal air pollution control program and provided stronger enforcement measures. Specifically, it required the establishment of primary and secondary air quality standards. The implementation timetable for compliance was extended and certain provisions were added to ensure compliance. The timetable for reductions in automobile emissions was outlined and new regulations for industries were authoried.

In 1972, the Federal Water Pollution Control Act was amended. The new legislation declared that all discharge of pollutants into receiving waters was illegal unless it was made under permit that specified the degree of reduction in effluents that the discharger must achieve. A deadline of 1985 was set as a target date for essentially eliminating all discharges of pollutants in the country. By 1977, all point-source effluents were to be limited to levels achievable through the use of the "best practicable technology" and, by 1983, to that achievable by the "best available technology." Also authorized were stiff civil and criminal penalties for violations.

In 1974, the Energy Supply and Environmental Coordination Act was passed authorizing variances from clean air requirements for stationary sources that could not obtain clean fuels during emergencies as well as encouraging the conversion of electric power plants to the use of coal. It also delayed the 1975 auto emission deadlines and certain other emission requirements. The next year, the Energy Policy and Conservation Act was passed which outlined the key elements of a Congressional energy program. The elements included authority to require electric power plants to convert to coal, an increase in Presidential control over the flow of energy supplies, establishment of a national petroleum reserve storage program, mandated fuel efficiency standards for automobiles, and continued federal price controls on domestic oil.

Summary

From the dates of legislation and the nature of the regulation and enforcement, it is evident that the major impact on industry would occur from the mid-1960's forward. During the late 1960's, it became clear to industry and investors that certain industries would be affected more than others. Then, beginning about 1970, specific measures began to evolve providing insight into the specific nature of standards and time tables for implementation of new regulations. It then became clear how and when industries would be affected. The only unresolved questions related to the level of investment required to achieve the standards and the magnitude of the future impact on earnings.

CHAPTER III

REVIEW OF RELATED STUDIES AND METHODOLOGY

Introduction

After reviewing the justification for this study and a summary of the legislation leading up to the present situation, one can see that several different approaches to the problem may be taken. In this chapter, there is provided a discussion of the Capital Asset Pricing Model (CAPM), a review of previous empirical studies which have used the CAPM as well as studies utilizing other methodologies. Also discussed are the two separately identifiable techniques of analysis used in this paper by which the pollution control expenditure effects will be analyzed. The first method divides certain industries into one portfolio that one intuitively would think be most affected by the legislation and two randomly generated control portfolios all of which are compared over three nonoverlapping time periods. The second method uses historical expenditure data published by the Department of Commerce to divide all industries into three groups based on the ratio of historical pollution abatement expenditures to total capital expenditures. Yearly beta values are calculated from 1973-1978 with the intent being that an inflection point will be found reflecting a change in risk that occurred after legislatively mandated deadlines had passed and that those firms in the high group have a higher beta value, therefore, a higher risk, than those firms in the medium or low groups. See Table I below for a summary of the time periods under consideration.

TABLE I

TIME PERIODS FOR TECHNIQUES OF ANALYSIS 1 AND 2

1.	Technique 1	Period 1 Period 2 Period 3	January 1953-December 1960 January 1961-June 1968 July 1968-December 1978
2.	Technique 2	Six Annual Periods	1973-1978

Alternative Models for Analysis

In empirically analyzing the hypothesis posed in Chapter I, one of a number of different models may be used ranging from financial ratio analysis to correlation analysis and regression analysis. The simplest of these, ratio analysis, is an attempt to observe the characteristics of a firm and an industry in order to determine if it has changed structurally over time or in relation to other firms and industries. The basic supposition is that there is an accepted norm for such traditional ratios as debt/equity, price/earnings, return on investment, and return on equity. This approach is adequate only in limited analysis since one must realize that these ratios change over time and do not properly reflect the effects of inflation. The second model, correlation analysis, is somewhat simplistic as well. In trying to correlate financial variables which are quantitative with qualitative variables, the accuracy of the analysis should be suspect and, since good qualitative data about industry success at pollution abatement is scarce, a correlation would be of limited value. A third possible model, regression analysis, relates a dependent variable to one or more independent variables. One must be careful, however, in interpreting the results for if the underlying assumptions of regression analysis do not hold true, then the results could be misleading. In security risk analysis, the capital asset pricing model may be utilized. Here, the returns over time of an individual company are regressed against that of the market giving an indication of the way in which rational investors perceive the riskiness of the company. Given these various types of models, the remainder of this chapter reviews the CAPM, relevant empirical studies, the two techniques of analysis used in this paper, the particulars of the model used, a justification of the time intervals, and recognition of the data sources used.

The CAPM and Risk

Attention is now turned to a consideration of the measure of risk used in this study, i.e., the beta value. Intuitively, one would expect that as risk averse investors evaluate securities, those stocks with greater systematic risk, or a higher beta value, would command a higher expected return. This relationship can be presented in the Capital Asset Pricing Model, a single index equation utilizing ordinary least squares regression to regress an individual company's return on a return of the market as a whole. Several assumptions regarding the CAPM are summarized by Modigliani and Pogue (1). Empirical tests of these assumptions by Jacob (2), Miller-Scholes (3), Friend (4), Blume (5), and Black-Jensen-Scholes (6) have yielded the following information:

(1) A significant positive relationship exists between realized returns and systematic risk even though the slope of the relationship is less than predicted by the CAPM.

(2) A linear relationship exists between risk and return.

(3) Both systematic and unsystematic risk appear to be positively related to returns but there is also support for the proportion that the relationship between return and unsystematic risk is partly spurious.

Thus, while the CAPM is not absolutely correct, the results of empirical tests do support the viewpoint that the beta value is a useful risk measure and that high beta stocks are priced correspondingly high.

Related Studies

Impact of Pollution Control Expenditures on Multiple Financial Variables

Even though the beta is a good measure of market risk, some researchers have preferred to use other methods to analyze the impact of pollution abatement expenditures. Roden (7) analyzed financial data for eight companies in the Portland cement industry for the time period 1962 through 1971. After establishing the relationship between pollution abatement expenditures, financial strength, and the price/earnings ratio, he tested the hypothesis that a firm's P/E multiple is dependent upon its dividend payout rate and the firm's liquidity. This relationship should hold true since the normal risk averting shareholder would prefer current dividends to future dividends, therefore, a higher payout ratio would lead to a higher demand for the stock and, consequently, a higher price. A higher price in turn leads to a higher P/E multiple. The liquidity component is measured by the ratio of net working capital to long-term debt. The larger the liquidty ratio is, the more investors should be willing to hold the stock since this closeness to money both reduces uncertainty and increases the store of value.

For the cement industry, Roden postulated that due to increased expenditures for pollution control equipment, both the price/earnings multiple and liquidity would decrease leading to an overall decline in the financial condition of the industry. He tested the hypothesis with a regression equation pooling cross section and time series data utilizing two variables plus eight dummy variables, one for each company tested. He found that both the average payout ratio and the liquidity variable decreased, implying that the cost of equity in the cement industry will increase. As shareholders demand a greater return to compensate them for the increased risk, the P/E multiple will fall, the consequence of which is to impair the ability of the industry to attract new financial capital and restrict its ability to increase productive capital. In the end, Roden suggests that the market price will fall and that, due to pollution abatement expenditures, the cement industry as well as other affected industries will experience financial difficulties in the years ahead.

