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Environmental Performance and Corporate Behavior

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Abstract. With its inception in the USA in 1970, the Environmental Protection Agency (EPA) was charged with creating and monitoring federal environmental standards across industries. The EPA establishes the standards that will govern the quality of US natural resources for generations to come, and it penalizes organizations that fail to adhere to these standards. In view of the obvious importance of natural resources to continued production and to the quality of life as well as the cost of violating environmental laws and regulations, several interesting questions arise including the characteristics of violating firms and why they choose to violate the law. This paper examines some of the economic characteristics of such firms. The results of this exploratory study suggest that non-public firms violate the law more frequently than public firms. However, public firms are the more frequent repeat offenders. Further, the data lend some inferential support to the hypothesis that the economic benefits of non-compliance may outweigh its costs.

JEL Classification Codes: G30, G38.

Keywords: Environmental Performance; Corporate Behavior.

1. Introduction

In his futuristic projection of *The World in 2020*, Hamish McRae (1994) discusses the forecasted growth of the world economies. He points out that the quality and quantity of our natural resources are a constraint on production and economic expansion in all countries and that regulations and laws that prescribe the quality of our environment and the availability of natural resources impact firm growth and GNP. Bartell (1997) recognizes the need to improve our social decision-making concerning the trade-offs between economic growth and

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ecological health. Freeman (1997) argues that it is useful to think of natural resources as assets which yield flows of valuable services (and hence cash flow) to the population. Yet, research concerning environmental performance and corporate characteristics is surprisingly sparse.[3] This paper extends existing research by examining the characteristics of polluting firms. We examine the characteristics of firms that violate environmental laws and conduct some exploratory and rudimentary hypothesis testing that moves us in the direction of understanding not only which firms pollute the environment but also why they may choose to do so, allowing us to begin the development of a theory of corporate environmental performance.

Firms in many industries have been cited by the EPA for environmental damage. The EPA assesses fines and penalties on firms that have violated the Comprehensive Environmental Response, the Compensation and Liability Act (CERCLA, also known as Superfund), the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA) or the Clean Water Act (CWA). Broadly, fines and penalties are levied in two areas.[4] The first, colloquially known by lawyers as "paper violations," are relatively minor infractions of the law that simply result from a firm's failure to file the proper paperwork with the EPA or to file it in a timely fashion.[5] The second area in which fines and penalties are levied includes situations that result in environmental damage arising from previous activity at a specific location. In these situations, firms may be failing to comply with current law in their current production activity, or they may be complying with current law and at the time the damage was

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[3]There is some research in the accounting, economics, finance, and management literature concerned with environmental policy and firm responses. See for some examples: Muoghalu, Robison and Glascock (1990), Blacconiere and Patten (1994), Hart and Ahuja (1994), Klassen and McLaughlin (1996), and Blacconiere and Northcut (1997).

[4]In 1993, during the EPA's enforcement reorganization, the EPA recognized the need to develop or find additional measures of regulatory compliance. The requirements of the Government Performance and Results Act (GPRA) provided the stimulus for a review of performance measures. Historically, the EPA has counted inspections conducted, the number of civil and criminal cases, and the penalties assessed as the predominant measures of compliance. They now consider other activities such as a) actions taken by violators to return to environmental compliance, b) quantitative and qualitative environmental impact, c) compliance assistance activities, and d) *industry* specific compliance rates. See Federal Register (May 13, 1997). *None* of these new measures is used in this study.

[5]In these instances, the illegality is the failure to report. For example, Dial Corporation failed to report the presence of PCBs at its South Gate, CA plant in 1991.

caused have been complying with earlier laws, but they are now required to pay penalties to clean up the environment to the new current standards.[6]

The objective of this research is to understand the firms that illegally pollute the environment better. However, many polluting firms are not examined here. Firms may pollute the environment because the technology does not exist that allows them to do otherwise, and in this situation, they are not required by the laws and regulations to achieve impossible standards. Thus, firms that are polluting the environment but are not cited in any way by the EPA are not available in the EPA database, and hence they cannot be examined in this study.[7]

Environmental pollution by firms may be viewed as distinctively different from that of individual illegal behavior. When managers of firms violate environmental law, individuals within the firm must act, or fail to act, collectively. Finance theory argues that the objective of the firm is to maximize shareholder wealth; and were this not so, the firm would not be able to produce goods and services, contribute to GNP, and provide employment. Following this line of thought, firms may violate environmental law because the financial penalties for doing so are small relative to the profit from failing to comply with costly pollution standards. Decanio (1997) alludes to this possibility when he suggests that an assessment of alternative economic policies would benefit from an analysis of the actual characteristics of firms.

Despite the possibility of relatively inconsequential fines, it may be that market mechanisms aid in deterring non-compliance with environmental policy.[8] Therefore, we would expect to see relatively fewer public firms than private firms found to be in non-compliance since there may be negative market reactions to repeated violations given that the EPA, an external monitor, has disclosed a defective process in the firm. Additionally, shareholders, who are internal constituents and want to see the stock price maximized, may consider the firm more risky than previously realized. Shareholders may also view

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[6]Coors Brewing, for example, was cited and fined $700,000 at a later date for contaminated soil and water under its brewery between 1981 and 1984. They were also required to steam clean the site.

[7]This will, of course, create an unavoidable sampling bias. In addition to this potential bias, another unavoidable bias may stem from the fact that state citations and fines are not included in this database. Thus, many polluting firms and many firms that behave illegally are not examined here.

