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Time Horizons of Environmental Versus Non-Environmental Costs: Evidence from US Tort Lawsuits

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ABSTRACT
One explanation for a positive correlation between environmental and financial performance at the firm level is a bias in firms' investment evaluation processes caused by systematic differences between environmental and other investment opportunities. One of these systematic differences, often hypothesized but still unverified, is that environmental costs occur farther in the future than other costs. We empirically test this hypothesis, and find statistically significant support for it. In our data set the mean time lag for environmental costs was more than ten years, compared with five years for the control set costs. Such a difference could induce managers to accept too much environmental liability if they evaluate investments using discounted cash flow methods with a discount rate based on the firm-wide cost of capital. Copyright © 2006 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

Firms' ability to anticipate and estimate the financial impacts of environment-related costs and benefits is increasing as environmental management accounting (EMA) systems develop.[1] Although non-financial impacts, such as material flows, are often easier to measure than financial impacts, EMA is increasingly allowing the financial impact of environmental costs, including liability for environmental externalities, to be measured and traced to the activities that incur them. This is especially important in supporting managerial decision making.

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[1] See definition of environmental management accounting by United Nations Department of Economic and Social Affairs (http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm (7 December 2004). Burritt (2004) reviews recent definitions of environmental management accounting and Burritt *et al.* (2003) explore the current thinking and practice in depth.

In a recent article, Burritt (2004) cites nine roadblocks to fully integrating environmental costs in management accounting, including the assumption that environmental costs are not significant, and investment appraisal processes that neglect environmental considerations.

We discuss an additional roadblock that can prevent the adoption of financially desirable projects, even when the environmental costs are fully measured and accounted for, and which forms the basis for a theoretical explanation of a causal link between environmental performance and financial performance. The problem occurs because commonly used investment evaluation methods employ high discount rates. This biases investment evaluation processes to understating the importance of distant future environmental costs.

Empirical evidence indicates that environmental and financial performance are correlated at the firm level (King and Lenox, 2001a; Cohen *et al.*, 1999; Jones and Rubin, 1999; Konar and Cohen, 1997; Feldman *et al.*, 1996), which suggests that firms are missing profitable opportunities to invest in environmental performance. Rennings *et al.* (2003) also find a significant positive correlation at the industry level. Nearly all empirical studies of this relationship are at the firm level because data relevant to environmental and financial performance at the sub-firm level are very difficult if not impossible to find.

A causal relationship would depend on industry and firm-specific factors and on the type of environmental performance in question. Moreover, high performance in environmental and financial dimensions may be caused by other, unmeasured variables such as overall management quality.

In part because of this difficulty, no causal link between environmental and financial performance has been conclusively demonstrated, nor is there consensus on a theoretical basis for causality (Schaltegger and Synnestvedt, 2002; Wagner, 2003; Figge *et al.*, 2002). However, many scholars have argued that the practice of investment analysis is systematically biased against environmentally friendly opportunities because they have atypical characteristics, including long time horizons.

Several researchers go so far as to recommend that special investment evaluation criteria be applied to environmental investments, in support of both financial and environmental objectives (Schaltegger and Müller, 1998; Moilanen and Martin, 1996; Gray *et al.*, 1993; US EPA, 1992). They argue that payback period and discounted cash flow criteria with high discount rates focus on the short term, whereas the savings associated with environmentally friendly alternatives occur in the long term, relative to comparable alternatives (Schaltegger and Burritt, 2000; Reinhardt, 1999; Schaltegger and Müller, 1998; Moilanen and Martin, 1996; Epstein, 1996; Gray *et al.*, 1993; US EPA, 1992).

These arguments presuppose systematic differences between environmental and other investment opportunities. One of these hypothesized differences is that costs associated with poor environmental performance occur later than other types of cost. However, this assumption has never been empirically tested. We perform an empirical study to test whether environmental costs in fact have longer than average time lags between actions that incur them and the costs themselves. Our results give significant ($p = 0.01$) support for the claim that environmental costs arise later than other costs, on average: in our data set the mean time lag for environmental costs was more than ten years, compared with five years for the control set costs.

The claim that environmental costs are postponed or prolonged into the future, as compared to other costs, makes intuitive sense. Environmental systems are quite complex, and can even exhibit chaotic behavior; they may be buffered from small changes, but at a tipping point show a dramatic impact from human intervention. Multiple human actions may affect an environmental system in an unanticipated, synergistic way so that the consequences of all the actions become evident simultaneously. For these reasons, the consequences of human actions could be expected to take longer to occur and/or to become evident when a complex natural system is involved. For example, a release of man-made chemicals to the environment might not require a groundwater cleanup cost for years, because it takes that long for

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the site's hydrology to transport the chemical to a drinking-water well. For these reasons, any resulting costs mediated by the environment would take longer to occur.

On the other hand, some would argue that artificial systems such as markets and governments are also quite complex, and costs that depend on the systems' behavior might occur in the very distant future. Moreover, even if the environment is acknowledged to be more complex, costs mediated by the environment may never be traced and assessed to the managers whose actions caused them, due to that very complexity.

Longer time lags for environmental costs imply that environmentally friendly investments are especially vulnerable to timing biases inherent in investment evaluation criteria, and that problems in the selection of discount rates induce managers to accept more environmental liabilities than would be financially optimal. Together with limitations of investment evaluation processes, this difference would partly explain the observed correlation between firms' environmental and financial performance.