Impact of Pollution Control Expenditures on Market Risk of Securities

Ray (8) tested for stock price reaction to the impact of pollution abatement expenditures on the debt capacity of the firm. His sample included 180 firms divided into three different portfolios; a group of 40 polluters, a randomly generated control group of 40 firms, and a randomly generated portfolio of 100 firms. The data was extracted from the CRSP tape prepared by the Center for Research in Security Prices at the University of Chicago. The only requirement for inclusion in the sample was that the firms be continuously listed on the tape from January 1953 through June 1968. The portfolio of 40 polluters was divided into four groups of ten firms each in the following industries: chemicals, paper, steel, and electric utilities. These four industries accounted for nearly 80% of all pollution abatement expenditures in the manufacturing sector in 1972, therefore one may expect that these industries would be particularly hard hit by stringent pollution legislation.

By dividing the time period into two nonoverlapping periods, Ray proposed to show that two different periods existed regarding the risk characteristics related to pollution abatement expenditures. Since both air and water conrol laws developed along similar, though independent, lines, Ray was able to approximate a compromise date as a division of the two periods. The first period January 1953-December 1960, is that period of time before the existence of "legislative risk", the risk that arises out of possible changes in the incentives that the government employs to induce industry to invest in pollution abatement equipment. The second period, January 1961-June 1968, was defined as that period after that risk had been recognized.

Mean beta values were computed for each firm and tested for stationarity across the two periods to determine the variation, if any, in market risk. The same test was also performed for mean standard deviation values to determine nonmarket risk variation. The beta tests conformed to Ray's hypothesis, that is, for the portfolio of 40 polluters the decline in the mean beta value from 1.04 to .838 was statistically significant indicating that market risk had declined from period one to period two. The next part of the test was to determine if total risk had declined, for if it had not, then one can say that nonmarket risk had increased. For the 40 polluting firms, the variance was calculated for each firm as a test of stationarity of total risk. The results show that while variance declined significantly for four firms, it increased for eight and remained constant for the remaining 28, indicating that total and nonmarket risk did indeed increase. The increase in nonmarket risk was tested directly using the same procedure as for the test of mean betas with the results showing a statistically significant increase in nonmarket risk. For the randomly generated portfolios of 40 and 100 firms, the results conform to the stationary findings of other empirical studies that the mean beta is stationary over time and approaches 1.0 as the number of firms in the portfolio increase.

Mahaptra (9) replicated the work of Ray, enlarged the sample to 59 firms in seven polluting industries (chemicals, paper, electric and gas utilities, iron and steel, petroleum refining, primary nonferrous metals, and textiles) and extended the study to include data through December 1975. Utiliting the SECURE program from the Sloan School, M.I.T., he computed separate ordinary least squares time-series regressions and tested the stationarity of betas across two nonoverlapping time periods. The results indicated that there was no significant change in market risk for the polluters as a portfolio even though the shift was statistically significant for individual firms. He also calculated yearly beta values for each industry noting that, in 1971, a significant shift in market risk did occur causing him to conclude that stringent legislation caused a structural change in all the industries. A randomly generated control portfolio of 60 firms showed, as expected, no significant change in the beta values.

Correlation of Financial and Environmental Quality Variables

Bragdon and Marlin (10) analyzed financial data for companies in the paper industry and compared that data with pollution control investment data as reported by Allen, Kaufman, and Underwood (11) for the Council on Economic Priorities (CEP). Twelve of the 24 companies analyzed in the latter work were ranked according to five measures of profitability and three pollution performance measures. The profitability measures and time periods involved were: earnings per share growth, 1965-1970; estimated earnings per share growth, 1970-1971; average return on equity, 1965-1970; return on equity, 1970; and average return on capital, 1965-1970. The measures of pollution control were an index with equal weights given to water treatment, particulate control, and gas and oder control; an index with equal weights given to water and both types of air pollution controls; and a score on overall pollution performance as determined by Allen et al.

Three general comments were made regarding the profit and pollution records. First, of the top five performers as measured by 1965-1970 earnings growth, four had above-average pollution control records as rated by the CEP. Second, of the top five performers in the 1970-1971 estimated earnings growth, four had above-average pollution records. Third, both of the firms given an overall good environmental rating by the CEP were among the top five earnings performers during 1965-1970 while the worst rated company had one of the worst earnings performances. Bragdon and Marlin attempted to statistically test the correlation of financial and environmental performance by calculating Spearman rank correlation coefficients. All of the coefficients calculated were positive and two-thirds were significant at the 95% confidence level indicating that there is compatibility between environmental protection and financial performence.

Methodology and Model Development

Technique of Analysis I

The empirical tests in this paper are composed of two separate, yet related, methodologies utilizing portfolios which are constructed in slightly different manners. See Table II for a summary of the portfolios used for each method of analysis. The first methodology is comprised of three portfolios; the polluting portfolio, control portfolio I, and control portfolio II. The polluting portfolio is made up of four industries which, intuitively, one considers to be most affected by pollution legislation; the chemical, steel, paper, and electric utility industries. Within each industry ten firms are selected with the only requirement for inclusion being that they be continuously listed on the New York Stock Exchange for the entire time period under consideration, 1953-1978. To derive the control portfolio I, a random sample of 40 firms is selected, the requirements for inclusion being, again, that the firms be continuously listed on the NYSE and that no firm in the polluting portfolio be included in the control portfolio. This portfolio is drawn so that a comparison could be drawn between two portfolios of equal size.

For control portfolio II, 100 firms are randomly selected, the requirements for inclusion being the same as for control portfolio I. This group of firms is used to test the methodological and sample selection techniques in a comparison with other studies. See Appendix A for a complete listing of all companies in each portfolio.

TABLE II

PORTFOLIO CLASSICIATION SCHEMES--TECHNIQUES 1 AND 2

General Classification Scheme

1. Polluting Portfolio--40 firms, 10 firms each from the chemical, steel, paper, and electric utility industries.

2. Control Portfolio I--40 firms selected at random from CRSP tape. Cannot be included in Polluting Portfolio and must be continuously listed on tape 1953-1978.

3. Control Portfolio II--100 firms selected at random. Requirements for inclusion same as for Control Portfolio I.

See Appendix A for details.

Relative Expenditure Classification Scheme

1. High Category--350 firms in six SIC major industry codes with highest relative expenditures for pollution control equipment.

2. Medium Category--367 firms in 15 SIC major industry codes with moderate relative expenditures for pollution control equipment.

3. Low Category--501 firms in 43 SIC major industry codes with lowest relative expenditures for pollution control equipment.

See Appendix B for details.

A regression is computed for each of the 180 firms (a total of 540 regressions) in each of three nonoverlapping time periods, the basis of which will be discussed in the next section. A Student's t-test on the average beta values is performed for the portfolio of 40 polluting firms to determine if any significant change in risk occurred between time periods, the stationarity test. The same test is computed for the standard deviation of the regression to determine if there is any significant change in nonmarket risk. As a basis of comparison, the same computations are made for the randomly generated control portfolio of 40 firms. The stationarity test of beta is performed with the control portfolio of 100 firms as a basis of comparison with the empirical studies of Blume (12) and Jensen (13) to insure that the general procedure was performed adequately.

Justification for Time Interval and Data Source

The total time interval for this method, from January 1953 through December 1978, was used for three basic reasons. First, the stock prices data is in readily available form for this period. The source of the data is the 1978 version of the CRSP Monthly Investment Performance File (CRSP Tape) as prepared by the Center for Research in Security Prices at the University of Chicago. Monthly stock price data is included for all common stocks listed on the New York Stock Exchange from December 1925 through December 1978. Second, the time interval is long enough to segment it into three nonoverlapping periods from which changes in risk can be analyzed. The first period, January 1953-December 1960, is that period before the existence of legislative risk and large capital outlays for pollution abatement equipment. The second period, January 1961-June 1968, is that period when legislative risk would play an increasingly important part of total risk perception and when major capital expenditures had begun. The third period, July 1968-December 1978, is that period when major expenditures were made to satisfy certain deadlines in pollution legislation. The third reason for this total interval is that, based on other empirical studies, it is of sufficient length to test for stationarity.

