

ENVIRONMENTAL UNCERTAINTY, CORPORATE STRATEGY AND PUBLIC POLICY

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1. Introduction

The past three decades have seen an explosion in the number of regulations and other environmental policies affecting the operation of business enterprises. The vast increase has been driven by a constant stream of discoveries of new environmental problems which are affecting the health of humans (and to lesser degrees nature as a whole) or have the potential to do so. The realization that nature is not a repository of unlimited sources of raw materials, waste accumulation capacity or agricultural land is not of recent date, but it is only with the development of modern industrial economies that it has become a pressing issue. One of the milestones in the process of realization was the Club of Rome's "Limits to Growth" (Meadows, Meadows, Randers, and Behrens 1972). Since this landmark contribution, governments at all levels have been busily engaged in devising new regulation, in the broadest sense of the word, to address the steady flow of discoveries of new or previously ignored environmental problems. For a long time, even much before 1972, regulation of environmental problems tended to be of the "command and control" variety, emphasizing performance standards on emissions and technology standards specifying acceptable technical solutions, and with strict liability as a key enforcement mechanism (Baumol and Oates 1988).

Two alternative trends in environmental regulation have emerged over the past ten to fifteen years. One trend essentially emphasizes the use of economic incentives in regulation, from Pigovian taxes aimed at driving external costs inside, over subsidies in return for pollution reduction, to mechanisms which create tradable property rights to pollute in a specified way or quantity (Dales, 1968 ;Tietenberg 1985). While the second trend is far more variable in terms of the mechanisms used to influence environmental behavior, "self-regulation" (Gupta and Lad 1983) is the term which most precisely summarizes the characteristics of the mechanisms. Efforts within the second trend are to some degree being undertaken without government involvement, as seen in environmental "charters" devised by a

variety of industry organizations, and in some product (environmental) labeling schemes. The most evolved form of non-government collective action in the environmental field has been the development of the ISO 14000 series of standards for environmental management. Despite a high degree of self regulation in these cases, other very similar but competing systems have been developed by government organizations. The only significant competitor to ISO 14000, for example, is the Environmental Management and Auditing System (EMAS) developed by the European Commission (Hilary 1994). Similarly, while a long list of product environmental labels have come about as a result of industry initiatives, many others are established as a result of government initiatives

Compared to a situation with command and control style regulation, both of these alternative trends in regulation may be argued to increase the level of uncertainty faced by companies. These alternative trends in regulation do not specify how firms are to improve their environmental performance (in the case of economic policy instruments), neither do they identify the desired outcome in anything that resembles operational terms (in the case of self-regulation). As such, while firms are given a great deal of latitude in their efforts, this same latitude makes the choices the firm faces more uncertain.

Assuming that minimization of uncertainty is an important objective in enterprises, the extent to which these new trends in regulation add to the firm's level of uncertainty has significant effects in terms of both corporate strategy and economic efficiency.

This paper first examines the sources of uncertainty faced by companies in relation to the natural environment. Four different types of uncertainty are identified, two of which are essentially external to the organization and two which are mainly internal. The external sources discussed in section 2 are associated with the complexity and variability characteristic of the natural environment itself, and with the externally determined pressures on the environmental performance of the company which arise as a

result of regulation and various forms of collective action by stakeholder groups. Together these types of uncertainty reflect the state of the surroundings in which the company or organization finds itself (Milliken 1987). The two sources of internal uncertainty discussed in section three are derived from Milliken's distinction between effect uncertainty (how does external variation affect the organization) and response uncertainty (how does the organization react and how does this response feed back into the surroundings). A structured understanding of these different types of uncertainty provides the foundation for the analysis, in section 4, of the ways in which companies can adapt their strategies to reflect the specific characteristics of the combination of uncertainties facing them. This analysis is followed, in section 5, by a discussion of the implications which the analysis of corporate strategy have for companies responses to environmental uncertainty have for the design or reform of public policy.

