DOES THE MARKET VALUE ENVIRONMENTAL PERFORMANCE?

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Abstract—Previous studies that attempt to relate environmental to financial performance have often led to conflicting results due to small samples and subjective environmental performance criteria. We report on a study that relates the market value of firms in the S&P 500 to objective measures of their environmental performance. After controlling for variables traditionally thought to explain firm-level financial performance, we find that bad environmental performance is negatively correlated with the intangible asset value of firms. The average "intangible liability" for firms in our sample is $380 million—approximately 9% of the replacement value of tangible assets. We conclude that legally emitted toxic chemicals have a significant effect on the intangible asset value of publicly traded companies. A 10% reduction in emissions of toxic chemicals results in a $34 million increase in market value. The magnitude of these effects varies across industries, with larger losses accruing to the traditionally polluting industries.

I. Introduction

U.S. firms spent more than $120 billion in 1994 to comply with environmental laws, in addition to several billion more on research and development (Vogan, 1996), an amount that represents between 1.5% and 2% of gross domestic product (GDP). However, the true cost of environmental protection may be higher. For example, expenditures on environmental protection may crowd out other more productive investments (Palmer, Oates, & Portney, 1995). Even direct costs are often underestimated. For example, a recent study estimated the hidden costs of environmental protection (such as product design or production changes, waste disposal, depreciation, and overhead) can account for as much as 22% of an oil refinery's operating budget (Ditz, Ranganathan, & Banks, 1995).

At the same time that these dollars are spent to comply with regulations, some firms are voluntarily reducing pollution beyond legal limits. For example, more than 1,200 firms participated in the EPA's 33/50 program, agreeing to voluntarily reduce certain chemical emissions by 33% by 1988 and 50% by 1995 (Arora & Cason, 1995). Various reasons have been cited for this trend, including reduced cost from material input usage, reduced cost due to less waste disposal, reduced regulatory scrutiny, less public and community pressure, and increased product value and firm competitiveness due to consumer demand for "green products."[1] Regardless of the reason or reasons behind this beyond-compliance movement, an important empirical question arises: does the market value firms that have better environmental reputations than those that do not? It is possible that firms that exceed regulatory standards do so at their own financial peril. Alternatively, these firms may expect to reap some benefits from a better environmental reputation.

This paper examines the extent to which a firm's environmental reputation is valued in the marketplace. Previous economics literature on firm valuation has focused on both the components of firm value (such as tangible versus intangible assets) and the factors that affect these components (such as patents, R&D expenditures, market share, and brand names). We extend the standard economic technique of decomposing a firm's market value into its tangible and intangible assets, by separating out environmental performance from the intangible assets of the firm. Our key finding is that there is a significant positive relationship between environmental performance and the intangible asset value of publicly traded firms in the S&P 500. Firms that have worse environmental performance have lower intangible asset values after controlling for other standard variables known to affect the market value of a firm. On average, firms in our sample have a $380 million reduction in market value that can be attributable to environmental concerns. This constitutes approximately 9.0% of the replacement value of tangible assets.

Section II reviews the literature on the effect of environmental performance on firm value. Section III briefly reviews the economics literature on firm valuation and derives the theoretical model for the empirical analysis that follows. Section IV describes the data, and our empirical results are contained in Section V. Section VI contains a few concluding remarks.

II. Relationship between Environmental Performance and Market Value of Firm

Previous literature on the relationship between a firm's environmental and financial performance has generally fallen into two distinct categories: comparing financial to environmental performance over time, or analyzing the effect of environmental performance on the market value of a publicly traded firm, generally through an event study examining the effect of new information (such as an oil spill or EPA penalty).

Previous studies that attempt to relate environmental to financial performance over time have often led to conflict-

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[1] These reasons are discussed at length and empirically tested by Konar and Cohen (1999). For a more detailed treatment and literature review, see Cohen (1999).

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ing results. Most of the early work in this area was based on a series of industry studies published by the Council on Economic Priorities (CEP) in the early 1970s that examined the pollution-control records of the petroleum refining, steel, pulp and paper, and electric utility industries. For example, Spicer (1978) found significant positive correlation between CEP's measures of firm environmental performance in the pulp and paper industry and firm financial performance. However, Mahapatra (1984) concluded just the opposite, using a larger sample and time period. Similar findings are reported by Jaggi and Freedman (1992).

These prior studies suffer from several problems, including small samples, lack of objective environmental performance criteria, and the fact that they are based on data now nearly 30 years old. More recently, Cohen, Fenn, and Naimon (1995) estimated the relationship between environmental and financial performance based on several objective measures of environmental performance and a large sample of companies: the S&P 500. They constructed "industry-balanced" portfolios of the environmental laggards and leaders in each industry, and found that stock market performance in the environmental leaders portfolio equaled or exceeded that of the environmental laggards during the period 1987–1990.