[8]Some firms in our sample, although cited, were not fined for environmental violations; many other firms were required to pay amounts less than $100,000.

themselves as citizens or external constituents and penalize a firm by attributing a larger discount rate to its shares, when that firm willfully engages in repeated environmental pollution.

This study should be viewed as exploratory; we have little foundation on which to build a theory. Further, we are not modeling the individual decision-making behavior within firms. Nor are we modeling the enforcement behavior of the EPA. Compliance and enforcement issues are ones that rightly should be considered simultaneously. Rather, we examine some characteristics of polluting firms in an attempt to define the types of firm that engage in illegal behavior and their financial characteristics better. Section 2 of this paper briefly reviews some relevant environmental laws and related research. Section 3 examines the characteristics of polluting firms. Section 4 considers some potentially interesting financial/economic hypotheses and the statistical results of hypothesis testing. Summary conclusions and potential public-policy implications are contained in Section 5.

2. Environmental Protection Law

2.1 Legal and Regulatory Rules and Issues

Concern for the world environment is growing both nationally and internationally. McRae (1994) suggests that, at present, the problem of natural resource availability and usage is not one of global shortage but one of uneven distribution. However, with increasing industrialization in developing countries coupled with costly and technically difficult pollution control, the degradation of the environment may be of significantly greater concern in 2020 than it is in the 1990s. Thus, one suspects that environmental regulation will become more important in domestic and multinational business and in international trade.[9]

Though states and some localities have environmental rules (State Environmental Policy Acts [SEPAs]), all geographical areas in the US are affected by the 1969 federal National Environmental Policy Act (NEPA). NEPA requires that an environmental impact statement (EIS) be filed with the

[9]For example, VanBeukering, Yongjiang, Yumin, and Xin (1998) discuss the issue of the environmental pollution associated with the development of the plastics industry in China. They point out that Chinese production will have to meet international levels of environmental efficiency in order to avoid protective trade measures.

appropriate agency whenever federal funding has been utilized in a private venture. It was in 1970 that the Environmental Protection Agency (EPA) was created and with it came the consolidation of such diverse functions as EIS compliance, establishing environmental protection standards, and conducting research on pollution. The 1971 Clean Water Act (CWA) provided a comprehensive plan to eliminate water pollution and set standards for compliance on an industry-by-industry basis. In 1987 the Water Quality Act amended the CWA to control "non-point source" pollution and also empowered the EPA to assess fines and penalties for pollution that is not eliminated or controlled through the "best available technology economically achievable." These penalties were intended to be on a sliding scale depending on the severity of the pollution, the nature of the circumstances, and the violator's history and ability to pay. Like the CWA, the Clean Air Act (CAA) of 1970 also empowered the EPA to set standards on air quality. To ease the potential burden on industrial firms, the EPA adopted a "bubble concept" under which a large facility with multiple emission points does not have to meet standards at each one but can instead aggregate them in one permit application.

The 1965 Solid Waste Disposal Act and its 1976 amendment known as the Resource Conservation and Recovery Act (RCRA) are aimed at more efficient management of toxic and hazardous waste. The RCRA provides regulation of active hazardous waste sites, but the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was enacted to provide for the clean up abandoned or inactive sites. The financial threat that the CERCLA poses to firms generating potentially toxic wastes as well as to companies that dispose of these wastes is significant since firms are responsible for "past sins" associated with their properties whether they were or were not the responsible parties. Finally, the 1976 Toxic Substances Control Act (TSCA) has as its objective controlling the processes of bringing chemical pollutants into the market place. Unlike the other environmental laws that have been promulgated, the TSCA requires the EPA to consider the economic and social impact of its decisions as well as their environmental effects. Thus, one suspects that perhaps more than some of the other regulations, the TSCA seeks to avoid unnecessary economic burdens. Also, in the area of toxic substance control are the Federal Environmental Pesticide Control Act (FEPCA) of 1972 and its predecessor, the 1947 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

EPA actions under the various above-cited laws can be either administrative or judicial, with administrative actions being more frequent. Balancing the competing interests of concern over the quality of our national and

international environment and the economic health of our firms and industries is seemingly a difficult task. However, if McRae's (1994) predictions concerning the quality of our world natural resources are correct, it is one that will receive heightened interest at the corporate and shareholder levels as time progresses.

2.2 Related Empirical Research

Research in the financial/economic area concerning environmental policy and protection is quite limited.[10] Muoghalu, Robison, and Glascock (1990) use standard event-study methodology to examine the deterrent effects of the RCRA and CERCLA.[11] They discover stockholders suffer a statistically significant loss at the time of an EPA filing. A recent working paper by Bolster and Badrinath (1995) also examines the stock market reaction to EPA judicial actions. They find a number of interesting results. First, the stock return for violator firms falls 0.43 per cent during settlement week, with more recent violations carrying a heavier market penalty than earlier ones and with more pronounced penalties resulting for firms that engage in repeated violations. The CAA violations appear to result in the strongest market reactions. Surprisingly, market responses appear independent of the magnitude of the fine that is levied.

In another working paper, Hart and Ahuja (1994) argue that pollution control has a positive effect on industrial performance. Firms that are innovators in industrial production seem to draw on those same capabilities in addressing environmental issues. Manufacturing processes seem to benefit from the environmental responsiveness of a firm. In a related paper, Florida (1996) examines the relationship between innovative manufacturing and environmental performance. On the basis of survey research, he finds that there are joint productivity and environmental gains associated with new manufacturing technologies. The efforts of firms to increase productivity also create

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[10]Klassen and McLaughlin (1996) use management science tools and techniques and hypothesize that environmental performance affects the financial performance of firms. Using standard financial event-study methodology, they find significant positive market response to positive environmental events, such as winning an environmental award. Significant negative abnormal returns are associated with an environmental crisis.