There is an important ongoing debate as to the relationship between environmental and financial performance. As King and Lenox (2002) observe, this debate is not just 'over the private cost of pollution. It is a debate about whether managers systematically miss profit opportunities'. A few scholars have begun to search for mechanisms that could explain such a relationship. Underlying this issue are the questions of whether, how and to what extent environmentally friendly investments differ systematically from other investments. Our study contributes some first answers to these questions.

Mechanisms for Bias

There is a vigorous discussion in the environmental management literature about the fundamental nature of the relationship between environmental performance and financial performance. This includes normative and empirical exploration of legal and other underlying structural influences (see Walsh *et al.* (2003) and references therein). Focusing on the present-day legal and economic climate, the discussion is still quite active. The zero-sum model, articulated by Palmer *et al.* (1995), is the seemingly inescapable implication of classical economic assumptions: additional constraints on firms cannot possibly improve their financial performance. Porter and van der Linde (1995) represent the contrasting win–win model, under which firms can simultaneously improve their financial performance and their environmental performance. The two viewpoints are summarized by Hoffman (2000) and Wagner (2003).

As cited above, a considerable amount of empirical work in recent years has been designed to test which of these models is consistent with historical firm performance (see also Deutsch, 1998). These studies have generally found a positive correlation between financial performance and environmental performance at the firm level,[2] suggesting that low-performing firms are making suboptimal decisions with respect to environmental performance. This has prompted a search for a theory to explain biased behavior.

Without an understanding of which decisions are suboptimal, documentation of causality would offer managers no directions for change. Even if no causal link is established at the firm level, the search for a mechanism for suboptimal decisions regarding environmental performance may yield evidence of systematic and detrimental bias in some subset of managerial decisions that would offer a profitable opportunity for change.

[2] At the level of individual projects, Halme and Niskanen (2001) find a negative but temporary effect of environmental investments on shareholder value.

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Three major categories of explanations have been offered for suboptimal decision making with respect to environmental performance. The first explanation is that because managers are limited in time and information available for analysis and because they are not familiar with the benefits of environmentally friendly investments, they fail to identify and consider profitable opportunities. We use the term 'environmentally friendly investment' to refer to any alternative that is expected to reduce net negative environmental impact, relative to alternatives considered or relative to the status quo. Usually, these alternatives will have net costs in the short run, and so can be called 'investments'. Examples include purchase and installation of pollution prevention and control equipment, spending to recover and handle hazardous materials and design and implementation of energy or material conservation measures.

Systematic bias could cause environmentally friendly investments to appear less profitable than they really are. As Schaltegger and Burritt (2000) put it (p. 158), 'the opportunity costs of unrealized environmental protection may be very significant for many companies'. In the win–win view, increasing environmental performance demands on industry are analogous to the 1980s quality revolution, which prompted some firms to identify profitable opportunities they had long neglected, and inspired the phrase 'quality is free'. The argument is that firms that fail to look for profitable investments in environmental performance will fail to find them, and will tend to underinvest in environmental performance, to their financial detriment. Recent regulatory and competitive spurs to environmental performance have motivated companies to look for product and process improvements in places they had not looked previously. As Porter and van der Linde (1995) put it, regulation (or other environmental constraint) 'signals companies about likely resource inefficiencies and potential technological improvements', so reducing waste often reduces costs because waste demands costly inputs. Porter and van der Linde (1995), Reinhardt (1999) and Hoffman (2000) give good explanations for and examples of this phenomenon, and King and Lenox (2001b) find empirical support for a complementary relationship between lean production and environmental performance.

A second explanation for systematic underinvestment in environmental performance is that accounting processes fail to assign relevant costs and benefits to environmental performance decisions (Schaltegger and Burritt, 2000). Currently most firms do not track the majority of their environmental costs (US EPA, 1995; White *et al*., 1995). Environmental costs can be defined many ways (see, for example, UNDSD, 2001), but frequently they are defined as any cost (or benefit) that is affected by environmentally friendly firm decisions, or that is directly or indirectly correlated with environmental impacts. This would include costs internal to the firm, such as pollution prevention and control measures, waste handling, product recoverys and the net cost of environmentally friendly design and production inputs. It would also include costs external to the firm, such as the impact of environmental damage on neighbors or consumers of the firm's product, and any liability for these external costs.

It is difficult to identify and trace all the costs and benefits to relevant decisions. Often costs such as waste disposal, energy consumption, and legal department time fall into an overhead category and therefore are incorrectly spread over all activities and never assigned to the activity that incurs them (Burritt, 2004; Macve, 1997; Epstein, 1996; Moilanen and Martin, 1996). Environmental liabilities are often not accounted for in decision-making because they are difficult to predict. Accounting methods also frequently neglect intangible costs such as reputation effects. In addition, cash flow projections are often based on the assumption of a steady-state business environment, whereas good strategic decision processes consider competitor behavior, changing regulatory requirements and other dynamic aspects of the business environment (Reinhardt, 1999; Del Sol and Ghemawat, 1999; Porter and van der Linde, 1995).

A final explanation for systematic underinvestment in environmental performance – and the one we are most concerned with in the present study – is that firms' decision methods are systematically biased against environmentally friendly alternatives. Just as cost accounting methods are not immutable,

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neither are decision methods: special characteristics of environmental costs demand reconsideration of investment evaluation criteria and decision methods.