In addition to studies of firm performance over time, several recent studies have examined the effect of environmental performance on the market value of publicly traded firms. Most of these studies have examined the contemporaneous effect of negative environmental "events" on stock prices. Klassen and McLaughlin (1996) found significant negative abnormal returns when firms had bad environmental news such as oil spills, and positive returns when firms received environmental awards. Similar results for negative environmental events were reported by Karpoff, Lott, and Rankine (1999) and Jones and Rubin (forthcoming). Hamilton (1995) found significant negative abnormal returns (averaging $4.1 million) on the day that the toxic release inventory (TRI) was first announced in 1989 in a sample of 436 publicly traded firms that had TRI emissions. Konar and Cohen (1997) expand on this result by showing that these abnormal returns were important enough to affect future firm environmental performance. In particular, firms that had the largest stock-price reaction to the announcement of TRI subsequently reduced their TRI emissions more than their industry peers.

Although the event studies have shown that the market reacts to discrete environmental events, they cannot analyze longer-term trends or objective measures of firm environmental performance that are not tied to a particular date. Barth and McNichols (1994) go beyond the event-study methodology and demonstrate that the market value of publicly traded firms includes an assessment of future Superfund liability. However, Superfund liability is based on past performance, not current environmental policies.

This study combines many of the best features of the previous literature by disaggregating the market valuation of objective measures of firm environmental performance. We offer new evidence on whether the market values firms that perform well on environmental criteria. Our analysis is based on a relatively comprehensive list of companies (the S&P 500) and objective measures of environmental performance based on government records and government-mandated SEC disclosures. Unlike many previous studies, we do not rely upon subjective or anecdotal analysis to characterize environmental performance, and do not rely solely on the risk of "bad outcomes" such as Superfund liability, oil spills, or government enforcement actions. Instead, we seek evidence that the market values positive environmental performance.

III. Decomposing Firm Valuation into Tangible and Intangible Assets

A firm's valuation in the financial markets is based on future profitability. Assuming efficient capital markets, security prices provide the best available unbiased estimate of the present value of discounted future cash flows (Fama, 1970). A firm's value can be disaggregated into its tangible and intangible assets. Tangible assets consist of the replacement value of property, plant and equipment, cash, inventory, and so forth. Intangible assets are factors of production or specialized resources that allow the firm to earn profits over and above the return on its tangible assets. Common examples of intangible assets are patents, trademarks, proprietary raw material sources, brand names, and firm goodwill. However, intangible assets may also be liabilities detracting from the earning power of the physical assets of a firm. For example, consumer mistrust of a company engaged in fraudulent activities might result in an intangible liability.[2]

Our approach to decomposing the market value of firms follows the work of prior authors interested in different aspects of firm valuation, such as monopoly power (Lindenberg & Ross, 1981), research and development investment (Jaffe, 1986), advertising (Megna & Mueller, 1991), and brand equity (Simon & Sullivan, 1993). We join this literature by investigating the role of environmental reputation on market value. Following Lindenberg and Ross (1981), the market value of the firm can be expressed as

$$MV = V_T + V_I, \tag{1}$$

where MV is the market value of the firm, and V_T and V_I are the portions of firm value attributable to the tangible and the intangible assets of the firm, respectively. The market value of the firm is observable, but subcomponents V_T and V_I are not. However, V_T and V_I can be estimated as follows: First,

[2] For example, there is evidence that firms lose considerable market value following convictions for corporate crimes or other fraudulent activities. See Karpoff and Lott (1993).

equation (1) is divided by the tangible asset value V_T to obtain

$$(MV/V_T) = 1 + (V_I/V_T). \tag{2}$$

The tangible asset value of the firm, V_T, is measured as the replacement cost (RC) of the tangible assets of the firm. RC may be estimated using accounting-based values for the assets of the firm. The left side of equation (2) may then be written as (MV/RC) which is by definition Tobin's q. For purposes of this paper, we calculate Tobin's q as

$$q = \frac{\textit{Market Value (Equity + Debt + Preferred Stock)}}{\textit{Replacement Value (Plant + Equipment + Inventory + Short Term Assets)}} \tag{3}$$

Thus, for a firm with no intangible asset value, the market value of the firm should equal the replacement value of its tangible assets, and Tobin's q should equal 1. As the value of the firm's intangible assets increases, the value of Tobin's q will increase accordingly.