[11]See also Ingram and Frazier (1980), Shane and Spicer (1983), and Wallace, Watson, and Yandle (1988) for similar studies.

opportunities for environmental improvement. Not surprisingly, he finds a close relationship between green design and Research and Development spending.

Reichert, Lockett, and Rao (1996) study illegal business practices in general and find that the public announcement of indictments for major corporate crimes has a significant impact on shareholder wealth. This impact is predictably negative, long-lasting, and stronger for illegal activity subsequent to the Boesky/Levine insider trading scandals. It is stronger for firms eventually found guilty, and the impact is **smaller** the **larger** the firm.

Concerning the issue of environmental performance and corporate behavior, Hansen and Lott (1996) suggest that since shareholders hold diversified portfolios and companies impose externalities on one another, shareholders may not want firm value maximizing corporate policy but portfolio value maximizing corporate policy. Therefore, as one company's activities may affect another's value, shareholders may have increased *economic* incentive to care about pollution control and abatement.

This relatively limited collection of empirical studies only begins to shed light on corporate environmental performance and firm behavior. Hopefully, our exploratory study will help us better understand which firms pollute the environment.

3. The Data

Our sample of firms is extracted from the Summary of EPA Actions included in the EPA's Civil Judicial Enforcement Docket. This database contains all civil judicial cases filed by the Department of Justice on behalf of the EPA. The data consists of 3,027 judicial cases undertaken by the Environmental Protection Agency from 1971 to 1991. Some of these cases are actions brought against public companies; others are those against closely-held firms, municipal governments, or non-profit organizations. Any organization may have multiple entries in the data file if the EPA brought separate actions against that entity in separate years. In addition, an individual organization may be cited as many as five times for violations of five different laws in a single judicial case.[12] Note that this database provided by the EPA contains only judicial cases. Thus, we

[12]This appears to be a database constraint that is sufficient for handling the cases brought by the EPA.

do not examine all firms with potentially polluting production functions. There also may be firms whose polluting activity never comes to the attention of the EPA. Additionally, there may be firms that the EPA chooses not to prosecute for reasons related to political, cost, scarce resource, or policy constraints.[13] Thus, the data we analyze, and hence the resulting empirical evidence, is biased. We have clearly not examined a random sample of firms. However, we believe that the benefits which may be derived from an analysis of this database outweigh the costs resulting from the necessary lack of scientific rigor that an examination of a non-random sample necessarily creates. Nonetheless, we do believe it is necessary to call the reader's attention to this reality so that all of our results can be interpreted in light of it.

We make no attempt to model the enforcement activity of the EPA, either. Cases that the EPA chooses to adjudicate may be no different from those that it chooses not to; alternatively, they may be substantially different. This database contains only adjudicated cases. Firms that were able to obtain an administrative settlement with the EPA are absent from the database. Table 1 contains a frequency count of the number of environmental cases per year as well as the total and average penalties assessed in that year. The number of cases rose to a high in 1987 of 294. Total penalties exceeded $34m in 1988 and the largest average penalty occurred in 1972.

Of the 3,027 cases litigated by the EPA, 351 were against non-profit organizations, 564 were against public companies, and 2,112 were against closely-held firms.[14] These numbers represent case counts. If instead we count organizations, there are 301 non-profit organizations represented, 38 of which had multiple citations totaling 88 in number. There are 246 public corporations, 85 of which had multiple citations totaling 403 in number, and there are 1,882 closely-held firms, 158 of which had multiple citations totaling 388 in number. Two reasonable conclusions seem plausible. It may be that non-public firms violate the law more frequently, perhaps owing to a lack of external security

[13]According to Stavins (1998), it was nearly eight decades ago that economists first proposed the use of corrective levies to internalize environmental impacts. Now, the potential list of regulatory instruments has expanded to include incentive-based instruments such as tradable permits. Firms subject to incentive-based mechanisms, who are in compliance with regulations, may still be those with polluting production functions.

[14]More precise terminology would indicate simply that these are not public firms. We know nothing of their total asset size, operating income, or even whether they are capitalized with private stock.

market monitoring or inadequate staff. Alternatively, the EPA may watch and thus prosecute these firms more frequently, perhaps for the same rationale.

Table 1: Distribution of the Cases of Environmental Law Violation and the Penalties by Filing Year

Year	Number of Cases	Total Penalty*	Average Penalty**
1971	0	0	0
1972	4	1,055,000	263,750
1973	2	250,500	125,250
1974	10	81,500	8,150
1975	43	449,890	10,463
1976	91	2,468,400	27,125
1977	133	10,659,759	80,149
1978	147	9,463,062	64,375
1979	183	28,196,737	154,081
1980	177	27,217,074	153,769
1981	78	3,633,875	46,588
1982	73	13,207,141	180,920
1983	192	20,453,666	106,530
1984	225	14,277,787	63,457
1985	237	16,386,438	69,141
1986	261	21,431,657	82,114
1987	294	28,562,275	97,151
1988	264	34,956,850	132,412
1989	281	14,972,485	53,283
1990	235	6,895,466	29,342
1991	97	2,565,939	26,453
	Total: 3,027		