Several researchers have suggested that limitations in the use of conventional investment evaluation criteria and special attributes of environmental investments lead to bias in decision outcomes (Schaltegger and Burritt, 2000; Neumayer, 1999; Thurston, 1999; Macve, 1997; Epstein, 1996; Moilanen and Martin, 1996; US EPA, 1999; Johnson, 1994; DeCanio, 1993). A critical limitation of investment evaluation in practice is that managers frequently use decision criteria that give too little weight to distant future costs; this applies to all investments, regardless of whether they have an environmental component. Many firms, especially small firms, continue to use payback period (Graham and Harvey, 2001; Farragher *et al*., 1999; Block, 1997) to evaluate investment opportunities, neglecting cash flows anticipated to occur beyond five years or an even shorter time horizon. While firms increasingly use discounted cash flow methods (Farragher *et al*., 1999; Graham and Harvey, 2001; Block, 1997; Del Sol and Ghemawat, 1999), discounted cash flow, 'which should encourage a longer term perspective, tends to discourage . . . projects with an expected life of more than about ten years and, most importantly in an environmental context, inevitably places less emphasis on events later in the project's life' (Gray *et al*., 1993).

In firms that use discounted cash flow methods, the selection of the discount rate is often tenuous. Kaplan (1986) has observed many blatant errors in estimating the appropriate discount rate, including application of nominal rates of return to inflation-free cash flows, which require a lower rate of return. It is not surprising that there should be frequent errors in practice: the textbook by Brealey and Myers (2003) says that 'Each project should be evaluated at its own opportunity cost of capital', but later says that 'many, maybe most, projects can be treated as average risk . . . For these projects the company cost of capital is the right discount rate'. Although risk-adjusted hurdles are the most commonly cited method for accounting for risk (Block, 1997), most firms – 59% in the Graham–Harvey (2001) survey – use a single firm-wide discount rate, usually equal to the firm's cost of capital, to evaluate all projects, despite differences in risk (and cost of capital) across projects. In a survey by White *et al*. (1995), 57% of managerial accountants reported using the same rate to evaluate environmental and non-environmental projects.

In particular, the most frequent criticism of discount rate selection is that the hurdle rates firms require for accepting an investment are too high (*The Economist*, 1999). Managers adjust rates upward due to capital constraints and to compensate for overoptimistic profitability projections: 43% of managerial accountants reported using rates in excess of 20% to evaluate environmental projects (White *et al*., 1995). DeCanio (1993) cites an unpublished survey of manufacturing firms whose average after-tax hurdle rate – in real terms – was 12%, although the historical average rate of return on investments in the market was 7%.

Overly high discount and hurdle rates are also one of the major criticisms of investment decision-making in the environmental management literature (Moilanen and Martin, 1996; DeCanio, 1993; Epstein and Roy, 1998). Boyd (1998) gives a case study in which a chemical manufacturer rejected an extremely profitable pollution prevention upgrade because the firm's capital budgeting process capped the total amount of capital expenditures, leading to an effective hurdle rate of 86% for that year.

Economic arguments can explain firms' use of high discount rates as an all-purpose adjustment factor. The time and cost required to conduct a more detailed analysis, including choosing a project-specific or cash-flow-specific discount rate and explicitly treating factors such as restricted capital and forecasting errors may sufficiently justify the use of discount rate as a proxy for other factors.

Nevertheless, using high discount rates across the board will bias managers in favor of alternatives that incur costs in the distant future. When future cash flows are revenues, discounting them at a high rate is conservative because more distant revenues are given less weight. However, when future cash

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flows are costs, discounting them at a high rate is implicitly risk seeking, and favors outcomes with future costs, as a simple example shows.

Consider the case of a manager of a gas station. She is faced with two alternatives: to (1) continue using an old underground storage tank, which risks a leak, or (2) take it out of service. The additional annual profit from continuing to use it is \$500 per year, but there is a probability p that it will leak and therefore require a clean-up cost of \$$L$ before the site can be sold. Let the probability of a leak after 10 years be 50%, and the cleanup cost be \$15 000, and assume that taking the tank out of service incurs zero net cash flows. The manager wants to make the decision that is best for the plant's bottom line.

A very common method of analyzing this decision would be to calculate the net present value (NPV) of the incremental cash flows associated with continuing to use the tank, using a risk-adjusted discount rate. Taking 4% as the risk-free rate and a risk premium of 9%,[3] the risk-adjusted discount rate is 13%. The formula for the expected NPV for this alternative is $\Sigma_{n=1}^{10}\$500/(1 + d)^n - pL/(1 + d)^{10}$. Using $d = 13\%$, the expected NPV of continuing to use the tank is about \$504, and based on the NPV the manager would choose to use the tank. However, the expected NPV evaluated using the risk-free rate of 4% is –\$1011, and the alternative adds risk to the station's bottom line.[4] The risk-adjusted discount rate actually favors the risky alternative.

Moreover, the longer the time horizon, the more severe this effect becomes. In the above example, let the time horizon for the resale of the property be pushed out to 20 years, keeping $p = 50\%$. At the risk-adjusted discount rate, the alternative to continue using the tank has a positive NPV of around \$504 if the clean-up cost is \$34 660. The NPV at the risk-free rate, however, is even more negative (–\$9023), while the risky cost is even higher. This simple example illustrates an effect that is simple, yet often overlooked: the major investment evaluation criteria based on discounted cash flow analysis are subject to errors whose severity is greatly amplified when applied to trade-offs across longer time periods (for more detail, see Regnier, 2001).