It was recognized in Chapter II that the legislation concerning water and air pollution developed along similar lines. Since the four industries in the sample are considered polluters of both air and water, it is possible to find compromise dates as divisions of the total period. In the area of air pollution, the series of events and acts leading up to the Clean Air Act of 1963 is considered the beginning of this era of legislation. The events leading up to the Water Quality Act of 1965 which, like the Clean Air Act, first established a national policy for water pollution control is considered to be the start of this era of legislation. Thus, the compromise date for division of the first two periods is set at January 1961. The demarcation between the second and third periods is set at June 1968 due to data limitations imposed on other similar empirical studies (8) and the desire in this paper to replicate, extend, and compare these results with those of the other studies.

Technique of Analysis II

The second phase of this paper is based on yearly surveys taken by the Department of Commerce concerning the actual amounts of pollution abatement expenditures (PAE) for the period 1973-1978. The data, expressed as a percentage of PAE to total capital expenditures and shown in Table III, are divided into industries by major Standard Industrial Classification (SIC) codes (14) and allow a breakdown of the industries into three groups; high, medium, and low polluting industries based on the criterion of percent pollution control investment to total capital investment in individual years. Six industry groups, those with pollution abatement expenditures greater than seven percent of all capital expenditures, were placed in the high expenditure category, seven whose PAE is between two percent and seven percent of total capital expenditures were placed in the medium expenditure category, and six, whose PAE is less than two percent of the total, were placed in the low expenditures category. A summary of the portfolios is contained in Table II. A complete listing of industry groups by category is contained in Appendix B.[1] Utilizing the data from the CRSP tape, yearly beta values are calculated for each firm, with mean values computed in each major industry group and in each category of industries. Again, a t-test is performed on the mean values to determine if there are any changes in risk across time and between categories. It is expected that the industry betas as well as the category betas will reflect a change in risk level that occurred as firms moved out of the phase of preparing for pollution control investment to one of supporting and operating the investment. In examining Figure 1, it appears that after 1975, pollution control investment had declined, therefore, one may also expect a decline in the risk premium required for the involved industries.

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[1]Within the Department of Commerce survey, not all of the SIC codes are represented because either the data was unavailable or because the industries have no expenditures to control pollution. See Appendix C for a list of those industries that were not included in the survey. By combining Appendix B with Appendix C, a comprehensive list of all industries classified using the SIC system is obtained.

TABLE III

POLLUTION CONTROL EXPENDITURES AS A PERCENTAGE OF TOTAL CAPITAL EXPENDITURES

Industry	SIC Major Code	Expenditure Classification	1973	1974	1975	1976	1977	1978
Primary Metals	33	High	23.84	16.61	17.18	15.69	15.72	12.59
Stone, Clay & Glass	32	High	9.85	12.88	14.25	6.15	7.31	6.60
Paper	26	High	19.49	19.29	16.82	14.71	13.78	7.09
Chemicals	28	High	10.15	8.33	10.86	11.83	10.16	7.84
Petroleum	29	High	10.94	10.12	11.80	10.86	8.23	8.32
Public Utilities	49	High	8.08	7.87	8.37	9.06	8.80	8.59
		Average	13.73	12.52	13.21	11.31	10.67	8.51
Electrical Machinery	36	Medium	4.97	6.67	5.84	5.61	3.37	3.30
Transportation Equipment	37	Medium	6.11	3.66	3.42	3.39	3.09	3.57
Other Durables	24,25,34,38,39	Medium	5.07	4.49	5.31	3.87	3.61	2.71
Food Including Beverages	20	Medium	5.25	4.68	5.17	4.48	4.24	3.57
Textiles	22	Medium	3.94	3.30	4.56	4.40	3.75	2.84
Rubber	30	Medium	3.32	3.19	3.95	3.39	3.26	3.31
Mining	10,11,12,13,14	Medium	3.66	1.84	1.91	2.17	2.18	4.25
		Average	4.62	3.98	4.31	3.90	3.36	3.36
Machinery Exc. Elect.	35	Low	2.44	1.81	1.75	1.59	1.78	1.73
Other Nondurables	21,23,27,31	Low	1.45	1.80	2.80	1.43	1.20	1.48
Railroad	40	Low	.88	1.17	1.38	1.15	.97	1.12
Air Transportation	45	Low	.66	.36	.59	1.21	.83	.64
Other Transportation	41,42,43,44,46,47	Low	.75	2.26	1.41	1.06	.95	1.05
Communication, Commercial and Other	See Appendix B	Low	.69	.56	.63	.53	.51	.43
		Average	1.15	1.33	1.43	1.16	1.04	1.08

Source: Department of Commerce, Survey of Current Business (June 1978, June 1979).