Theory does not dictate a specific functional form for an equation to estimate q. Although authors have used a number of different specifications, most studies use the additive form derived from the specification in equation (1). The market value of the firm is thus the sum of the values accruing to the tangible and the intangible assets of the firm, that is, $Mv = V_T + V_I$. Dividing both sides by the tangible asset value of the firm gives us

$$q = Mv/V_T = 1 + V_I/V_T \tag{4}$$

To estimate the impact of various factors on the intangible asset value of the firm, the following regression equation is estimated:

$$(q - 1) = V_I/V_T = \alpha + \sum \beta \mathbf{X} + \varepsilon, \tag{5}$$

where $\mathbf{X}$ is a matrix containing the explanatory and control variables that are thought to affect intangible asset values. This specification is not unique to this paper, and is essentially the model estimated by Hirsch and Seaks (1993) and others. Instead, our main contribution is to include environmental performance as explanatory variables in estimating intangible assets. An alternative semi-log specification may also be used, where the right-side variable is the natural log of q:

$$\ln(q) = \alpha + \sum \beta \mathbf{X} + \varepsilon. \tag{6}$$

In this paper, we estimate both functional forms.[3]

[3] Hirsch and Seaks (1993) compare the two specifications using Box-Cox transformations and find that the semi-log specification has higher log-likelihood values than the linear specification. Note that we estimate both equations using White's heteroskedasticity-consistent OLS estimator.

IV. Environmental and Firm Performance Data

This section describes the data collected for both environmental variables and financial variables. Our approach in data collection and empirical analysis has been to replicate existing studies of market valuation in order to isolate any added value contributed by environmental reputation.

A. Data Sources

The most significant constraint on sample size is the availability of environmental performance data. This restricted our analysis to an industry-balanced sample of the largest publicly traded firms in the United States, the S&P 500. After eliminating nonpolluting industries (primarily banking and insurance), we were left with 321 firms, most of which belong to the manufacturing sector, SIC 20-39. Throughout the study, the number of observations varies depending upon the specification and which variables have missing data points.

The primary year of the study is 1989, but lagged values for certain variables have been used. Because the sampling is nonrandom, the data are not perfectly representative of the U.S. manufacturing universe. Nevertheless, the sample consists of many of the largest firms in the United States from very diverse lines of business. Table 1 contains a complete list of variable definitions, sources, and descriptive statistics; table 2 reports the correlation between these variables.

B. Financial Performance and Market Valuation

Our measure of firm performance and valuation is based on Tobin's q, defined above as equation (3). Data are taken from Compustat. The value of the common stock is calculated using the year-end common stock market price multiplied by the number of shares outstanding (MVE). The market value of preferred shares is proxied by the liquidation value of these shares (LPS) as reported on the company balance sheet. Long-term debt (LTDEBT) and short-term debt (STDEBT) values for the firm are also taken from the company balance sheet. The replacement value of firm assets is the sum of the property plant and equipment (net) of the firm (PPEN), cash and short-term investments (CASH), receivables (REC), and inventories (INV).[4]

Because market valuation is based on expected future profitability, there is a strong linkage between studies that

[4] A number of studies address the measurement issues regarding the estimation of the Tobin's q. Using accounting-based numbers raises some concerns. Active markets often do not exist for used capital goods, and book value based on reported depreciation may not reflect replacement costs. Lindenberg and Ross (1981) calculate q ratios using estimated market values for firm debt and firm reported replacement costs. (The SEC required large firms to report replacement costs in their 10K filings in 1976–1979 and 1980–1985.) Chung and Pruitt (1994) use the simpler formulation of Tobin's q used in this paper and compare it to the Lindenberg-Ross q values for the 1978–1985 period. They find that the simple formulation for Tobin's q explains at least 96.6% of the variability in the Lindenberg-Ross q.

TABLE 1.—DESCRIPTIVE STATISTICS AND DATA SOURCES

Variable (Units)	Definition and Sources	Mean	Std. Dev.	Min.	Max.	Cases
QB89 (ratio)	Tobin's *q* value for 1989; Market value/replacement value (Compustat)	2.3146	1.4014	0.5826	7.918	315
VI89 (million $)	Value of intangible assets 1989 (Compustat)	3856.8	9651.8	−3633	107800	315
RV89 (million $)	Replacement value of assets 1989 (Compustat)	4206	7584.5	53.51	68060	318
LNRV89	Ln (RV89) (Compustat)	7.4658	1.3098	3.98	11.13	318
RD89 (million $)	R&D expenditures 1989 (Compustat, Disclosure)	215.58	558.89	0	5248	272
RDVAL89 (ratio)	RD89/RV89	0.059717	0.0655	0	0.325	272
AD89 (000 $)	Advertising expense for firms for 1989 (LNA)	38056	116350	0	1082000	321
ADVAL89 (Ad$/'000$RV)	AD89/RV89	12.485	31.668	0	282.5	318
MSH89 (ratio)	Market share for 1989 at the four digit SIC level (WBD)	0.17525	0.19818	0.000434	0.9767	318
CON89 (ratio)	Four-firm concentration ratio for 1989 at the four digit SIC level for 1989 (WBD)	0.52817	0.20599	0.05143	1	318
GR8789 (% change)	Two-year sales growth 1987–89 (Compustat)	0.2534	0.32053	−0.4534	3.3	318
IMPIO (ratio)	Imports/value of shipments at the two digit SIC level (I-O Table)	0.15337	0.17518	0	1.104	321
AGE89 (ratio)	Age of the plants assets; Property plant and equip. (PPE) Net/PPE gross for 1989 (Compustat)	0.56854	0.11329	0.2809	0.9171	320
INV89 (ratio)	(Capital expenditures-depreciation)/RV89 for 1989 (Compustat)	0.045059	0.048857	−0.05841	0.2318	315
TRI88 (#/'000 $)	Toxic chemical releases in 1988/revenue 1988 (IRRC)	3.4486	8.2281	0	66.95	268
LAW89	No. of environmental lawsuits against the firm in 1989 (IRRC)	241.96	3433.9	0	58200	314