Investment evaluation methods – ways of quantifying and integrating costs and benefits of a project to evaluate their impact on profitability – depend on estimates of the future costs and benefits of any project. Therefore, the mechanism for bias that we describe is relevant for costs that are recognized and quantified during the decision making process. To the extent that costs can be anticipated, they should be hedged (e.g. using insurance) or included in decision-making, using the expected cost or a risk-adjusted measure, such as certainty equivalent, even when there is uncertainty about whether they will occur. Although accounting and reporting rules generally do not require the estimation of potential liabilities that are considered improbable, failing to incorporate such costs in decision-making can lead to a bias towards incurring too much environmental cost, to the firm's financial detriment.

Environmental liabilities are not always quantified. In a survey of manufacturing firms (White *et al.*, 1995), well under half of management accountants reported quantifying liability for personal injury (35%), workers' health and safety claims (43%) and Superfund costs (20%). It is worth noting that their major reasons for not quantifying these liabilities were not fear of lawsuits (5%) or required disclosure to the Securities and Exchange Commission (3%). The three most commonly cited reasons for not quantifying Superfund liability were difficulty in predicting whether the loss would occur (58%), difficulty in estimating the magnitude of the loss (45%) and difficulty in identifying when the loss would occur (29%). Burritt *et al.* (2003) report on a 1999 survey showing that while 87.5% of responding organizations in Germany collected environmental information in financial terms, only 39.2% in Australia and

[3] The values of 3.9% for nominal (with inflation) treasury returns and 9.1% for the risk premium are the average historical values based on 1926–2000 data (Brealey and Myers, 2003). The effect illustrated in this example remains if real (inflation-adjusted) discount rates are used.
[4] In this simple example, a manager might notice the effect of this simple decision rule. However, when many costs and benefits are included in an analysis, perhaps in a spreadsheet, this effect would be disguised. As discussed above, this is in fact a very common method for evaluating cash flows.

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27.4% in Japan did so. In addition, individual managers may have incentives to implicitly discount costs by failing to quantify costs they expect will not arise before they leave their position or firm.

The purpose of this paper is not to expose limitations of payback periods or the selection of discount rates, which are well known. Rather, our aim is to discover whether these limitations are particularly influential when environmentally friendly investments are evaluated. Note that these arguments do not relate to environmental costs external to the firm, but only to costs that eventually affect the firm's bottom line.

Epstein (1996) argues that environmental investments do not require special attention because

> It is not that capital budgeting models are inadequate but rather that they often are not used in environmental capital investment decisions. Long time horizons, uncertainty and risk are dealt with in other capital investments . . . By including all environmental impacts, companies can apply the same discount rates as they do for other projects (p. 179).

However, if discount rates are too high – and, as cited above, there is evidence that this is the case, either explicitly or implicitly in a payback period analysis – decision methods are biased towards investments that incur more future costs than would be optimal from shareholders' perspective, and this bias increases with the time horizon of the costs. If environmental costs take longer to occur than other costs, the bias is especially severe for environmental investments, and they deserve special attention. The claims that environmental costs take longer to occur therefore warrant testing.

Methods

In order to test whether environmental costs take longer to occur than non-environmental costs, we required a set of otherwise comparable costs that included both types. Empirical research regarding the consequences of decisions at a sub-firm level is difficult, because firms do not often share data about individual investments, and data may not be comparable across firms.

In addition, to assess time lags between decisions and consequences requires not just cost data, but also information about actions that led to the costs. This additional informational requirement made the study design more of a challenge.

We selected, as the source of data for this study, tort lawsuits in which the plaintiffs sought compensation for injuries to which actions by the defendants allegedly contributed. A tort is an injury one party causes to another, through a civil (as opposed to criminal) action. The costs under study were initially externalities that were (at least partly) internalized to the defendants as a result of the lawsuits. By its very nature, a lawsuit requires the plaintiff to establish a causal relationship between his injury (not necessarily a physical injury) and an action by the defendant.[5] The facts of the case, including the causal action, are usually summarized in the judge's opinion. Hence this data source was well suited to testing our hypothesis.

There were two other principal reasons for selecting lawsuit data. First, as a practical matter, the data are publicly available, unlike cost/benefit data for most firm-level decisions. Second, the types of action and injury that are involved in the cases in the data set are very diverse, which helps to reduce bias in the sample based on the fact patterns of included cases. The study, which was designed to include liability costs arising from the largest possible set of consequences, includes cases with very diverse fact

[5] Since many of the consequences covered in the data set have multiple contributing causes, the defendant's action may be one of many contributory factors, but will be referred to as the causal action hereafter.

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patterns. These are quite varied between categories, but are also very varied within each category. This heterogeneity allows the study results to reflect systematic differences between environmental and non-environmental costs, rather than differing characteristics of a few specific fact patterns.

We gathered data about occurrences in which one party (the defendant) allegedly took some action or decision that caused or contributed to an injury to another party (the plaintiff). The occurrences were divided into those that were mediated by the environment, and a control group. This categorization is discussed in more detail later. We measured the time lag between the defendant's causal or contributory action and the lawsuit costs and compared the average amount of time that elapsed between the action and the lawsuit for environmental and control group cases.