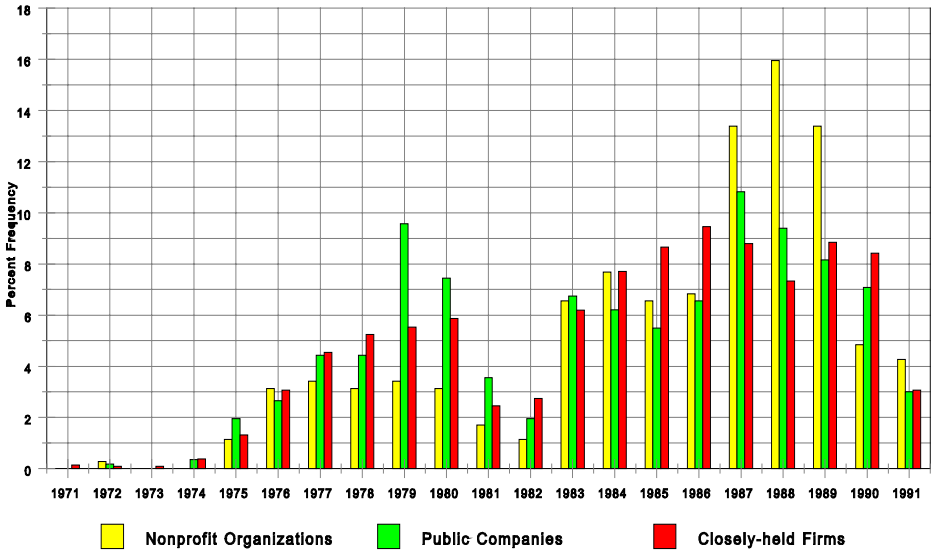
* Total penalty in dollars. The amount of penalty imposed across all cases filed that year.

** The average penalty in dollars equals the total penalty imposed divided by the number of case filings for that year (rounded).

It is also worth noting that, in general, there are more closely-held firms than public companies, so from this perspective these numbers may not be disproportionate. Figure 1 contains a percentage frequency diagram of closely-held firms, public companies and non-profit filings across time. As can be seen, there are relatively few violations for any entity in the first four years of the EPA's existence. Public companies had a larger percentage frequency of violations than did non-profit and closely-held firms in 1979 and 1980. The largest percentage for public companies was in 1987, but in that year non-profit organizations had a larger percentage frequency than public corporations. For non-profit organizations, the largest percentage frequency was in 1988, when the violations were approximately double the percentage frequency of public companies. Closely-held firms had their highest percentage frequency in 1986.

Figure 1

Percentage Frequency of Violations by the Type of Organization by Year



The issue of repeat offenders uncovers a potentially surprising result. When we examine multiple citations, 12.6% of non-profit organizations are repeat offenders, 34.6% of public companies are repeat offenders, and 8.4% of closely-held firms are repeat offenders. When multiple judicial filing dates are considered, the numbers change only slightly: 12% for non-profit organizations, 34% for public firms, and 7% for closely-held firms. Thus, even though closely-held firms appear most likely to violate the law initially, they have the lowest percentage of repeat offences while public companies have the highest.[15]

Table 2 contains a listing of the various environmental codes that may be violated. It should be remembered that each case, or each judicial filing by the EPA may contain as many as five citations. Thus, Table 2 itemizes the frequency of each code violation by citation position. Glancing at the table, we see that the Clean Water Act and the Clean Air Act are the most frequently violated.

Table 2

Distribution of Environmental Laws Violated by Citation Position*

Law**	Citation #1	Citation #2	Citation #3	Citation #4	Citation #5
CAA	1,042	176	26	1	0
CERCLA	566	239	72	17	6
CWA	1,033	382	156	39	10
FIFRA	49	3	1	0	0
MPRSA	12	0	0	0	0
RCRA	186	101	66	24	7
REFA	1	7	3	3	1
SDWA	80	22	3	4	2
TSCA	59	20	5	0	3

[15]Large public companies may be larger pollution sources than closely-held firms. This may help explain why larger companies are more often repeat offenders.

* Citation Position refers to the number of sections a particular case has been listed as having violated. There are 3,027 cases, some of which have as many as five code section citations or violations and some of which have as few as one. Thus, the column totals for Citation #1 to Citation #5 will not necessarily add up to 3,027.

** The following is a list of the abbreviations of the :

LAW	**DESCRIPTION**
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CWA	Clean Water Act
FIFRA	Federal Insecticide, Fungicide, & Rodenticide Act
MPRSA	Marine Protection, Research, and Sanctuaries Act
RCRA	Resource Conservation & Recovery Act
SDWA	Safe Drinking Water Act
TSCA	Toxic Substances Control Act
EPCRA	Emergency Planning & Community Right to Know Act (no violations)
MWTA	Medical Waste Tracting Act (no violations)

Table 3 examines the average penalty incurred by citation position and by act. Despite its name, the average CERCLA (Superfund) penalty ($54,835) is smaller than either the CAA penalty ($110,031) or the CWA penalty ($87,456) when it is the first violation cited. However, CERCLA penalties exceed those of other violations in subsequent citations in the EPA judicial cases. Thus, disregarding citation position, the total of the average CERCLA penalties ($292,949) exceeds those of the CAA ($270,029) but not those of the CWA ($613,893), the RCRA ($1,412,614), or the REFA ($2,017,507) totals. The largest average penalty ($259,178) paid in the first citation position is for violations of the TSCA.[16] If we ignore citation position, the largest total of the average penalties in dollars is paid for REFA violations ($2,017,507); however,

[16]We ignore REFA penalties whose dollar value surpasses this figure because there are so few citations in this category.

there were only 15 such citations in 20 years (Table 2). The next largest total results from violations of the RCRA with the total of the average penalties in excess of $1m ($1,412,614).