2. External sources of environmental uncertainty

The natural environment and the various agencies involved in environmental regulation provide companies with a number of somewhat related sources of uncertainty. The first part of this section deals with those problems which can be traced to the basic uncertainty about what the state of nature is or is likely to be in the future, and with the problems human observers have in recording and comprehending the state of nature. The second part deals with the interaction between the firm and external decisionmakers, mainly regulatory agencies but also other stakeholders, including financial institutions.

The natural environment

Three problems are included under this heading: ambiguity about ecological cause-effect relationships; dimension scaling problems; and errors introduced when data are time-averaged. The cause and effect problem arises when simplified models and limited sets of data are used to conceptualize and analyze

relationships in ecosystems (and their relation with economic systems) which tend to be extremely complex. The use of simplified models may lead to decisions which, regardless of whether they are made by firms or regulators, are based on incorrect information or assumptions.

A related part of the problem with complex ecosystem-economy interaction is dimension mis-matching (Lee 1993; Sharfman, Shaft, Anex, Ellington, Meo, Meima, and Sinding 1998) . This occurs when information about one element in a system mis-matched with that of another element, in the sense that the temporal, spatial or functional information about the respective elements is not comparable. This problem is further complicated when the dynamic nature of the system components is taken into account. Information about one element may increase greatly while that about other elements remain constant by comparison, leading to invalid comparisons.

The third problem is also methodological in that it is part of the larger debate about how we can measure the variables associated with social events (assuming that we have defined the variables properly). One of the ways in which complex ecosystem information is reduced to simpler formats is by calculating time averages, for example for stream flow at a given point. A stream, however, is itself a complex system where flow depends both on surface and subsurface runoff, and thus on precipitation over a variety of timescales. Unless these timescales are properly treated, time averaging data on for example precipitation can introduce systematic errors if the wrong period is chosen for the calculation.

The regulatory context

The second source of external uncertainty in relation to the natural environment is associated with the processes leading to the creation and enforcement of regulations. Regulation can vary in several dimensions, thus creating uncertainty about the present and future operating conditions for firms. First

of all, even the most casual observation will show that the body of environmental regulation changes over time, usually in the direction of more stringency. However, the specific trajectory of change is often a function of that whimsy called politics rather than being based on good science. As such, the uncertainty increases as agendas other than environmental protection are interwoven into the regulation.

The source of uncertainty is not only the fact that change occurs, but also the magnitude and variation of the rate of regulatory change. Closely related to this problem is the question of what delays separate causal events from their results, e.g. how long time passes from the discovery of a dead lobster to the enactment of sweeping constraints on the use of fertilizers in the farming industry (always assuming that the causal event can be identified).

The second dimension possibly offers even greater potential for adding to uncertainty. This is the regulatory or policy tool dimension. Any form of regulation is associated with added uncertainty, but it may be argued that some add more than others. Command and control regulation specifies what a firm can or must do, either in the form of emissions standards (i.e. emissions per unit time) or as specifications of mandatory abatement technology¹. Newer forms like self-regulation or pollution prevention regulation do not offer the certainty of command and control. If the outcomes of the newer forms are even specified (something not always the case), then the methods, mechanisms or technologies are not. While such freedom of operation may be welcomed by firms (see below in section 5), it still introduces uncertainty into decision making. If as, we argue above, the trajectory of these new forms of regulatory change stems from politics, the target for such requirements can change

¹ Within this regulatory paradigm there are also variations with attendant uncertainties. These arise partly because there may be considerable variation in the level of detail incorporated in individual laws and regulations, and partly because each regulation is subject to enforcement, the style of which may vary as well (*Kagan, 1994*).

quite easily. As a result, firms are faced with constant concern about whether what they are doing will both meet today's requirements and tomorrow's.