This study focuses on one subset of environmental costs: specifically, expenditures to remediate or compensate for environmental damage caused by earlier decisions. In other words, the costs are initially externalities, borne outside the firm, which are internalized by the decision-maker as a result of tort lawsuits. The results of this study are also relevant to other types of environmental cost, such as the net costs of inputs whose production has environmental consequences relative to close substitutes (energy, biomaterials, secondary or recyclable materials),[6] or of selection of suppliers with high environmental performance because the financial performance of suppliers will be affected by the externalities they cause. To the extent that this study characterizes the time lags associated with environmental externality costs, it will support the theory offering investment evaluation methods and timing as a source of bias against environmentally friendly decisions.

The amount of the cost was not analyzed in this study. An accurate measure of the cost to the defendant is usually unavailable because many lawsuits are settled before they reach a judgment, and the terms of settlement are generally not made public. In addition, the defendant may experience costs regardless of the judgment or settlement: the total cost of the lawsuit can also include legal fees, employees' time and non-financial costs such as damage to the defendant's reputation.

Data Collection

Data were extracted from opinions from two courts, which were selected because of the large number of cases available electronically, and to increase the diversity in types of case in the data set by using courts in two different states, one federal and one state level. This diversity means that differences between the results for the two courts could be attributed to systematic differences in the types of case in each state, in the types of case brought to state courts versus federal courts, and in which types of case are appealed, instead of settled or not appealed. These factors are confounded.

The differences between the two courts also mean that consistency in our results should reflect an underlying difference between environmental and control cases. Combined with the diversity of the fact patterns under study, this should allow the statistical tests to elicit systematic differences in the averages between environmental and non-environmental time lags.

- *The US District Court for the District of New Jersey*. We used opinions listed in the directory at http://lawlibrary.rutgers.edu/fed/html/ as of 28 January 2000. There were approximately 500 files. The opinions were handed down between March 1998 and January 2000, and included suits with filing dates ranging from December 1989 through December 1999.
- *The Supreme Court of Mississippi*. We used opinions available at http://www.mssc.state.ms.us/decisions/during the week of 17 March 2000. Approximately 3000 opinions were available on the

[6] For more on environmental costs, see references in Bennett *et al.* (2003).

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web. The opinions dated from March 1996 through December 1999, and the filing dates of the suits ranged from September 1983 through May 1997.

The databases include all opinions submitted by the judges for publication on the website, some of which are listed for publication in print and other sources, and some of which are not. Opinions are included at the judges' discretion and there is no information regarding bias in the inclusion/exclusion of opinions from the online databases.

Case Screening

All of the approximately 3500 files available from the two courts were examined. Opinions were eliminated if they did not describe a lawsuit in which the plaintiff sought monetary compensation for injury to himself.[7] Opinions eliminated on this basis described

- lawsuits in which the plaintiff was seeking only declaratory or injunctive relief, but not monetary relief,
- contract disputes in which the liability was not for compensation for an externality injury, but incurred contractually by the defendant (this includes most insurance cases),[8]
- divorce and estate settlements, which may involve some kind of injury to one party, but were at least partly governed by a marriage contract or will,
- appeals of administrative decisions, such as a denial of benefits by the Social Security Administration and appeals of criminal convictions or sentences,[9] and
- complaints that were originally brought in another venue, such as employment discrimination complaints originally brought to EEOC or a state equivalent.[10]

Also excluded were cases that involved a physical injury or health effect to the plaintiff. Like the natural environment, the human body is a complex and incompletely understood system that might be expected to show timing behavior similar to that of environmental consequences.

Often the database contained more than one opinion related to the same underlying lawsuit. These sets of opinions were treated as a single opinion, and supplied only one observation to the data set. Multiple plaintiffs and/or defendants named in the same suit, with the same action or injury, were only used once. If they brought separate suits, multiple plaintiffs complaining of the same action by the same defendant were not included as separate occurrences; instead, one of these occurrences, selected at random, was included.

After screening for monetary compensation, and identifying multiple opinions and plaintiffs, the set of files reduced to a total of about 800 underlying lawsuits. These form the basis for the study. Environmental occurrences were very rare in both data sources, and therefore all available environmental opinions were identified by searching all available opinions. A subset of the control occurrences was selected at random from each data source, since they were far more numerous. A total of 24 cases from New Jersey and nine cases from Mississippi were included in the statistical analysis.

[7] In some cases, the available file described a counter-suit, so the plaintiff in the underlying suit was named as the defendant. In these cases, the nominal defendant might be the original party seeking damages, and was considered the plaintiff for the purposes of this study.
[8] However, a lawsuit demanding compensatory or punitive damages for breach of contract would be included in the data set. The causal action would be the failure to fulfill the terms of the contract, rather than the act of entering into the contract.
[9] Although appeals of administrative decisions are excluded, in some cases a government can incur a liability for injury caused by legislation or regulation. For example, in one occurrence, the plaintiffs sued the state government for compensation for the 'taking' of value in their property due to an environmental law forbidding them from building a dock on their waterfront. This case was included in the data set in the control category.
[10] While some of these complaints can relate to an externality injury to the plaintiff (e.g. worker's compensation and employment discrimination complaints), the complaint's arrival in court is delayed by the administrative process, thus biasing the time lag data.