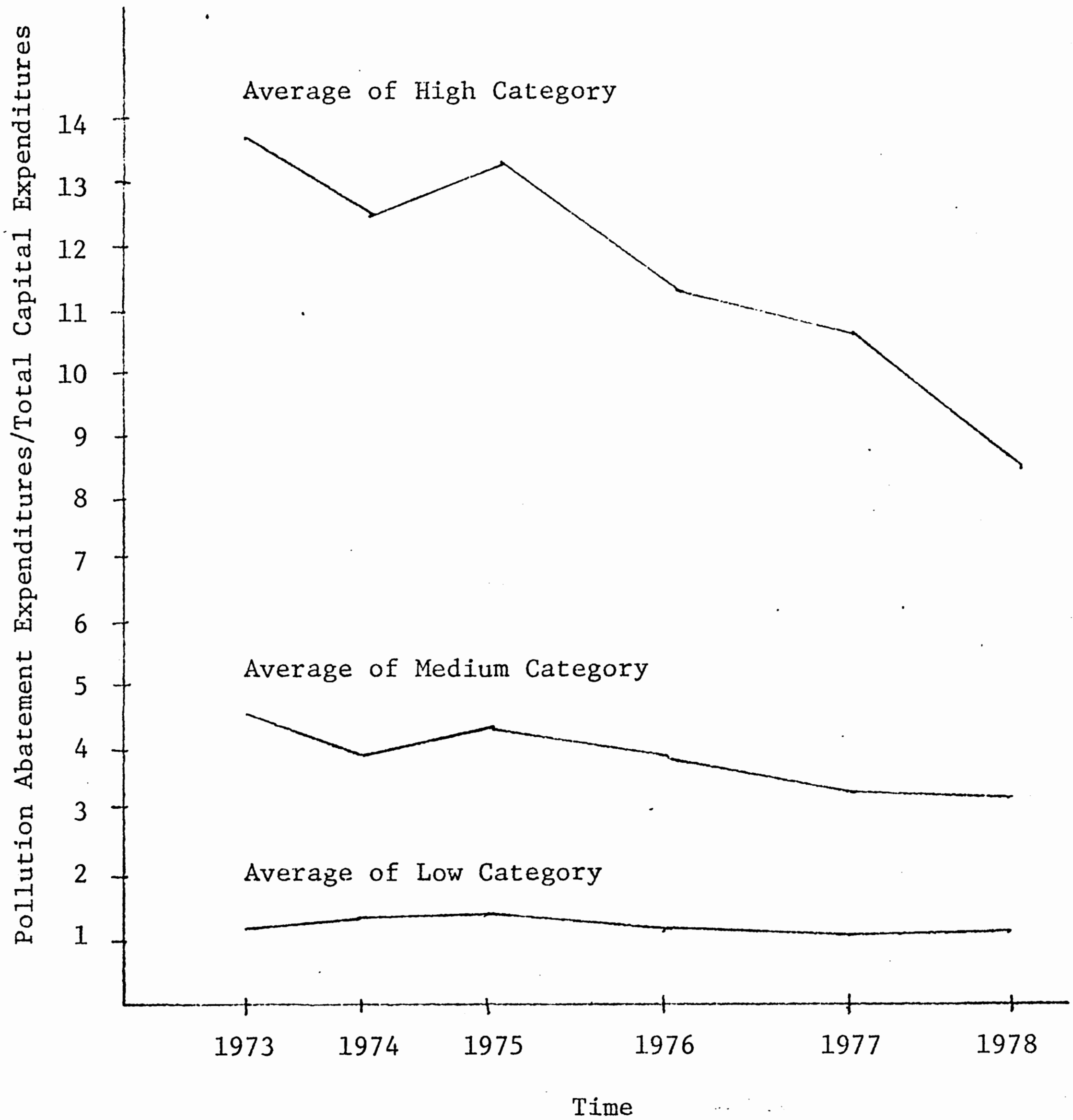

Figure 1. Average Ratio of Pollution Abatement Expenditures to Total Capital Expenditures by Category, 1973-1978

Explanation of Model

The testing procedure utilized is the single index or Capital Asset Pricing Model as developed by Markowitz (15) and refined by Sharpe (16). Utilizing a simple linear regression, the covariance between a company's stock and the market index can be measured. The general form of the model is as follows:

$$R_{it} = a_i + B_i M_t + e_{it} \qquad t = B1, E1$$

with the following assumptions of general linear least squares analysis:

$E(e_{it}) = 0$ (the expected value of the error term is 0)

$Var(M_t, e_{it}) = 0$ (the covariance between the market and the error term is 0)

$Var(e_i, e_j) = 0$ (the covariance between error terms of different securities is 0)

and where:

B1 = beginning of time interval (January 1953, January 1961, or July 1968)

E1 = end of time interval (December 1960, June 1968, or December 1978)

$R_{it} = n \frac{D_{it} + P_{it}}{P'_{it-1}}$ (return including all distributions on security i from time t to t-1)

a_i = intercept of linear relationship (alpha value)

B_i = slope of linear relationship (beta value)

$M_t = n \frac{(L)_t}{(L)_{t-1}}$ (return including dividends on a value-weighted market portfolio from time t to t-1)

e_{it} = random error term (residual)

D_{it} = cash dividend on common stock i in time t

P_{it} = closing price for common stock i at end of month t

P'_{it} = closing price for common stock i at end of month t-1

$(L)_t$ = value-weighted market index of all NYSE firms, adjusted for cash dividends at end of month t

$(L)_{t-1}$ = value-weighted market index of all NYSE firms, adjusted for cash dividends at end of month t-1

This model allows the analysis of the return on a particular stock in a particular time period (R_{it}) to be a factor of: (1) general market trends (B_iM_t) and (2) circumstances unique to that particular security ($a_i + e_{it}$) which are independent of the general market. Extending this to a portfolio analysis, it is recognized that the market factor (systematic risk) cannot be diversified away because of the covariance between all securities and the market, while the nonmarket factor (unsystematic risk), on the other hand, can be eliminated through the diversification of the portfolio.

ENDNOTES

1. Franco Modigliani and Cerald A. Pogue, "An Introduction to Risk and Return: Concepts and Evidence." Financial Analysis Journal (May-June 1974), p. 78.

2. Nancy Jacob, "The Measurement of Systematic Risk for Securities and Portfolios: Some Empirical Results." Journal of Financial and Quantitative Analysis, Vol. 6 (March 1971), pp. 815-834.

3. Marton H. Miller and Myron S. Scholes, "Rates of Return in Relation to Risk: A Reexamination of Recent Findings." Published in Studies in the Theory of Capital Markets, edited by Michael Jensen. (New York: Praeger, 1972), pp. 47-78.

4. Irwin Friend and Marshall E. Blume, "A New Look at the Capital Asset Pricing Model." Journal of Finance, Vol. 28 (March 1973), pp. 19-33.

5. Marshall E. Blume, "Portfolio Theory: A Step Toward its Practical Application." Journal of Business, Vol. 43 (April 1970), pp. 152-173.

6. Fischer Black, Michael C. Jensen, and Myron S. Scholes, "The Capital Asset Pricing Model: Some Empirical Tests." Published in Studies in the Theory of Capital Markets, edited by Michael Jensen. (New York: Praeger, 1972), pp. 79-121.

7. Peyton Foster Roden, "Financial Implication of Pollution Abatement in the Cement Industry." Working Paper Series No. 9, Louisiana State University in New Orleans, Graduate Research Council.

8. Marvin E. Ray, The Environmental Crisis and Corporate Debt Policy, (Lexington, Mass.: D. C. Heath and Company, 1974).

9. S. Mahaptra, "Impact of Pollution Control Regulations on the Market Risk of Securities." AIDS-Ninth Annual Conference, 1977.

10. J. H. Bragdon and J. A. Marlin, "Pollution and Profitability: The Case of the Pulp and Paper Industry." Risk Management, (April 1972), pp. 9-18.

11. L. Allen, E. Kaufman, and J. Underwood, Paper Profits: Pollution in the Pulp and Paper Industry, (Cambridge, Mass., The MIT Press, 1972).

12. Marshall Blume, "On the Assessment of Risk." Journal of Finance, (March 1971), pp. 1-10.

13. Michael C. Jensen, "Risk, The Pricing of Capital Assets, and the Evaluation of Investment Portfolios." Journal of Business, (April 1969), pp. 167-247.

14. Office of Management and Budget, Executive Office of the President, Standard Industrial Classification Manual, (U. S. Government Printing Office, 1972).

15. Harry Markowitz, "Portfolio Selection." Journal of Finance, (March 1952), pp. 77-91.

16. William F. Sharpe, "A Simplified Model for Portfolio Analysis." Management Science, (January 1963), pp. 277-293.

CHAPTER IV

RESULTS AND CONCLUSIONS

Introduction

In this chapter, the empirical results are presented in an attempt to provide answers to the basic question of whether or not pollution abatement expenditures adversely affect the perceived market risk of various industries and firms within those industries. The two separate, yet related, techniques utilize the single-index Capital Asset Pricing Model to regress company returns on a market return to calculate beta values as a measure of market risk. The first approach uses three portfolios, one comprised of firms generally considered as polluters and two control portfolios, calculating betas and standard errors for three nonoverlapping time periods. It is expected that the betas be higher for the polluting portfolio and that there will be an increase in the market risk of those firms from period to period as evidenced by an increase in the beta coefficient. In the second, approach, yearly betas are calculated for three portfolios designated as high, medium, and low polluters with the expectation that, again, the high polluters will experience the largest market risk and that all the portfolios will show a change in risk during 1975. Also, presented in this chapter is a comparison of these results with other empirical studies as well as any implications for future research.

Technique of Analysis I

This method of analysis parallels that of the Ray approach and extends the time period he used for an additional ten years. Three portfolios were generated; the first being comprised of 40 polluting firms in the chemical, paper, steel, and electric utility industries, the second being a randomly selected control portfolio of 40 firms, and the third being another randomly selected portfolio of 100 firms. See Appendix A for a list of the firms included in each portfolio. The time periods for the three non-overlapping periods of analysis were chosen as: Period One--January 1953-December 1960; Period Two--January 1961-June 1968; and Period Three--July 1968-December 1978. Mean beta and standard error values were then computed for each portfolio in each time period and compared across the time periods using a Student's t-test to determine if any significant changes had occurred.