Table 3

Average Violation Penalty* by Environmental Law and by Citation Position

Law**	Citation #1	Citation #2	Citation #3	Citation #4	Citation #5	Total Average
CAA	110,031	107,148	52,850	0	0	270,029
CERCLA	54,835	113,280	20,078	69,457	35,299	292,949
CWA	87,456	120,937	261,579	143,821	100	613,893
FIFRA	2,297	3,389	840	0	0	6,526
MPRSA	2,500	0	0	0	0	2,500
RCRA	98,778	251,360	423,860	622,187	16,429	1,412,614
REFA	411,269	3,571	0	102,667	1,500,000	2,017,507
SDWA	13,968	137,639	0	0	0	151,607
TSCA	259,178	57,558	5,200	0	0	321,936

* The average penalty in dollars (rounded)

Figure 2 presents the percentage frequency of the laws violated by closely-held firms, public firms, and non-profit organizations. It does not appear that closely-held firms violate a specific law more than public firms or non-profit organizations, or vice versa. However, if we examine the percentage frequency

within each category of law violated, it does appear that non-profit organizations violate the CWA relatively more than public or closely-held firms when the number of organizations in each category is taken into account. Public firms seem to have the highest percentage frequency of CAA violations.

Figure 2

Percentage Frequency of the Laws Violated by Type of Organization*

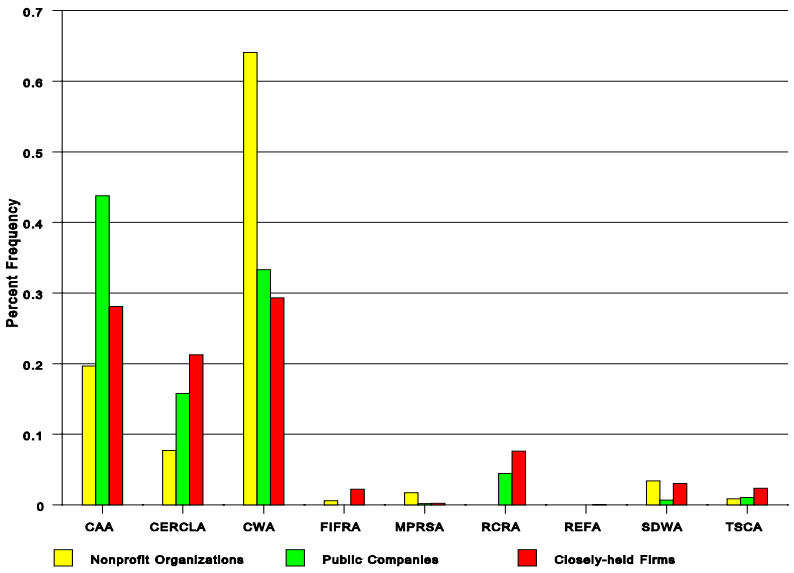


Table 4 presents a description of the average amount paid in fines by public, private, and non-profit entities as well as a statistical comparison of their means and variances.

The average fine for public firms is $354,284, for closely-held firms $111,862, and for non-profit organizations $76,459. Using standard *t* and F

tests, the means and variances of these fines are statistically significantly different at $p<0.01$.[17]

Table 4

The Amounts Paid in Fines by Type of Organization

Entity	Mean Fine ($)	Minimum Fine ($)	Maximum Fine ($)	Standard Deviation
Public	354,284*	62,120	15,000,000	1,090,211*
Closely-Held Firm	111,862*	16,535	13,100,000	567,037*
Non-profit	76,459	11,179	1,500,000	164,307*

* These figures are statistically significant at the 0.01 level.

To summarize, closely-held firms are cited for violations of environmental laws more frequently than public companies. However, they tend to repeat their violations less frequently than the larger public companies, and the average fine paid by closely-held firms and non-profit organizations is significantly lower than those paid by public companies.

4. Exploratory Hypothesis Testing with Public Corporations

With the aim of better understanding firms that violate the law, we examine some of the financial characteristics of the public firms in the EPA database. It is plausible that managers of publicly traded firms choose to ignore existing laws and regulations to avoid making costly changes to their current operational processes. Thus, a firm's violations might be related to its financial functioning. Fines are costs which depress net operating income and stock price performance. However, pollution control may also involve costs that depress net income and stock price. Therefore, we speculate that one motivation for polluting behavior

[17]The p-value for comparing the mean fines in the non-profit and closely-held firm categories is 0.076.

might be a cost-benefit analysis that suggests the costs of pollution control are weightier than the present value of *potential* future fines. Thus, we hypothesize that a fine a firm receives is negatively related to variables which represent its operating characteristics. We do not presuppose that this is the only possible motivation, nor that it and any others one might hypothesize are mutually exclusive.

This hypothesis suggests that firms may violate the law because judicial outcomes prevent penalties from being sufficiently large enough to deter illegal behavior. This is a cost-benefit argument in which operating cash flows and hence stock prices are maximized by non-compliance with costly pollution standards. This argument suggests that even though firms that realize they may be penalized, the financial benefit of non-compliance outweighs the financial cost of compliance. If this is so, the implication may be that government pollution policy is ineffective in deterring environmentally irresponsible behavior.