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Categorization

The categorization of each occurrence depended on the linkage between the causal action and the injury to the plaintiff that forms the basis for the tort lawsuit. In environmental occurrences the link between action and the injury to the plaintiff was mediated by the natural environment.[11] In the control cases, only the social, economic and built environments were involved in the link between action and injury. The control cases are very diverse, reflecting tort claims arising from many types of injury to the plaintiffs, including damage to property value, reputation and financial loss to the plaintiff. Examples of each type from the data set are given below.

- *Environmental.*
  - Multiple plaintiffs sued the operator of a service station for contamination of a groundwater well due to repeated discharges of gasoline from underground storage tanks at the station.
  - A property owner sued to recover environmental remediation costs from a bank that invested in a property management company that in turn allowed the property to be used as a sulfurizing manufacturing plant that caught fire and contaminated the site.
- *Control.*
  - A property owner sued a timber management company hired by the adjacent property owner for compensation for trespassing and mistakenly cutting down trees on the wrong property.
  - A condominium association sued the developer and contractor for fraud and negligence, which led to construction defects in their building.

Pinpointing Action and Lawsuit Dates

Each relevant event was assigned a date. When the opinion gave a range of dates, the mid-point was used: for example, if the opinion stated that a lawsuit was brought in January 1997, 15 January was used as the date; if the opinion stated that the action occurred in early 1997, then 1 March (the mid-point of the first four months of 1997) was used.

The date of the lawsuit was used as a proxy for the date of the costs to the defendant. The true costs might include an eventual adverse judgment, immediate legal expenses, employee time and even reputational effects such as increased cost of capital for defendant firms. The use of this proxy could induce bias in the data, but only if the time lag between the lawsuit date and the bulk of lawsuit-related costs is systematically different for environmental cases.

For most occurrences, the date of the initial filing was given explicitly in the text of the opinion. When the date of the initial complaint was not given, the earliest available date for any document or legal action related to the case was used. If there was no date associated with the lawsuit before the current opinion, the date of the opinion was adjusted by the average time elapsed between the initial filing and the date of the available opinion, for the relevant court, to estimate the date of the original lawsuit. Since all the cases in the Mississippi Supreme Court and nearly all the cases in the New Jersey court originated in lower courts, and were on appeal, the original lawsuit usually occurred several years before the available opinion. Failing to adjust the dates of the lawsuit for the appeal lag time would distort the data for these

[11] Liability for cleanup of hazardous waste sites under US Superfund (officially CERCLA) regulation is an important source of cost for US operations. The Superfund law provides a means to require parties responsible for hazardous waste sites to clean them up and (until recently) required certain industries to pay into a fund that would pay for cleanup of sites for which no responsible parties could be found. However, Superfund is not the controlling law in any of the cases in this study because of the type of case in this study (tort injuries to non-governmental plaintiffs). Although one of the cases involves a Superfund site, all the injuries in the study were to individuals. The delay between action and discovery of environmental injury that this study shows would also apply to Superfund liabilities, as this delay is attributable to the fact that the natural environment itself causes a delay in occurrence and/or discovery of the externality consequence.

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cases considerably. Of 24 total observations for the New Jersey court, two suit dates were adjusted in this manner, and of the nine observations for the Mississippi court, one suit date was adjusted.

The date of the action was much more difficult to pinpoint. There was often considerable ambiguity in identifying the date of the action that allegedly caused or contributed to the plaintiff's injury. For example, in class action suits, there was generally a range of dates applying to multiple plaintiffs. In environmental cases, the defendant might have contributed waste to a site over decades. In negligence cases where the causal action is actually a failure to take action, no discrete action or decision is cited. For example, in the case of a plaintiff who fell through a hole in the rotting deck of the defendant's boat, the defendant was allegedly negligent in maintaining the boat. He may have made no conscious decisions regarding the repair and maintenance of the deck, and if he did they are not identified in the case documentation. Any date between the defendant's acquisition of the boat and the date of the accident is defensible as the date of the causal action.

Because of these ambiguities, we bounded the date of the action/decision as well. Each observation therefore consisted of the date of the lawsuit, and three data values related to the date of the action that allegedly caused or contributed to the consequence – the estimated date, the earliest possible date and the latest possible date. These dates, subtracted from the date of the lawsuit, yielded respectively the estimated lag, the upper bound and the lower bound on the action–lawsuit time lag. When fewer than three of the measures for the date of the action were available, the observation was used only in the statistical tests for which the data were available, as reflected in Table 1.

If the opinion specified a date for the relevant action, it was used as the estimate and the lower and upper bound. When the court opinion did not specify a date, the earliest possible and the latest possible bounds on the date were usually unambiguous. For example, if a plaintiff complained of ongoing harassment by his employer, the date of his termination was taken as the last possible date for the action. If the plaintiff alleged some discrete action by the defendant, but no information about the date was given in the documentation, then the latest possible date was taken to be the date the suit was filed, and the earliest possible date was not available. The estimate of the date of the action was more complicated. It was of great value in this study that tort lawsuits focus on establishing a causal action. Typically, once an action was identified, the date was specified in the documentation. Often there were multiple contributory actions, but only one or a few were associated with dates – in these cases the most important