I-O Table: Detailed Input-Output Tables for the US Economy 1987, Bureau of Census.
LNA: Leading National Advertisers, 1989, The Arbitron Company.
IRRC: Corporate Environmental Profiles, Investor Research Responsibility Center, 1993.
USPO: United States Patent Office, Patent Listings CD-ROM, 1993.
WBD: Wards Business Directory, Firms Listed by SIC Code, vol. 4, 1990.

estimate market value and those that examine firm profitability. Thus, in addition to the literature on Tobin's *q*, we also considered other variables that affect firm market value through profitability. Based on our review of this literature, we determined the following variables to be important determinants of market value: market share of the firm, industry concentration ratio, sales growth, advertising intensity, research and development intensity, firm size, and the import intensity in the markets for the firms products. Each is discussed briefly below. Unless otherwise noted, all financial data are from Compustat.

Market share of firm: Cross-sectional differences in the intangible market value of firms and their *q* values can be partly explained by the extent of monopoly power. Firms with higher market shares or industries with higher concentration levels have been found to have higher *q* values (Comanor & Wilson, 1967). We proxy market power by the market share of

TABLE 2.—DEPENDENT-VARIABLE CORRELATION MATRIX

	RV89	ADVAL89	RDVAL89	CON89	MSH89	GR8789	AGE89	INV89	IMPIO	LEV189	TRI88	LAW89
RV89	1.000											
ADVAL89	−0.038	1.000										
RDVAL89	−0.045	−0.062	1.000									
CON89	0.024	0.245	−0.021	1.000								
MSH89	0.087	0.181	−0.117	0.651	1.000							
GR8789	−0.037	0.016	−0.082	0.055	−0.026	1.000						
AGE89	−0.021	−0.213	0.219	−0.059	−0.088	0.242	1.000					
INV89	−0.032	0.012	0.021	−0.092	−0.075	0.066	−0.337	1.000				
IMPIO	−0.011	−0.034	0.184	0.094	−0.014	0.021	0.121	−0.136	1.000			
LEV189	0.193	−0.209	−0.154	0.054	0.040	0.025	0.001	−0.124	0.116	1.000		
TIN88	−0.012	−0.084	−0.002	−0.124	−0.010	0.074	0.061	0.130	−0.048	−0.027	1.000	
LAW89	−0.025	0.003	−0.027	0.119	0.184	−0.034	−0.017	0.048	0.145	0.010	0.000	1.000

the firm within its primary four-digit SIC code (MSH89) and the four firm concentration ratios at the four-digit SIC code level (CON89). We obtained market share and concentration data from Ward's Business Directory (1990). This source lists the primary four-digit SIC code for public and large private U.S. companies. It also contains a listing by four-digit SIC code of each company selling in that industry and their respective sales in that four-digit industry. Thus, we were able to estimate actual market share in a firm's primary SIC code as well as that SIC code's level of concentration.[5]

Sales growth: Recent growth in firm-level sales is found to be positively correlated with profitability (Schmalensee, 1989; Hirsch, 1991). We measure sales growth as the increase in sales between 1987 and 1989 (GR8789).

Import-consumption ratios: Previous studies have documented that higher levels of foreign competition are correlated with reduced domestic profitability (Schmalensee, 1989). Thus, we measure the ratio of imports to total domestic consumption (IMPIO) as a measure of import penetration.

Research and development expenditures: R&D intensity has been found to be positively correlated with firm profits (Hirschey & Weygandt, 1985; Cockburn & Griliches, 1988; Megna & Mueller, 1991). Because Compustat does not have comprehensive data on R&D, we augmented R&D expenditures using data from the Disclosure database. Ideally, R&D should be a stock measure, perhaps estimated as the present value of past R&D expenditures. However, because of the limitations of Compustat and our inability to obtain entirely comparable data over time, we cannot estimate a stock measure in many cases. Thus, the main results reported in this paper use 1989 expenditures (RD89). However, we also test alternative measures in a smaller sample, such as three years of R&D expenditures (expressed in present-value terms) and the growth in past R&D. As an alternative to R&D expenditures, we also used the number of patents.[6]

Advertising expenditures: Advertising expenditures can lead to product differentiation and consumer loyalty, resulting in brand equity. Comanor and Wilson (1967), Hirschey and Weygandt (1985), and Simon and Sullivan (1993) all find significant positive relationships between firm-level advertising expenditures and profitability. We cannot rely upon Compustat for advertising data, because this would restrict our sample size considerably. Instead, advertising expenditures (ADVAL89) were taken from data published by the Arbitron Company.[7] This source compiles firm-specific advertising expenditures for firms that spend more than $3,000 annually in any of nine major media outlets, including television, major newspapers, radio, and magazines.[8] As in the case of R&D expenditures, limitations on data comparability over time make it impossible to estimate a stock measure in many cases. Thus, although the main results reported in this paper use advertising expenditures in 1989, we also test alternative measures in a smaller sample, such as three years of advertising expenditures (expressed in present value terms) and the growth in past advertising.