The empirical results, presented in Table IV, do not provide support for the hypothesis proposed in this paper. For the polluting portfolio, no significant difference in the mean beta values was detected between periods one and two or periods two and three even though the average beta did decline throughout time. In examining the individual companies, from period one to period two, it was found that 22 firms had betas that decreased and 15 firms had betas that increased with three remaining constant although it is not known if these individual shifts were significant. From period two to three, 21 companies had betas that decreased and betas for 19 companies increased. Thus, one may conclude that, although there was some variation in the beta values and that, on the whole, they declined over the three time periods, the decrease is not statistically significant. However, looking at the mean standard error of the regression

TABLE IV

SUMMARY STATISTICS FOR ALL PORTFOLIOS USING
TECHNIQUE OF ANALYSIS I

Polluting Portfolio	Mean Beta	t	Mean Standard Error of Regression	t
Period 1-	1.071		0.048145	
Period 2	1.034	0.6455	0.0497	-.4721
Period 2-	1.034		0.0497	
Period 3	.977	1.1879	0.06511	-4.9211*
Control 1:				
Period 1-	.878		0.05501	
Period 2-	1.139	-3.9872*	0.06499	-1.927
Period 2-	1.139		0.06499	
Period 3	1.107	0.4393	0.08520	-3.2826*
Control 2:				
Period 1-	1.039		0.05843	
Period 2	1.220	-5.6235*	0.06149	-1.1032
Period 2-	1.220		0.06149	
Period 3	1.042	4.0937*	0.07858	-5.8267*

*Denotes .05 level of significance.

equations, the measure of nonmarket risk, it is seen that no significant shift occurred from period one to period two, but that a significant increase did occur between periods two and three. Again, examining the companies in the polluting portfolio on an individual basis, 25 companies had standard errors that increased from period one to period two while 15 companies experienced a decline. From period two to period three, the standard error for each of 38 companies increased while it decreased for only two companies. Therefore it is concluded that there was no significant shift in the market risk of the firms in industries generally considered to be polluters but that the nonmarket risk did increase significantly, but only from period two to period three.

The control portfolio one was generated to serve as a comparison for the polluting portfolio. In examining the betas, it is seen that, from period one to period two, there was a significant shift in market risk, but that between periods two and three, no significant change occurred. On an individual company basis, 32 companies experienced an increase in their beta value while eight companies experienced a decline from period one to two and, from period two to three, 21 betas decreased, 17 increased, and two remained constant. For the standard error, the results are similar for control one as for the polluting portfolio, that is, a significant change was experienced only from period two to period three. For that time period, 34 companies experienced an increase, while the standard errors for six companies decreased. From period one to period two, 29 companies showed an increase in standard errors with 11 showing a decline. It should be noted that the findings of the control portfolio one do not conform with the stationarity findings of Blume (1).

For the control portfolio two, significant shifts in mean betas did occur between all the time periods, a finding contrary to the expectations and to findings of other empirical studies. Not only were the mean betas expected to be stationary, but they should approach 1.00 as the size of the portfolio increases. From period one to period two, the mean beta actually increased to 1.22 but then dropped in period three to a value of 1.042. For the standard errors, as in the case of the other two portfolios, a significant shift occurred only between periods two and three.

Technique of Analysis II

This method of analysis divides the sample firms into, again, three portfolios, but in this case they are based on the results of a survey by the Department of Commerce which reported expenditures on pollution abatement equipment together with total capital expenditures by SIC major code. The firms were segmented into high, medium, and low categories of polluters after which yearly mean beta and standard error values were calculated for each portfolio for the years 1973-1978. Those firms in the high category of polluters invested a minimum, seven percent, of their total capital expenditures for pollution abatement equipment in each of the six years, those in the medium category had invested between two and seven percent, while those in the low category generally invested less than two percent. See Appendix B for a list of those industries included in each category. A comparison between the yearly values and also between the categories was made.

The results, presented in Tables V and VI, are somewhat surprising. While there were significant changes between nearly all beta values (market risk) throughout the six year period, 1973-1978, and also

TABLE V

MEAN BETA VALUES FOR ALL CATEGORIES 1973-1978
USING TECHNIQUE OF ANALYSIS II

	1973	1974	1975	1976	1977	1978
High	1.207	0.756*	1.147*	1.047*	0.817*	0.924*
Medium	1.62	.860*	1.405*	1.446	1.130*	1.314*
Low	1.67	.834*	1.59*	1.45*	1.16*	1.32*

*Denotes that change from previous year is significant at .05 level.

TABLE VI

MEAN STANDARD ERROR VALUES FOR ALL CATEGORIES 1973-1978
USING TECHNIQUE OF ANALYSIS II

	1973	1974	1975	1976	1977	1978
High	0.0688*	0.0822*	0.08293	0.0610*	0.0537*	0.0574
Medium	0.0874	0.1039*	0.1101	0.0823*	0.0733	0.0829
Low	0.0855	0.1048*	0.1169*	0.0839*	0.0209*	0.0774*

*Denotes that change from previous year significant at .05 level.

significant changes in the standard deviations (nonmarket risk), the relative values for each category are not what was expected. This is evident by examining Figures 2 and 3. Normally, one would expect that the betas for the firms in the category of high relative polluters would be higher than firms in the medium or low categories reflecting a higher market risk due to the nature of their capital investment. However, quite the opposite appears to be the case. The same reasoning would also apply to the nonmarket risk of the affected firms, however, again, no evidence is shown to support this contention. One phenomenon that was expected was the inflection point in 1975. It appears that as firms met the deadlines of pollution control legislation, their market and nonmarket risks increased. However, this phenomenon could also be attributed to the effects of the general economic recession that was occurring at that time. Therefore, it is difficult to draw any conclusions from this data other than that the effects of pollution control legislation were overshadowed by other, more pervasive considerations.

Comparison of the Two Techniques

An analysis comparing the results of the two methods provides support for the computational techniques utilized in this paper. Intuitively, it would be expected that the mean beta and standard error values for period three of the polluting portfolio in method one are similar to those obtained for the high category of polluters in method two since the two methods used similar time periods and similar companies. The evidence presented in Tables IV and V support this contention. The period three mean beta for the polluting portfolio is .977 while the average 1973-1978 beta for the high category of polluters is .983. The mean standard error for the former group of firms is .06511 with the latter being calculated