Court	Time lags (years)								
	estimated			upper bound			lower bound		
	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s
New Jersey environmental	4	12.1	6.2	4	14.2	6.4	5	7.4	6.8
Control	18	5.5	5.6	17	7.0	6.6	19	2.7	3.1
Total	22	6.7	6.0	21	8.4	7.0	24	3.7	4.4
Mississippi environmental	3	8.1	8.4	3	8.9	9.1	3	6.1	8.6
Control	6	2.4	2.4	6	2.8	2.7	6	1.9	2.2
Total	9	4.3	6.2	9	4.9	5.9	9	3.3	5.1
Combined environmental	7	10.4	6.9	7	11.9	7.5	8	6.9	6.9
Control	24	4.7	5.2	23	5.9	6.1	25	2.5	2.9
Total	31	6.0	6.0	30	7.3	6.8	33	3.6	4.5

Table 1. Summary statistics for time lag data

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Court	Time lags								
	estimated			upper bound			lower bound		
	n_E	n_C	p-value	n_E	n_C	p-value	n_E	n_C	p-value
New Jersey	4	18	0.027	4	17	0.040	5	19	0.051
Mississippi	3	6	0.15	3	6	0.19	3	6	0.45
Combined	7	24	0.010	7	23	0.020	8	25	0.068

Table 2. Results of Mann–Whitney rank-based comparisons

of the dated actions was used for estimating the date. When the selection was very ambiguous, as for ongoing harassment, the mid-point of the earliest possible and latest possible date was used.

Results and Analysis

The time lag between the defendant's causal action and the date of the lawsuit filing averaged more than twice as long for environmental cases as for the control group. This result holds for each of the three measures of time lag, and for each court. The number of observations (n), means ($\bar{x}$) and standard deviations (s) of time lags by court, category and measure type are given in Table 1.

The estimated lags and the upper and lower bound data were treated as separate experiments and analyzed using the same statistical procedure. The mutual independence of all observations used in each test was ensured because only one observation based on the same underlying case and plaintiff–defendant pair was included in the data set. The concordance of the statistical results between our estimate and the upper and lower bounds reinforces the conclusions and indicates that the conclusions are not sensitive to the ambiguity in identifying the date of the action.

Because the number of observations for environmental cases was small, and the distribution of time lags in each category could not be treated as normal,[12] a Mann–Whitney non-parametric rank-based test was used to evaluate the statistical significance of the difference between the environmental and control group time lags (Conover, 1999). Table 2 gives the results, and Table 3 shows the test statistics. The experimental and control group sizes are denoted by n_C and n_E, respectively. Each court's ordinal data set was normalized by quantile for the combined analysis.[13] Analysis of variance (ANOVA) tests of differences in the means would show even higher significance levels, but the data do not justify this approach.

The combined results from the two courts, given in the bottom row of Table 2, provide strong confirmatory evidence that the environmental lags are greater than the control lags. This test finds a 0.010 significance level ($z = 2.32$) for the hypothesis that the environmental mean is larger than the control mean, based on the estimated lags. The significance level is 0.020 ($z = 2.06$) for the upper bounds, and 0.068 ($z = 1.49$) for the lower bounds on time lag.

[12] For the New Jersey control cases, a Shapiro–Wilk test leads to rejecting normality with p-values much less than 0.01 for the upper and lower bounds and 0.02 for the estimated time lag. The sample sizes for Mississippi and for the New Jersey environmental cases are too small for the normality test to have much power, though the longest time lags for New Jersey environmental ($n = 4$) are rejected with p-value = 0.02 and Mississippi control ($n = 6$) is rejected with p-value = 0.06.
[13] The normalization would not affect the single court analyses because the Mann–Whitney test utilizes only ordinal information.

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Court	Time lags								
	Estimated			upper bound			lower bound		
	r_E	r_C	$U_C(z)$	r_E	r_C	$U_C(z)$	r_E	r_C	$U_C(z)$
New Jersey	17.3	10.2	59	16	9.8	54	17.1	11.3	70.5 (1.64)
Mississippi	6.5	4.3	13.5	6.3	4.3	13	5.3	4.8	10
Combined	23.1	13.9	133.5 (2.32)	21.6	13.7	133 (2.06)	21.5	15.6	136 (1.49)

Table 3. Mean ranks (r); U- and z-values from Mann–Whitney tests. Subscript E indicates environmental cases and C indicates control group

The analysis of the lower bounds has a lower significance level, because there were seven cases (six in New Jersey and one in Mississippi) for which no latest possible date of action could be obtained, and therefore all these cases were assigned a time lag equal to zero. We report the upper and lower bounds in addition to the estimated lags because the measurement of the time lags is the least explicit portion of the study. The ratios of the time lags across categories are nearly equal for all measures. This uniformity provides additional assurance that the observed difference between environmental and control time lags was not a result of the method of estimating time lags.

Considering the New Jersey data in isolation, the environmental mean is significantly larger at $p = 0.027$ using the estimated lags, at $p = 0.040$ for the upper bounds and at $p = 0.051$ for the lower bounds (Mann–Whitney non-parametric rank-based test, Table 2). For most of these data, the U-value exact Mann–Whitney test (Hollander and Wolfe, 1999) was used, as appropriate for $n_E < 5$. Five observations of the lower bound time lag were zero because the date of the original lawsuit was taken as the latest possible date of the causal action, and therefore there was less ability to distinguish between the environmental and control categories.[14]

The differences in the Mississippi data are not statistically significant in isolation. These data are very sparse, and no additional environmental observations were available for this court. The environmental time lags did average more than twice as long as the control means for the estimate and the two bounds.