Other variables: The natural log of the replacement value of firm assets (LNRV89) is used to control for differences in the size of the firm. We also attempt to control for the "dying-firm effect" by looking at the capital expenditure-depreciation differential (INV89). Lindenberg and Ross (1981) find that firms with declining capital stocks tend to have lower intangible-asset values. Thus, the age of a firm's assets plays an important role in determining its intangible-asset value. A firm with older technology and equipment may be less efficient and hence not as profitable as a firm with new technology.[9]

Finally, industry-wide effects on the intangible-asset value of the firm are controlled for by including industry dummies at the two-digit SIC code for the firm.[10] Among other things, the industry dummies control for the possibility that a heavy-polluting industry, for example, will require larger capital expenditures on pollution-control equipment. In that case, we would expect a lower Tobin's q in heavy-polluting industries simply due to the fact that these expenditures will increase replacement value of capital but not market value. In addition, to allow for the possibility that

[5] Previous studies generally use one of two methods in estimating market share: either Compustat data or proprietary data sources that collect firm-specific sales at the four-digit SIC code level. Using Compustat provides unreliable estimates of market share, because Compustat provides only an estimate of total company sales (not sales within any one SIC code). For example, if 50% of a firm's sales are in its primary SIC code and all other firms in that SIC code derive 100% of their sales in that industry, using Compustat would result in a market share estimate that is twice what it should be for the diversified firm. Our approach avoids this problem because it compares sales only within the firm's primary SIC code. If we had access to proprietary data at the four-digit SIC code level for our companies in 1989, we could construct a weighted average market share estimate based on all SIC codes in which the firm operates. This latter approach incorporates more information about the firm's market share because it includes more than one SIC code. However, unless there is a simple linear relationship between market share and profitability, there is no reason to believe that a weighted average market share is a better measure of market power than the market share of the firm's primary SIC.

[6] Patents were highly correlated with R&D expenditures. In addition, missing observations for the patent variable would have restricted our sample size further. Thus, we opted to use R&D expenditures in this paper. Results with the patent variable included do not qualitatively change.

[7] Leading National Advertisers, The Arbitron Company, 1989.

[8] Because these figures are calculated from media sources and not company-based accounting figures, they exclude some advertising-related expenditures such as company payroll. However, unlike the data available in Compustat, the Arbitron data are much more comprehensive and based on a consistent methodology. As discussed later, we have also tested the robustness of our results using the more limited Compustat data.

[9] The age of a firm's assets is proxied by dividing the value of the property, plant, and equipment of the firm (net of accumulated depreciation) by the gross value of property, plant, and equipment. This gives us a 0-1 scale for the age of a firm's assets, with a firm closer to 1 having newer assets.

[10] Industry dummies are included for only those industries with a minimum of seven firms in them.

TABLE 3.—DETERMINANTS OF TOBIN'S Q

Dependent Variable	(1) $(q - 1)$	(2) $\ln(q)$	(3) $(q - 1)$ (interaction terms included)	(4) $\ln(q)$ (interaction terms included)
Constant	1.83	0.84	2.40	1.04
	(0.001)***	(0.000)***	(0.000)***	(0.000)***
LN of replacement cost of tangible assets (LNRV89)	−0.20	−0.08	−0.25	−0.10
	(0.003)***	(0.001)***	(0.000)***	(0.000)***
Advertising expenditures as percentage of RV89 (ADVAL89)	0.005	0.002	0.03	0.01
	(0.12)	(0.08)*	(0.002)***	(0.003)***
Advertising expenditures × growth in revenue (AD8789)			0.002	−0.002
			(0.91)	(0.79)
R&D expenditures as percentage of RV89 (RDVAL89)	5.08	1.98	5.08	2.40
	(0.001)***	(0.002)***	(0.24)	(0.22)
R&D × growth in revenue (RD8789)			8.08	4.09
			(0.009)***	(0.005)***
Market share (MSH89)	1.42	0.69	1.23	0.63
	(0.002)***	(0.000)***	(0.01)***	(0.000)***
Growth in revenue (GR8789)	0.99	0.43	0.33	0.13
	(0.000)***	(0.000)***	(.22)	(0.33)
Age of assets (AGE89)	−0.05	0.17	0.22	0.093
	(0.95)	(0.57)	(0.35)	(0.78)
Capital expenditure/depreciation differential (INV89)	2.65	0.98	0.69	0.93
	(0.11)	(0.11)	(2.89)	(0.13)
Import penetration (IMIO)	0.89	0.24	−0.14	−0.14
	(0.26)	(0.40)	(0.80)	(0.52)
Toxic chemical (TRI88)	−0.03	−0.011	−0.034	−0.011
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Environmental lawsuits (LAW89)	−0.00004	−0.00002	−0.00004	−0.00002
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Number of observations	233	233	233	233
Adjusted R^2	0.365	0.375	0.47	0.458