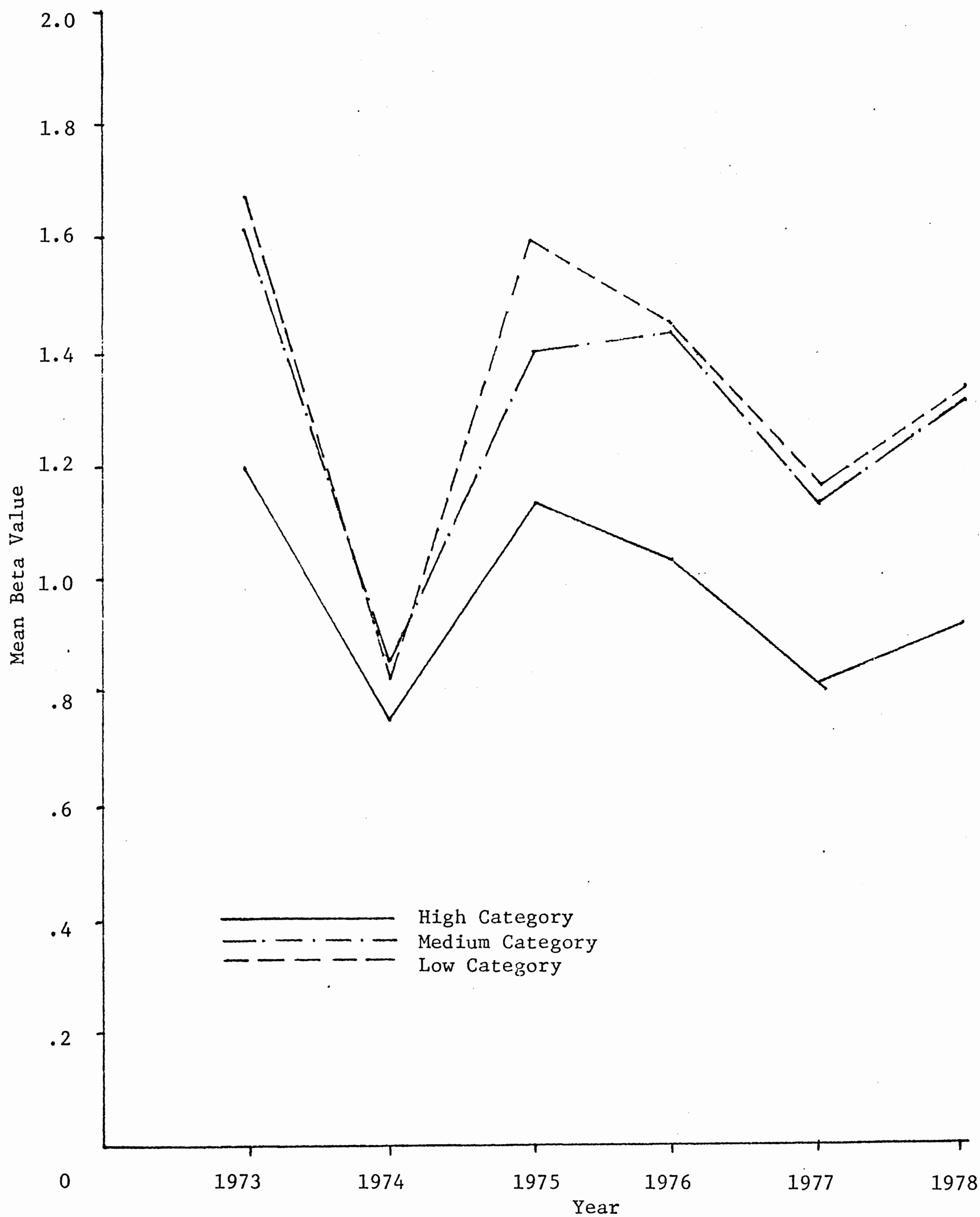

Figure 2. Mean Beta Values Plotted by Year Using Technique of Analysis II

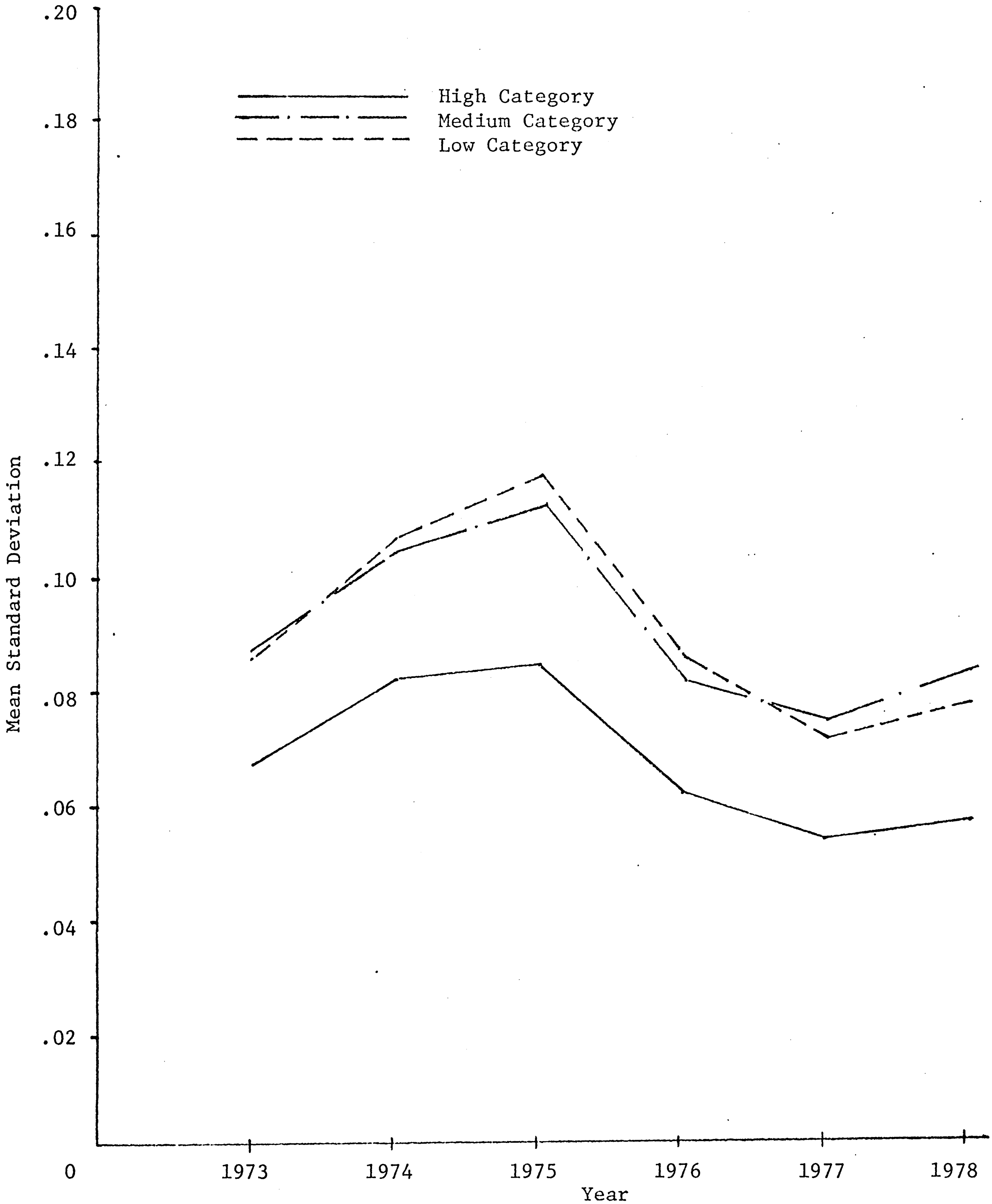

Figure 3. Mean Standard Deviations Plotted by Year Using Technique of Analysis II

as .0676. Therefore, it can be stated with a fair degree of certainty that the computational techniques are consistent for each method of analysis.

Comparison with Previous Studies

The results of method one differ markedly with those obtained by Ray (2) who found a significant shift in market risk (beta) from period one to period two for the polluting portfolio, no change in beta for either one of the control portfolios, and that the mean beta value approached 1.00 for control portfolio two. An explanation for the difference in the results of the polluting portfolio could be in the computational techniques utilized in each study. Although attempts were made to follow the Ray approach as closely as possible, discrepancies in the data could have been a further factor in causing the variance in results. The difference for the control portfolios is probably due to the fact that different companies were included in the sample or, again, that the computational techniques were not the same. However, this still does not explain the differences with the stationarity findings of other empirical studies. The results of this paper, though, do reflect the implications of a Department of Commerce study conducted in August, 1979 (3). That study concluded that for 1975-1978 productivity of American business was 98.8% of what it would have been had no pollution control legislation been passed thus implying that the perception of risk presented in this paper is not out of line. Also the betas presented in this paper reflect the spending patterns of the industry groupings, however, the fact that the high polluters have the lowest betas is still not explained.