For the 564 judicial cases brought by the EPA against public corporations, we scaled the dollar amount of the first citation fine (DF) levied by the total asset (TA) size of the firm and regressed it against four financial variables: cost of goods sold, free cash flow, operating income, and Research and Development expenditure. The choice of these variables is partially a consequence of availability; these variables are all available on S&P Compustat files. They were all scaled by total firm sales.[18] Scaling on the left-hand side of the equation is by total assets. The value of total assets is a static or historical value that tells us something about the capital employed in the production function of the firm. Further, the dollar fine, through accounting treatment, would have a direct impact on the balance sheet value of total assets. The right-hand side of the equation contains values that are operating or income statement related and are thus also available. More appropriate variables that may have some influence might have been regressors such as the *possible* cost of installing and operating facilities to prevent pollution and consequent fines.[19] Obviously, data such as this was unavailable. Thus, we rely on the previous work of Hart and Ahuja (1994) and Florida (1996) to suggest regressors that are observable and potentially influential.[20] Scaling on the right-hand side by sales provides some standardization across firms for the financial success of the firm.[21]

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[18]Scaling by total asset size and by sales provides some measure of control for differences in firm size and performance.

[19]We wish to thank an anonymous referee for this helpful insight.

[20]Further, in a subsequent regression, we have attempted to isolate industry influences

$$\frac{DF}{TA_j} = \alpha + \beta_1\left(\frac{COGS}{SALES}\right)_j + \beta_2\left(\frac{CF}{SALES}\right)_j + \beta_3\left(\frac{OI}{SALES}\right)_j + \beta_4\left(\frac{R\,\&\,D}{SALES}\right)_j + e_j$$

for j = 1...564,

where

DF = Dollar Fine

TA = Total Assets

COGS = Cost Of Goods Sold

CF = Free Cash Flow

OI = Operating Income

R&D = Research & Development Expense

and

SALES = Total Firm Sales.

Admittedly there is no financial theory that explains the choice of these four independent variables. However, the public policy research of Hart and Ahuja (1994) and Florida (1996) suggests that these independent variables are potentially important ones. Their research suggests that cost of goods sold is related to the firm's production technology, with presumably a more expensive production technology being more capital intensive and perhaps more modern and hence less polluting. Free cash flow is related to managerial "slack," the opportunity management might have to employ costly pollution controls without reducing dividends or firm growth or increasing firm debt. Operating income is a reasonable measure of the success of the firm's production and marketing efforts. Finally, Research and Development expenses might be related to the innovative efforts of the managerial

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with the use of a matched pair design.

[21]We scale the left-hand side differently from the right-hand side of the equation because it is not necessarily true that large firms with more capital employed are more successful.

team. As all four of these independent variables might be proxying for an industry influence, we attempt to provide some control for that in a PROBIT regression discussed later.

The R-squared of the above regression is 0.77, and the F value is 64.355 with a significance greater than .0001, suggesting that the variation in the data is well captured by the independent variables. The parameter estimates are all significant ($p<.01$) and there is no substantive multicolinearity among the four variates.[22]

$$\frac{DF}{TA_j} = -.0012 - 0.126\left(\frac{COGS}{SALES}\right) - 1.027\left(\frac{CF}{SALES}\right) + 0.262\left(\frac{OI}{SALES}\right) + 0.212\left(\frac{R\ \&\ D}{SALES}\right)$$

($p<.01$) ($p<.01$) ($p<.01$) ($p<.01$)

As can be seen from the above results, the dollar amount of the fine is negatively related to cost of goods sold and to free cash flow but positively related to operating income and Research and Development expenses. This might be interpreted as indicating that firms with relatively inexpensive production technologies and little slack incur relatively large fines.[23] We interpret this as providing inferential support for our hypothesis that the dollar amount of the fine is negatively related to financial performance. However, the last two variates, operating income and Research and Development expenses, are positively related to the dollar amount of the fine. This suggests that the EPA penalizes firms that can afford better pollution control more severely and is, in fact, consistent with its legislative mandate to do so. These results do not prove that the proportional dollar fine is inversely related to the financial characteristics of firms. Further, they do not prove that firms violate the law because the cost of a probable violation and subsequent citation outweighs the cost of compliance. However, they do provide some inferential evidence concerning the relationship between fine size and the operating characteristics of firms. The inference we tentatively draw is that firms with inexpensive

[22] A correlation matrix and co-linearity diagnostics are available from the authors.

[23] Lower values of cost of goods sold suggest that a lower cost of technology is employed by these firms. Thus, the equipment and materials used for the production process may be older and lack the appropriate pollution controls.

technology and little slack may choose a potential fine rather than depress their cash flow and stock price through implementing pollution-control measures.

Two regressions related to the above-mentioned one were also run. One of these examined all citations per firm across years and aggregated the individual firm's dollar fine for various judicial cases. This regression included a dummy variable to indicate when there was more than one fine for a given firm. The second examined all citations per year per firm and regressed the total scaled dollar fine against the four variables listed above. This regression included a dummy for more than one citation per case per firm per year. In both of these cases the coefficient of the dummy variable was significant at p=0.0582 and p=0.065. Otherwise, there are no substantive differences between these regressions and the one reported above. The positive coefficients of the dummy variables for judicial cases in more than one year, and for more than one citation in any given year, suggest that the EPA penalizes repeat offenders more heavily than firms that violate the law only once.

A second question we examine is whether larger public firms are assessed smaller fines and penalties than smaller public firms.[24] Institutional holdings and analyst following may create enough visibility for larger firms for the market to monitor and enforce their environmental behavior.[25] Consequently, larger firms may incur relatively smaller fines than smaller firms. If this is so, it indicates to us that larger public firms may be polluting the environment less seriously than smaller public firms.[26] This hypothesis is a direct extension of the earlier comparison between (large) public firms and (presumably smaller) private corporations.