p-values are reported in parenthesis: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.
Industry dummy variables have been included for industries with more than seven firms in the sample (not reported here). Models 3 and 4 also include two additional sets of interaction terms between the industry dummy variables and advertising and R&D.

the marginal returns to these investments vary by industry, two sets of interaction terms were specified: between the industry dummies and advertising, and between the industry dummies and R&D expenditures.

C. *Environmental Performance*

We examine two environmental performance measures: TRI88, the aggregate pounds of toxic chemicals emitted per dollar revenue of the firm; and LAW89, the number of environmental lawsuits pending against the firm in 1989. These data were provided by the Investor Responsibility Research Center (1993) and are readily available to the investing public. Reporting of toxic emissions (TRI) data are required under the Community Right to Know Law (1986), which mandates that firms emitting any one of a list of 320 toxic chemicals and employing more than ten people report their emissions to the EPA. These plant-by-plant data are subsequently compiled into firm-level data and reported in the media. Previous studies by Hamilton (1995) and Konar and Cohen (1997) have shown that the disclosure of TRI data had a significant effect on firm stock prices and subsequent firm behavior. These data were first released to the public in 1989. We use the 1988 emission levels to reflect environmental performance, because there is a lag between the actual emissions and the date the data are released.[11] The litigation data for 1989 is taken from 10K disclosure forms required by the SEC.

V. Empirical Results

Table 3 lists the results from the estimation of equation (5) and (6). The dependent variable in this regression is Tobin's q for 1989.[12] The coefficients on the independent control variables are generally as expected based on prior literature. As shown in the first column, Tobin's q (and, hence, financial performance) is positively related to R&D expenditures, market share,[13] firm growth rates, and advertising expenditures.[14] It is negatively related to the tangible

[11] We estimated the models using both the 1988 and the 1989 level of emissions and find no difference in the results. This is not surprising, because the data series are highly correlated with a correlation coefficient of 0.96. We use the 1988 data to control for possible information flow and simultaneity problems.

[12] From equation (2) we get $MV/RC = 1 + V_I/RC$

$$MV/RC - 1 = (q - 1) = V_I/RC$$

[13] We also estimated separate regressions with the four-firm concentration ratio (CON89) as an explanatory variable instead of market share. This variable is also positive and statistically significant ($p < 0.05$). However, because market share and concentration ratios are highly correlated, we only include the variable with the highest level of significance in our reported regressions (market share).

[14] It is possible that the advertising variable is related to environmental performance and thus may also be picking up some environmental liability

assets of the firm. Industry dummy variables are also included but suppressed in the table.

After controlling for the traditional explanatory factors of Tobin's q, we turn our attention to the effect of firm-specific environmental performance on intangible-asset value. Both variables used to measure environmental performance have a negative impact on Tobin's q and are statistically significant ($p < 0.01$). The effect is much more pronounced for toxic chemical (TRI) disclosures than for lawsuits.[15]

Table 3 also reports several alternative specifications of the model. The second column estimates a semi-log specification as suggested by Hirsch and Seaks (1993),[16] with results that are qualitatively identical. The third and fourth columns repeat the first two models but add several interaction terms to allow for differential returns to the intangible investments of advertising and R&D. Thus, in addition to the eleven industry dummy variables, these models have 22 additional variables: eleven interaction terms between firm-specific R&D and the industry dummy, and eleven interaction terms between firm-specific advertising and the industry dummy. These latter specifications also add two additional interaction terms: sales growth and advertising, and sales growth and R&D. Although these varying specifications result in slightly different coefficients and degrees of significance for the control variables, our two variables of interest—TRI88 and LAW89—are always highly significant and their magnitudes extremely robust. Other specifications confirm this robustness.

Next, instead of Tobin's q, we specify the dependent variable to be V_I, the intangible asset value of the firm. Table 4 reports on two specifications, corresponding to column 2 and 3 in table 3. The results are qualitatively similar to those reported in table 3, and the environmental variables still remain negative and statistically significant. The only exception is that the log of the replacement value (LNRV89) is now positive, indicating that higher tangible assets are associated with higher intangible assets. Although not reported in table 4, these equations also contained the 33 dummy variables and interaction terms specified in table 3. Similarly, we conducted identical robustness checks to determine if our results hold up to changes in specification. Not only do we find a consistent pattern of significant environmental performance variables, but their magnitude is surprisingly stable across specifications.