The concept of regulatory uncertainty or regulatory risk has been extensively used in some narrowly defined fields. These fields are typically subject to regulation of market failure arising from the presence of natural monopolies, for example in the electricity, gas and transport sectors. In these industries rate of return limitations or price caps are typically used to limit company profits to what is deemed acceptable by society. In this context regulatory uncertainty refers to the extent to which regulated companies will face changes in the rate of return they are allowed to earn or the prices they are permitted to charge. The argument presented by industry is that regulatory uncertainty is a real risk for which they (and their shareholders) need to receive compensation in the form of being permitted a slightly higher rate of return. This issue was at the center of a recent case before the United States Supreme Court (*Duquesne Light Co. v. Barasch* (1989)). Here, the utility had seen regulators reduce the asset base to which the allowed rate of return could be applied and viewed this as an indication of future trends. As a result the utility wanted to increase the allowed rate of return, a position accepted by the court (Kolbe, Tye, and Myers 1993).

When approached from a financial economics point of view the question of regulatory uncertainty or risk takes on several additional dimensions, the most important being the effects of regulatory decisions in one industry have on other similarly regulated industries (Appleyard and McLaren 1997). Research using the Capital Asset Pricing Model (CAPM) to test the impact of an unexpected regulatory policy change suggests that regulatory risk does exist and that it transcends the specific industry to which the policy change formally applies (Appleyard and McLaren 1997).

As we have argued, the regulatory framework used to protect the environment is far more variable than the examples of utility regulation described above. This makes it difficult apply a similar approach to determine whether quantifiable regulatory risk exists in the field of environmental regulation.

Nevertheless, given the vast growth in environmental regulation since the mid-1960s, there can be little doubt that firms face significant uncertainties when it comes to the introduction of new or revised environmental regulation.

External responses

A third category of external uncertainty comes as result of actions taken by organizations as a result of other forms of external uncertainty about the natural and regulatory environment. It refers not to anything the focal organization itself does but reflects the fact that any action it takes may have strategic implications for external actors, including regulators, competitors and various forms of stakeholders, which may precipitate action on the part of these external organizations. However, in keeping with the structure proposed above, these games of strategy are discussed in the latter part of section 3 which concerns strategy responses and reactions.

An exception to the distinction between internal and external responses used here is required to discuss the shareholders incentives to minimize the transactions costs of diversifying portfolios by holding shares with lower risk in order to reduce the trading volume and its associated costs (Amit and Wernerfeldt 1990). This is a response to environmental risk which does not directly involve the organization or its management. The implication that firms facing some environmental risk may end up as a residual group which nobody wants to own. This is another way of saying that uncertainty arising out of the firm's impact on the natural environment is strongly dependent on the nature of the industry and that the associated risks cannot be fully diversified.

A further external motive is related to reduction of cash flow volatility (Amit and Wernerfeldt 1990). A stable environment allows more efficient management and thus significant cost savings. According to this motive, shareholders will pursue any option to reduce uncertainty due to the natural environment. Depending on the circumstances this could result in passive, compliance-oriented environmental investments which do not go beyond what regulators demand. When management compensation is linked to cash flow stability, managers have a further incentive to reduce uncertainty.

Finally, it can be argued that law in general and regulation in specific are the codification of society's beliefs about some specific set of issues. Edwin Epstein (Epstein 1987) argues that the law and its regulatory apparatus are the method "by which ever-escalating public expectations concerning acceptable business behavior are articulated and implemented." If society's beliefs about proper environmental behavior are changing/evolving then presumably regulation would lag those changes. The greater the lag between changes in society's beliefs and the manifestation of changes in regulation, the higher the level of uncertainty firms face. Further, observant managers will follow current trends in society as well as be aware of the expectations inherent in the regulations their firms face. Most managers will want to respond to the trends in society but will have to respond to strictures of whatever regulations they face. The potential for conflict between these two desires also increases the uncertainty inherent in environmental issues.

3. Internal sources of environmental uncertainty

When the state of an organization's surroundings changes or are perceived to change, it raises questions about how these changes will affect the situation or conditions within the focal organization (Milliken 1987) in terms of what the impact will be, its severity, and its timing. The implications of

effect uncertainty can be further broken down into three categories, financial impact, impact on organizational values and information processing impacts. These are considered in the first part of the present section.