To examine this hypothesis, large and small public firms are defined, respectively, as those falling above and below the median value of total asset size. Firms falling above the median value of total assets have significantly higher values of fines (p=0.07). However, if we scale the fines by total asset size, firms falling above the median have significantly smaller values of scaled fines (p=0.04). Thus, in terms of dollar values, larger public firms violating environmental laws incur larger fines. However, relatively speaking, they incur smaller fines than their smaller public firm counterparts. As asset size is clearly not the only way to categorize firms, we examined the same issue dichotomizing

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[24]Note that here large and small categorizations refer to public firms only.

[25]For a discussion of analyst following and firm size see Ferris and Sarin (1997).

[26]An alternative explanation may be that large firms spend enough on legal advice to avoid problems with environmental laws.

the sample based on market return.[27] Once again the *t* test demonstrates that firms above the median have significantly smaller values of dollar fines (p=0.03). These results also tend to support our intuition that the cost of violating environmental laws and being fined may not be sufficient to outweigh the benefit afforded by avoiding compliance with expensive pollution standards. Again, care must be taken in considering these results. There are no corporate finance theories upon which we may create hypothesis testing. Instead, we have conducted an exploratory examination which may be helpful in understanding corporate behavior.[28]

4.1. A Comparison of Violating and Non-Violating Public Corporations

In the previous regression, we examined whether one might infer that managerial teams conduct a cost-benefit type of analysis when making decisions about pollution control. We speculate that *potential* fines may be compared to *certain* costs of pollution control when management makes pollution control policy decisions. Thus, we regressed (scaled) fines against operating and income statement variables that in some way proxy for the costs to *the firm* of pollution control. We find what we interpret as inferential support for our hypothesis. It appears that firms with inexpensive technology and little financial slack may choose *potential* fines rather than a certain cost of pollution control. However, as in all empirical work, these results may be spurious. It also occurs to us that a significant factor in explaining polluting behavior may be industrial categorization.

Hence, to examine this idea, we choose a PROBIT regression. In a PROBIT regression, the zero-one dependent variable of fined (and thus polluting) firms vs. non-polluting (and therefore not fined) firms is regressed against operating and income statement variates as before. Our zero-one categorized firms are matched on industrial classification (SIC code) and size (total assets). Will we draw the same inferences? Does it appear that technology and lack of financial slack lead management to avoid pollution control costs with the resulting consequence of polluting behavior and the *potential* for incurring fines?

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[27]This size definition has little to do with either stock price (market value) or total asset size. It attempts to capture a large and small definition that may be more closely related to operational success and hence stock-price maximization.

[28]As yet there is no well developed behavioral theory of finance or accounting.

Each public firm in the EPA database is matched to a public firm not in the database.[29,30] Matching is based upon three factors: SIC code, event time (judicial filing date of the violating firm), and total asset size.[31] Matching on the SIC code provides *some* control for industry characteristics influencing inclusion in the EPA database and hence violation of the law. Matching on event period provides *some* control for differing judicial interpretations at different points in time and for differing economic conditions at differing calendar times. Matching based on total assets provides some control for firm size. The result of this matching procedure is a dichotomous zero-one classification of firms that are as similar as possible in size, business or industrial characteristics, and similar given the economic characteristics of the time period we examine. What differentiates these firms is whether they are violating or non-violating firms. This classification, violating or non-violating, is coded zero-one and represents the left-hand side of the PROBIT regression while the right-hand side contains an extensive listing of accounting variables. Again, there is no theory which determines the choice of these accounting variables. PROBIT regression questions whether the right-hand side variables influence the probability of membership in either category on the left-hand side, violating or non-violating firms. Again there is no theory or explicit hypothesis testing here. Rather, we attempt to provide an exploratory examination of a basic issue: whether financial accounting characteristics influence the probability of violation.

In PROBIT analysis, the binary outcome of the i^{th} firm can conveniently be represented by a random variable, y_i, such that y_i equals zero if the firm has not (to date) violated environmental protection laws and y_i equaling one for a violating firm. For each individual firm i, i = 1,.....419, we observe a (1 x 21) vector x_i^N of financial economic characteristics as measured by accounting and stock price values. In PROBIT analysis, F( ) is the cumulated distribution function of a standardized normal variate and p( ) is the conditional probability.

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[29]Again there is a potential sampling bias in this methodology. Any matching firm, not found in the EPA database of violating firms, may eventually become a violating firm. However, this potential sampling bias seems unavoidable.

[30]Matching was achieved by first generating a list of all four digit SIC code matching firms from the Compustat database. Total asset size was then examined and the firm closest in total asset size was chosen as the matching firm, provided that data was available for that firm for the same event period as the violating firm, and provided that it was not elsewhere listed in the EPA database as a violating firm.

[31]When a trade-off had to be made in matching SIC code or total asset value to the violating firm, SIC code was given precedence.

Thus, $y = F^{-1}(p)$. The conditional probability of a violation, given that an independent variable equals x, implies

$$p(x) = F(\beta_0 + \beta x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_0 + \beta x} e^{-\varepsilon^2/2} d\varepsilon$$

or

$$F^{-1}(p(x)) = \beta_0 + \beta x$$

Maximum-likelihood estimation for parameters β_o and β is used. In PROBIT analysis, the estimated PROBIT regression coefficients do *not* indicate an increase in the probability of the event occurring, given a one-unit increase in the corresponding independent variable. The coefficients reflect the effect of a change in an independent variable on $F^{-1}(P_i)$, and the increase in the probability depends on the original probability and thus on the initial values of all the independent variables and their coefficients:

$$\frac{\delta p_i}{\delta x_{ij}} = f(x_i \beta).\beta_j$$

where x_{ij} is the j^{th} element of x_i.