To estimate the economic significance of the environmental performance of firms on their intangible asset value, we calculated the average intangible asset "liability" associated with environmental performance from model 2 in table 4. For the average firm in our sample, the impact of a firm's environmental performance on its intangible asset value is[17]:

$$\text{ENV} = -99.04\ \text{TRI88} - 0.169\ \text{LAW89}.$$

Given average TRI levels and lawsuits in the sample of 233 cases, the average liability is $380 million, which is 9% of the replacement value of assets. Table 5 reports the average intangible-asset value loss by industry[18] for those industries in the sample that had at least seven companies. Firms in industries with fewer than seven companies are classified under the "other" category.[19] The first column indicates the average dollar value loss per firm, and the second column reports this loss as a percentage of the replacement value of tangible assets. The loss value is largest for the chemical (31.2%), miscellaneous manufacturing (29.7%), primary metals (27.7%) and paper (21.1%) industries. Smaller losses are reported in the transportation equipment (1.0%), petroleum and coal (1.3%), food products (1.5%), electric machinery (3.1%), and non-electric machinery (4.2%) industries. The petroleum industry might appear to be an anomaly, because it is a heavy-polluting industry and has come under increasing scrutiny in recent years. However, it should be noted that the petroleum industry is very capital intensive, and their replacement value is approximately five times the average replacement value for all the firms in the sample.

The intangible-asset value loss is derived from two sources: toxic releases and environmental litigation. However, environmental litigation accounts for only a very small portion of the loss for most of the industries studied. For all industries except chemicals and miscellaneous manufactur-

effects. Firms in more-visible industries such as consumer products may be under more public scrutiny with regard to their environmental performance than firms that produce intermediate products. If so, firm-level advertising expenditures may act as a proxy for 'visibility' and potential consumer pressure to be a good environmental actor. To test this, we introduced an interactive term, ADVAL89*TRI88. If the above hypothesis is correct, this term should be significant and negative (indicating firms with large advertising expenditures are affected by environmental reputation more than their nonadvertising peers). However, we find that the interaction term is positive and statistically not significant ($p < 0.35$) in most specifications of table 4. When included in the regression using ($q - 1$) as the dependent variable, the coefficient is positive and significant ($p < 0.01$), implying that firms that are large emitters and highly visible actually have higher intangible-asset values. Thus, either external pressures do not come from these market forces, or advertising expenditures are not a good proxy for these pressures.

[15] There is considerable variability in the number of lawsuits, with two firms reporting more than 30,000 lawsuits in 1989. The significance and the coefficient on the LAW89 variable is influenced by these cases. We estimated the regressions using the natural log of these variables to control for this, but the coefficient was still significant and negative. Alternatively, if these observations are dropped, the coefficient is no longer statistically significant. Because we find no economic justification for doing this, the observations remain a part of the sample. However, the magnitude of the coefficient is so small that, in most cases, it does not contribute much to the loss in firm value. These results are discussed later on in this section.

[16] Hirsch and Seaks (1993) evaluate various functional forms for the estimation of Tobin's q equations. Using Box-Cox transformations, they find that the semi-log form affords a better fit to the model than the linear form.

[17] This assumes that the effect of a firm's environmental performance on its financial performance is fully characterized by its emission levels and environmental litigation. There may be other effects that we do not capture effectively. Thus, one might consider our results to be a lower bound estimate of the effect of environmental performance on intangible-asset value.

[18] The industries are defined by the SIC code and the primary SIC classification for firms is used to classify the firms in the sample to the various industry groups.

[19] There are 41 firms in the "other" category.

TABLE 4.—EFFECT OF ENVIRONMENTAL PERFORMANCE ON INTANGIBLE FIRM VALUE

Dependent Variable: Intangible Assets	1	2 (Interaction terms included)	3 (Restricted sample)
Constant	−30,147	−23,951	−52,064
	(0.000)***	(0.000)***	(0.000)***
LN of replacement cost of tangible assets	4,689	4,109	6,879
(LNRV89)	(0.000)***	(0.000)***	(0.000)***
Advertising expenditures as percentage of	33.3	−51.7	
RV89 (ADVAL89)	(0.05)**	(0.57)	
Advertising stock (ADSTVAL)			10.86
			(0.14)
Advertising × growth in revenue		465.3	−54.5
(AD8789)		(0.002)***	(0.20)
R&D expenditures as percentage of	5,336	52,941	
RV89 (RDVAL89)	(0.66)	(0.31)	
R&D stock (RDSTVAL)			−496
			(0.94)
R&D × growth in revenue (RD8789)		−6,965	−6,303
		(0.72)	(0.12)
Market share (MSH89)	8,814	8,119	7,904
	(0.09)*	(0.125)	(0.26)
Growth in revenue (GR8789)	4,441	2,752	8,575
	(0.006)***	(0.21)	(0.02)**
Age of assets (AGE89)	−9,062	−15,602	−7,437
	(0.13)	(0.06)*	(0.44)
Capital expenditure/depreciation	29,723	42,213	59,111
differential (ING89)	(0.20)	(0.11)	(0.14)
Import penetration (IMPIO)	4,347	2,682	29,641
	(0.12)	(0.52)	(0.43)
Toxic chemical releases (TRI88)	−88.2	−99.04	−124.8
	(0.007)***	(0.008)***	(0.008)***
Environmental lawsuits (LAW89)	−0.158	−0.169	−0.153
	(0.05)**	(0.05)**	(0.24)
Number of observations	233	233	132
Adjusted R^2	0.309	0.388	0.435