Concluding Remarks

Overall, the results of the empirical analysis have provided little evidence to support the hypothesis that pollution control legislation has had an adverse impact on the riskiness of affected industries. Except for significant changes in mean nonmarket risk between periods two and three for the polluting and control portfolios, virtually no significant changes in risk were observed. In the second phase of analysis, significant changes in betas and standard errors within each category of polluters were obtained, however, the relative values of the measures of risk were not expected. Thus, it appears that factors beyond the scope of this analysis were responsible for this phenomenon.

Regarding future research, one might conclude that the assumption that each company in the study has invested in pollution abatement equipment in an amount consistent with the average reported in the industry is not a valid one. Perhaps an approach utilizing individual case study analyses would be more useful than the broad, macro approach used in this paper. As reported by Bragdon-Marlin (4) and reviewed in Chapter III of this paper, certain companies have given a good deal of consideration to environmental policies when establishing their overall goal structure and strategic course. Therefore, different management styles creating a greater level of conscienceness about the environment can more than offset the adverse effects and risks inherent in pollution control investment. Also, the SIC grouping of method two does not allow the researcher to view the company in an individualized, divisionalized sense, thus the effects of pollution abatement expenditures in one division may be masked by the lack of such expenditures in another division resulting in a misclassification of the company and a misinterpretation of the results of the analysis on that company. Therefore, future research into the effects on one industry on a divisionalized, company basis may provide more meaningful results.

ENDNOTES

1. Marshall E. Blume, "Portfolio Theory: A Step Toward its Practical Application." Journal of Business, April 1970, pp. 152-173.

2. Marvin Ray, The Environmental Crisis and Corporate Debt Policy, (Lexington, Mass., D. C. Heath and Company, 1974).

3. Edward F. Denison, "Pollution Abatement Programs: Estimates of Their Effect Upon Output per Unit of Input, 1975-1978," Survey of Current Business, August 1979, pp. 58-63.

4. J. H. Bragdon and J. A. Marlin, "Pollution and Profitability: The Case of the Pulp and Paper Industry," Risk Management, April 1972, pp. 9-18.

BIBLIOGRAPHY

Allen, L., Kaufman, E., and Underwood, J. Paper Profits: Pollution in the Pulp and Paper Industry, (Cambridge, Mass., The MIT Press, 1972).

Black, Fischer, Jensen, Michael C., and Scholes, Myron S. "The Capital Asset Pricing Model: Some Empirical Tests." Published in Studies in the Theory of Capital Markets, edited by Michael Jensen. (New York: Praeger, 1972), pp. 79-121.

Blume, Marshall E. "Portfolio Theory: A Step Toward its Practical Application." Journal of Business, Vol. 43 (April, 1970), pp. 152-173.

__________. "On the Assessment of Risk." Journal of Finance (March, 1971), pp. 1-10.

Dworsky, Leonard B. Conservation in the United States, A Documented History--Pollution. (New York: Chelsea Publishers, 1971).

Friend, Irwin and Blume, Marshall E. "A New Look at the Capital Asset Pricing Model." Journal of Finance, Vol. 28 (March, 1973), pp. 19-33.

Jacob, Nancy. "The Measurement of Systematic Risk for Securities and Portfolios: Some Empirical Results." Journal of Financial and Quantitative Analysis, Vol. 6 (March, 1971), pp. 815-834.

Jensen, Michael C. "Risk, The Pricing of Capital Assets, and the Evaluation of Investment Portfolios." Journal of Business (April, 1969), pp. 167-247.

Mahaptra, S. "Impact of Pollution Control Regulations on the Market Risk of Securities." AIDS--Ninth Annual Conference, 1977.

Markowitz, Harry. "Portfolio Selection." Journal of Finance (March, 1952), pp. 77-91.

Miller, Merton H. and Scholes, Myron S. "Rates of Returns in Relation to Risk: A Reexamination of Recent Findings." Published in Studies in the Theory of Capital Markets, edited by Michael Jensen. (New York: Praeger, 1972), pp. 47-78.

Bragdon, J. H., and Marlin, J. A. "Pollution and Profitability: The Case of the Pulp and Paper Industry." Risk Management (April, 1972), pp. 9-18.

Mills, Edwin S. The Economics of Environmental Quality. (New York: W. W. Norton and Company, Inc., 1978.)

Modigliani, Franco and Pogue, Gerald A. "An Introduction to Risk and Return: Concepts and Evidence." Financial Analysts Journal (May-June, 1974), pp. 69-86.

Ray, Marvin E. The Environmental Crisis and Corporate Debt Policy. (Lexington, Mass.: D. C. Heath and Company, 1974.)

Roden. Peyton Foster. "Financial Implication of Pollution Abatement in the Cememt Industry." Working Paper Series No. 9, Louisiana State University in New Orleans, Graduate Research Council.

Rutledge, Gary L., Dreiling, Frederick J., and Dunlap, Betsy C. "Capital Expenditures by Business for Pollution Abatement, 1973-77 and Planned 1978." Survey of Current Business (June, 1978), pp. 33-38.

Rutledge, Gary L., Dreiling, Frederick J., and O'Connor, Betsy C. "Capital Expenditures by Business for Pollution Abatement, 1977, 1978, and Planned 1979." Survey of Current Business (June, 1979), pp. 20-22.

Sharpe, William F. "A Simplified Model for Portfolio Analysis." Management Science (January, 1963), pp. 277-293.

Office of Management and Budget, Executive Office of the President, Standard Industrial Classification Manual (U. S. Government Printing Office, 1972).

APPENDIXES

APPENDIX A

PORTFOLIO OF FORTY FIRMS IN POLLUTING INDUSTRIES, CONTROL PORTFOLIOS I AND II

Portfolio of Forty Firms in Polluting Industries

Chemical Industry:

Allied Chemical Corporation
American Cyanamid Company
Celanese Corporation
Dow Chemical Corporation
Du Pont (E. I.) De Nemours and Company
Koppers Company, Inc.
Monsanto Company
Rohm and Haas Company
Sun Chemical Corporation
Union Carbide Corporation

Paper Industry:

Chesapeake Corporation of Virginia
Crown Zellerbach Corporation
Hammermill Paper Company
International Paper Company
Kimberly-Clark Corporation
Mead Corporation
St. Regis Paper Company
Scott Paper Company
Union Camp Corporation
Westvaco Corporation

Steel Industry:

Allegheny Ludlum Industries, Inc.
Armco Steel Corporation
Bethlehem Steel Corporation
Copperweld Corporation
Inland Steel Company
Interlake, Inc.
Lukens Steel Company
National Steel Corporation
Republic Steel Corporation
United States Steel Corporation

Electric Utility Industry:

Carolina Power and Light Company
Commonwealth Edison Company
Consolidated Edison Company of New York
Detroit Edison Company
New England Electric System
Pennsylvania Power and Light Company
Philadelphia Electric Company
Potomac Electric Power Company
Southern California Edison Company
Southern Company

Control Portfolio I

Adams Express Company
American Invt. Company
Asarco Inc.
Atlantic Richfield Company
Bayuk Cigars Inc.
Canadian Pacific Ltd.
Carling O'Keefe Ltd.
Central Illinois Light Company
Chrysler Corporation
Cincinnati Milacron Inc.
Collins and Aikman Corporation
Consolidated Foods Corporation
Consumers Power Company
Crane Company
Cunningham Drug Stores Inc.
Dresser Industries Inc.
Elgin National Industries Inc.
GATX Corporation
General Instruments Corporation
Gable Industries Inc.
Genesco Inc.
Gulf Oil Corp.
Internation Minerals and Chemicals
Manhattan Industries Inc.
Metro Goldwyn Mayer Inc.
Midland Ross Corporation
National Tea Company
Northwest Industries Inc.
Outboard Marine Corporation
Pacific Lighting Corporation
Public Service Electric and Gas Company
Quaker Oats Company
Ronson Corporation
Standard Oil Company of California
Texasgulf Inc.
Uniroyal Inc.
Walgreen Company
Walker Hiram Gooderham and Worts
Washington Water Power Company
Western Pacific Industries Inc., Del.