As this is an exploratory study and no economic theory suggests what financial characteristics might have an impact on the likelihood of becoming a violating firm, we chose variables based on our own speculations and previous research.[32,33] We considered one-year indexed total return, five-year indexed total return, the ratio of short-term debt over long-term debt, the quick ratio of current assets over current liabilities, operating income scaled by sales, the

[32]Our earlier regression results and the previously cited research of Hart and Ahuja (1994) and Florida (1996) provide some benchmarks for our selection of variables.

[33]As a validity check on our technique and hence results, we employ two additional PROBIT regressions, one with a larger number of right-hand side variates and a second where the software uses a backward selection method of entering variates into the equation. Both regressions result in similar outcomes as that reported here and are available from the authors.

natural log of total assets, and a control for fiscal year end, (FY), where fiscal year is one for firms with a December 31 year end and zero, otherwise.[34]

When we examined the resulting classification tables, we chose an *ex-ante* probability of 0.5, reflecting the naive forecast that a firm is a violator or non-violator in (what to us appears as) a random fashion.[35] Thus, the question is whether the regression coefficients provide evidence that right-hand side accounting variables influence the probability of a firm's status as a violator or a non-violator over a random assignment to either left-hand side category.

The results are p=0.0001 for the global null hypothesis Beta=∅. This provides some inferential evidence of the existence of a relationship between these accounting variables and the probability of being a violating firm. The concordant of predicted probabilities and observed responses equals 72.8%. The correct classification at a probability level of 0.5 is 65.6%, which is some evidence of an increase in predictive ability (violator vs. non-violator firm) resulting from the use of financial accounting right-hand side variables.

The statistically significant (p#0.05) variables resulting from this PROBIT regression are the ratio of short-term debt to long-term debt, the natural log of total assets, scaled operating income, and fiscal year end. These variables again suggest that firm size, operating characteristics, and liquidity have some significant effect on the probability of being classified as a violating firm.[36]

These PROBIT regression results, in conjunction with the OLSQ regressions, provide some preliminary evidence of a relationship between

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[34]While many firms have December 31 year ends, the fiscal year end as a dummy may capture some operating characteristics that the SIC code does not.

[35]Note that from a statistical perspective this interpretation is not literally accurate. The probability of being included in the regression for an EPA judicial case is nearly certain, whereas the probability of being included in the sample for a non-violating firm is much smaller. However, as some non-violating firms may be polluters that do not come to the attention of the EPA and as all polluters who do come to the EPAs attention may not be fined or may not become judicial cases, this subjectively assigned *ex-ante* probability may not be too far wrong.

[36]When we conducted a PROBIT regression on a larger model of twenty-one somewhat arbitrary independent variables, the results were substantively the same as our original model with the addition of scaled net income and one year or five year indexed total return as significant independent variables. Finally, a backward selection PROBIT regression produced no substantial differences in empirical findings. In this model formulation, cost of goods sold scaled by inventory valuation replaced the scaled net income variable as significant.

violating environmental laws and being fined and the financial characteristics of firms. The PROBIT results may be interpreted as some classification improvement or some indication that financial variables affect the probability of violating environmental laws. In addition, the OLSQ results suggest some relationship between firms being fined (and therefore being polluting firms) and accounting variables relating to technology and financial slack. However, the results reported here are not definitive and future research needs to be conducted to more fully understand firms' environmental behavior.

5. **Summary and Conclusions**

The data provided by the EPA suggests that closely-held firms violate the law more frequently than larger firms. This may not mean that there are proportionally more closely-held firms polluting the environment. Instead, it may simply be a reflection of the fact that there are more closely-held firms than public ones and, lacking market monitoring, the EPA may monitor them more closely. It is public companies, however, that have the highest percentage of repeat offences. This is perhaps because, relatively speaking, public firms may create more pollution. However, it may also be that the fines and penalties public firms incur are not substantial enough to deter non-compliance. This suggests that even though public firms realize they may be penalized, the cost of non-compliance does not outweigh its benefit. Further, given the larger number of closely-held firms in the country, and the fact that they are less frequently repeat offenders, it appears that the EPA may be policing this group of firms well. As public firms are more frequent repeat offenders and, relatively speaking, have smaller fines than closely-held firms, it may be that neither the market nor the EPA is adequately penalizing them for polluting behavior.

OLSQ and PROBIT regression results suggest that cash flow, size, and income and technology variables may have a significant influence on a firm's violation of environmental laws. The interpretation that the PROBIT model lends to this analysis suggests that different levels of these economic characteristics, as measured by accounting variables, may have a significant effect on a firm's probability of being a violating firm. The results of the regressions reported here provide some limited evidence that firms violate environmental laws and regulations when they cannot afford not to do so. However, it seems that for those public firms that may be better financial performers and also pollutes of the environment, the judicially imposed fines are inadequate to promote deterrence.

We do not claim that financial motivations are the only factors affecting a firm's compliance with environmental law. Agency problems and corporate governance issues are two obvious areas that may also have a significant impact. Further research is necessary to ferret out a more complete list of characteristics that might indicate a firm's predisposition to ignore pollution standards. Additionally, this sample consists only of US firms. As the global economy becomes increasingly more integrated, it will be of considerable interest to ask these same questions concerning firms in other countries. The answers have public-policy implications for this and future generations.

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