p-values are reported in parenthesis: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.
Industry dummy variables are included for industries with more than seven firms (not reported here). Model 2 also includes two sets of interaction terms between the industry dummies and advertising and R&D. Model 3 is a restricted sample in which advertising stocks and R&D stocks could be estimated.

ing, the loss amounts to less than a million dollars. Thus, the primary component of loss in value for most industries is the level of toxic emissions. The main exception is for the miscellaneous manufacturing industry, in which approximately one billion dollars is due to litigation, which constitutes 67% of the total value loss in the industry group. However, outliers in the environmental litigation data primarily drive this result, because two firms with a large number of lawsuits lie within this industry group.

TABLE 5.—ESTIMATED EFFECT OF ENVIRONMENTAL PERFORMANCE ON INTANGIBLE-ASSET VALUE

Industries by SIC Code	Intangible-Asset Loss due to Environmental Performance (million $)	Intangible-Asset Loss due to Environmental Performance (% of Replacement Value of Tangible Assets)
Food products (20)	41.2	1.5%
Paper and allied products (26)	628.7	21.1%
Printing and publishing (27)	210.1	15.1%
Chemicals (28)	989.2	31.2%
Petroleum and coal (29)	259.5	1.3%
Primary metals (33)	890.8	27.7%
Non-electric machinery (35)	110.1	4.2%
Electric machinery (36)	94.0	3.1%
Transportation equipment (37)	88.1	1.0%
Measure, photo equipment (38)	170.2	7.7%
Miscellaneous manufacturing (39)	1,674.8	29.7%
Others	249.8	8.3%

Millions of 1989 dollars. The estimates for the dependent variable, *ENV*, are based on the regression coefficients reported in model 2 of table 4. Intangible-asset value loss due to environmental performance is estimated to be: ENV = −99.04 * TRI88 − 0.169 * LAW89.

In addition to attributing a small but significant portion of intangible-asset value to environmental performance, we can examine the effect of changes in the environmental performance on the market value of firms in our sample. For example, for the average firm in our sample, a 10% reduction in TRI emissions (from 3.44 to 3.09 tons per thousand dollars of revenue) results in a $34 million increase in intangible-asset value (99.04 × 10% of 3.44 = $34.1), which constitutes approximately seven-tenths of 1% of the replacement value of assets for the average firm. If we had data on the cost of reducing TRI emissions by 10%, we could directly compare the costs and benefits of further reductions in TRI from the firm's perspective. In contrast, a reduction in one environmental lawsuit increases average firm value by only $170,000. Given the high cost of litigation, it does not appear that being sued has a significant effect on firm valuation.[20]

[20] Note that our data cannot distinguish between lawsuits that have merit and will have a large effect on the firm and those that are frivolous and/or will have a trivial effect.

VI. Summary and Conclusions

This paper compares the environmental and financial performance of manufacturing firms in the S&P 500. The primary objective of the study is to explore the relationship between firm-level environmental performance and intangible assets. After controlling for the effect of a number of variables on firm-level financial performance, we find that poor environmental performance has a significant negative effect on the intangible-asset value of publicly traded firms that belong to the S&P 500. This effect is both statistically and economically significant. Firms in our sample have an average "liability" associated with environmental performance of about $380 million in market value, which constitutes approximately 9% of the replacement value of tangible assets. Of course, this result is symmetric, and the corollary is that firms that have better environmental reputations have higher intangible assets. The effect of environmental litigation on intangible-asset value, although statistically significant, tends to be economically insignificant in most industries. On the other hand, the effect of toxic-emission levels tends to be both statistically and economically significant. We also find that the magnitude of the loss varies across industries with larger losses accruing to the traditionally polluting industries.

We believe our results are an important first step in understanding why large publicly traded companies invest in environmental-reputation capital. Major corporations voluntarily overcomply with environmental regulations and externally portray an image of being environmentally concerned. Our evidence suggests these firms are rewarded in the marketplace for taking these actions. What we have yet to understand fully, however, is whether this relationship is truly causal. Are highly reputable and profitable companies environmentally sound because they can afford to be, or does that environmental concern enhance their reputation? Is it possible that good managers spend more on environmental quality, but these expenditures do not create any value to the firm? If so, our results might be an indication that environmental reputation is a proxy for good management. These important questions are left for future research.

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