Control Portfolio II

Abbott Labs
Amalgamated Sugar Company
Amax Inc.
American Branks Inc.
American Std. Inc.
American Water Works Inc.
Ametek Inc.
Aristar Inc.
Ashland Oil Inc.
Atlantic Richfield Co.
Baltimore Gas and Electric Company
Beech Aircraft Corporation
Bell and Howell Company
Beneficial Corporation
Borden Inc.
Brunswick Corporation
Buffalo Forge Company
CIT Financial Corporation
Carrier Corporation
Chris Craft Industries Inc.
Cincinnati Milacron Inc.
Consolidated National Gas Company
Corning Glass Works
Dayton Power and Light Company
De Soto Inc.
Dr. Pepper Company
Dresser Industries Inc.
Eagle Picher Industries Inc.
Easco Corporation
Eltra Corporation
Empire District Electric Company
Esmark Inc.
Ferro Corporation
Gamble Skogmo Inc.
Gardner Denver Company
General Host Corporation
General Motors Corporation
General Portland Inc.
Georgia Pacific Corporation
Goodyear Tire and Rubber Company
Grumman Corporation
HMW Industries Inc.
Hackensack Water Company
Hall W. F. Printing Company
Heinz, H. J. Company
Hercules Inc.
Idaho Power Company
Interco Inc.
International Business Machines
International Harvester Company

International Telephone and Telegraph Corporation
Jewel Companies Inc.
Johns Manville Corporation
Kansas City Power and Light Company
Kennecott Copper Corporation
Kroger Company
Lowenstein, M. and Sons Inc.
MacAndrews and Forbes Company
Marathon Oil Company
Marine Midland Bks Inc.
Mreck and Company Inc.
Minnesota Mining and Manufacturing Company
Missouri Pacific Corporation
Motorola Inc.
National Airlines Inc.
National City Lines Inc.
National Distillers and Chemical Corporation
Natomas Company
Northern Natural Gas Company
Olin Corporation
Outboard Marine Corporation
PPG Industries Inc.
Pacific Tin Cons. Corporation
Penn Dixie Inds. Inc.
Phelps Dodge Corporation
Pillsbury Company
Pittsburgh Forgings Company
Public Service Company, Colorado
Pullman Inc.
Roper Corporation
Safeway Stores Inc.
St. Louis San Francisco Railway Company
Seagrave Corporation
Simmons Company
Smith, A. O. Corporation
Southern Railway Company
Standard Brands Inc.
Standard Oil Company of California
Standard Oil Company of Ohio
Sterchi Brothers Stores Inc.
Superior Oil Company
Texas Pacific Ld. Tr.
Toledo Edison Company
Trans World Airlines Inc.
Transamerica Corporation
Walker Hiram Gooderham and Worts
Washington Water Power Company
Woolworth, F. W. Company

APPENDIX B

INDUSTRIES WITHIN EACH CATEGORY FOR METHOD 2 BY SIC MAJOR CODE INCLUDED DURING THE YEAR 1973-1978

SIC Major Code	High Pollution Expenditure Industries
26	Paper
28	Chemicals
29	Petroleum
32	Stone, clay and glass
33	Primary metals
49	Public utilities

SIC Major Code	Medium Pollution Expenditure Industries
10	Metal mining
11	Anthracite mining
12	Bituminous coal and lignite mining
13	Oil and gas extraction
14	Mining and quarrying of nonmetallic minerals, except fuels
20	Food, including beverages
22	Textiles
24	Lumber and wood products, except machinery and transportation equipment
36	Electrical machinery
37	Transportation equipment
38	Measuring, analyzing, and controlling instruments, photographic, medical, and optical goods, watches and clocks, and miscellaneous manufacturing industries

SIC Major Code	Low Pollution Expenditure Industries
21	Tobacco manufacturers
22	Textile mill products
27	Printing, publishing, and allied industries
31	Leather and leather products
35	Machinery, except electrical
40	Railroad
41	Local and suburban transit and interurban highway passenger transportation
42	Motor freight transportation and warehousing
43	U. S. Postal Service
44	Water transportation
45	Air transportation
46	Pipelines, except natural gas
47	Transportation services
48	Communication
50	Wholesale trade--durable goods
51	Wholesale trade--nondurable goods
52	Building materials, hardware, garden supply, and mobile home dealers
53	General merchandise stores

SIC Major Code	Low Pollution Expenditure Industries
54	Good stores
55	Automotive dealers and gasoline service stations
56	Apparel and accessory stores
57	Furniture, home furnishings, and equipment stores
58	Eating and drinking places
59	Miscellaneous retail
60	Banking
61	Credit agencies other than banks
62	Security and commodity brokers, dealers, exchanges, and services
63	Insurance
64	Insurance agents, brokers, and service
67	Holding and other investment offices
72	Personal services
73	Business services
75	Automotive repair, services, and garages
76	Miscellaneous repair services
78	Motion pictures
79	Amusement and recreation services, except motion pictures
83	Social services
89	Miscellaneous services

APPENDIX C

INDUSTRIES NOT INCLUDED IN DEPARTMENT OF COMMERCE SURVEY

SIC Major Code	Industry Name
01	Agricultural production--crops
02	Agricultural production--livestock
07	Agricultural services
08	Forestry
09	Fishing, hunting, and trapping
15	Building construction--general contractors and operative builders
16	Construction other than building construction--general contractors
17	Construction--special trade contractors
65	Real estate
66	Combinations of real estate, insurance, loans, law offices
70	Hotels, rooming houses, camps, and other lodging places
80	Health services
81	Legal services
84	Museums, art galleries, botanical and zoological gardens
86	Membership organizations
88	Private households
91	Executive, legislative, and general government, except finance
92	Justice, public order, and safety
93	Public finance, taxation, and monetary policy
94	Administration of human resources programs
95	Administration of environmental quality and housing programs
96	Administration of economic programs
97	National security and international affairs
99	Nonclassifiable establishments

VITA

Kenneth John Martin

Candidate for the Degree of

Master of Business Administration

Report: THE IMPACT OF POLLUTION ABATEMENT EXPENDITURES ON THE MARKET RISK OF SECURITIES: AN EMPIRICAL ANALYSIS

Major Field: Finance

Biographical:

Personal Data: Born in Perry, Oklahoma, May 31, 1955, son of Dr. Charles E. and Marjorie Martin.

Education: Graduated from Perry High School, May 1973; received the Associate of Business degree from Northern Oklahoma College, Tonkawa, Oklahoma in May, 1975; received the Bachelor of Science degree from Oklahoma State University in May, 1977; completed requirements for the Master of Business Administration degree at Oklahoma State University, May, 1980.

Professional: Accountant, Gas-Gas Liquids Division, Koch Oil Company, Wichita, Kansas, June 1977-August 1978. Graduate Research Assistant in Department of Administrative Sciences, Oklahoma State University, January 1979-May 1980.