The observed average time lags are shorter across the board for Mississippi, although the differences in average time lag for the two courts are much less than one sample standard deviation. If there are true differences between these courts, they may be caused by differences not just between the types of case that are appealed (rather than settled or not appealed), but also between the types of case brought in the state versus federal court, and between the two states in the study.

Discussion: Possible Sources of Bias

An important possible source of bias is statutes of limitation. Statutes of limitation restrict the filing of lawsuits to a certain period after the action by the defendant and/or injury to the plaintiff. Statutes of limitation vary by state and under federal laws, and the limitation periods differ by type of lawsuit. Under Mississippi code, they range from one year (or less) for certain torts and two years for medical malpractice to six years for most tort damages to property and even 10 years for suits to recover land. These

[14] Modified calculations to take advantage of the reduced variance in the presence of ties (Hollander and Wolfe, 1999) increase the significance level, but only slightly.

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differences could bias the data set if the timing of lawsuits is affected by the statutes of limitation and if the applicable statutes of limitation differ across categories, for example if environmental cases were subject to less stringent – or no – statutes of limitation.

It is likely that the statutes of limitation influenced filing dates for some cases in the data set; in a few cases in the data set, the opinions discussed whether the limitation period had expired on the claim. However, generally, environmental lawsuits fall into a legal category that includes other types of suit as well – for example, most (all in this data set) are tort claims.

Some claims under specific environmental laws do carry separate statutes of limitation. However, even if statutes of limitation did not restrict the period for filing lawsuits, a plaintiff would have incentive to file suits early because of the opportunity costs of postponing the return she anticipates (a plaintiff would not sue if she did not anticipate a positive return – whether a settlement, favorable verdict or non-financial satisfaction), and therefore we do not believe the statutes of limitation would cause systematic differences between environmental and control cases.

A more important factor influencing the date of the lawsuit is the date of discovery. The clock on statutes of limitation generally starts at the time that the plaintiff knew or could reasonably have known of her injury. Many of the time lags measured between causal action and lawsuit date are longer than applicable statutes of limitation. This discrepancy is due largely to the time required for the causal action to affect the plaintiff and/or for the plaintiff to become aware of the injury and its cause.

If environmental lawsuits occur long after the date of the action because the discovery takes many years, this indicates that the complexity or some other property of the environment delays the lawsuit consequence, regardless of the legal reasoning that allows the delay. The lawsuit costs are the subject of this study, so if discovery delayed the lawsuit date, the intended quantity was measured. Because statutes of limitation are much less important than the time delay before discovery in determining the observed time lags, statutes of limitation are not believed to influence the results of this study.

Since there is a difference in the average time lag before lawsuits are brought, environmental cases in this data set originate (on average) in an earlier period than control cases. It is possible that since environmental cases were rarer before the surge in environmental awareness and regulation in the 1970s, lawsuits in this study were brought in response to these changes, rather than in response to an injury or its discovery, thus their timing would be an artifact of changes in regulations. However, since none of the environmental lawsuits was filed before 1989, it is unlikely that the change in legal climate affected the data set.

Not all the lawsuits in the data set were (or will be) resolved in favor of the plaintiffs, and in some cases the plaintiff may even be required to pay the defendant's legal and court fees, possibly resulting in no financial cost to the defendant. However, this would introduce bias in the study only if losing cases had, on average, longer or shorter time lags than winning cases, and if this tendency were different for environmental versus control cases. There is no reason to suspect such a relationship.

Conclusions

This study supports the claim, often asserted but to our knowledge never previously tested, that environmental costs on average take longer to occur than other costs. In this data set, environmental costs take twice as long to occur as other costs – an average of more than ten years for environmental costs, as compared with less than five years. The difference is significant at the $p = 0.01$ level. This difference is a key element of a frequently proposed explanation for an apparent underinvestment in environmental performance by firms: investment evaluation methods that give too little weight to future liabilities tend to induce decision makers to undertake too many environmental costs because of their late timing. Even

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if managers use a high discount or hurdle rate as a legitimate proxy for other considerations, this higher rate will disproportionately distort the analysis of environmental investments. These results could be used to financially justify lower rates of return for investments that reduce the risk of environmental liability.

The data for this study are US specific, but there is reason to believe the timing difference between environmental and non-environmental costs would hold in other countries as well. The study was designed to reflect differences in the time until an environmental externality is discovered by the plaintiff, which would not be influenced by US-specific regulations on industry or statutes of limitation for lawsuits. The time until discovery could be influenced by the level of environmental monitoring or awareness in the US or by systematic differences in the types of environmental externality occurring across countries.

Much of the environmental management accounting literature is based on some reasonable hypotheses regarding systematic differences between environmental costs and other costs. This study is the first to undertake to verify and quantify one of these hypotheses. Our results suggests that environmental management accounting should consider not only the acquisition and quantification of environmental cost/benefit data but also the traditional discounted cash flow evaluation processes that utilize these data.

This study was designed to test for systematic differences between environmental and non-environmental costs and therefore includes very diverse fact patterns. Any change in corporate decision-making practice based on the systematic timing difference should be based on a study specific to a narrower category of liabilities relevant to a given decision context, in terms of both the type of environmental cost and the country of operation.

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