Just as there is uncertainty about the effects specific events or trends external to the focal organization have inside it, a further distinct type of uncertainty may face to organization. This is related to the nature and consequences of responses chosen by the organization and may be further classified as uncertainties regarding the nature of response options, the outcome of choices made, and the value resulting from the chosen option (Milliken 1987).

The presence of effect uncertainty is another way of saying that some organizations are unable to evaluate the linkage between cause and effect. The distinction between the nature, severity and timing of impacts (Milliken 1987) which can be attributed to the natural environment is not necessarily conducive to the manager grappling with such problems. A more operational distinction is between three effects which cause uncertainty i.e., financial effects, organizational value effects and information processing effects.

Financial effects arise when changes originating from the natural environment have a direct or indirect impact on the focal firm's financial performance. These implications are, of course, still only vaguely defined, but thinking in terms of financial implications may help gain decisionmaker's attention. For example, the growing literature in so-called "green accounting" (Schaltegger 1996) is the collective attempt to understand these effects. Given there are such financial implications, managers will have at least two motives to reduce the uncertainty (Amit and Wernerfeldt 1990), one related to the manager as agent, and the other to stable cash flows (for the latter, see the previous section).

The agency motive arises because managers care about stable earnings (Amihud and Lev 1981) and the risk of going out of business (Holmström 1979) and as a result take action to reduce risk, even if this is not in the best interest of shareholders (who can diversify their portfolios to compensate for non-systematic or business risk). Under this motive, managers would pursue environmental protection efforts which involved least risk, i.e. those which are flexible and reversible, and at the same time produce a high degree of leverage relative to the resource commitment, corresponding to a “Green success” (Rugman and Verbeke 1998). However, whereas uncertainty about regulation, consumer preferences and industry trends may make managers hesitate when considering environmental investment, they are seldom able to wait too long if they are to remain in compliance with current regulation, even if it means making investment mistakes.

Values play an important role in any effort to affect an organization’s environmental management, particularly as individual organizational members bring their values to bear on environmental efforts with the organization. However, there is likely to be considerable variation in both the values themselves and the factors that shape such values. An organization subjected to a sudden severe shock, e.g. the occurrence of a serious environmental accident may have its collective values directly effected., Such a shock may cause organization members to reevaluate what they value (hold important) as a result of the event. This can lead to a more cohesive collective value set for the organization. As such, the level of uncertainty in such an organization may decrease as organization members come to closer agreement about what is important. Alternatively, take the organization which is producing sulfur emissions that turn into acid rain far away from its facilities. Such an on-going environmental problem may have little effect on the collective values of the firm regardless of the damages generated by the organization’s activity. In this situation, managers face response uncertainty because they do not have

a cohesive organizational value structure with to which to compare any environmental management choice they make.

The organization's ability to manage and process information is the third internal element contributing to effect uncertainty in relation to the natural environment.

There are several reasons why information processing regarding the natural environment is uncertain (cf. Shaft, et. al , 1997). In this paper we concentrate on two; the difficulty in analyzing environmental information caused by its inherent ambiguity and the complexity inherent in analyzing large volumes of ambiguous information.

First, environmental information is difficult to analyze because many variables are required to assess environmental impact. The uncertain nature of these variables occurs because relationships between many of them are not well-understood. Quantitative information processing methods for conceptualizing and analyzing even well-understood problems frequently rely upon simplification so that only the few variables, believed to be relevant, are considered. However, any analysis of toxic pollution in which the complexity of the interactions among different components of the ecosystem is simplified to address only certain variables may have gruesome impact e.g. the disastrous effect on bird populations from the use the of the highly effective pesticide DDT . As such, the organization's need for simplification so that it can process the information can increase uncertainty by the simplification's introduction of error into the analysis.

Another issue that contributes to the uncertain nature of environmental information processing is the volume of complex information that must be considered. Voluminous information, in itself, is not unique to environmental problems. However, high volumes of information typically are not found in

unstructured problem solving and decision making activities such as those that are part of environmental management. Hence, the issue is not just the sheer volume of information processing that will be necessary for firms engaged in environmental management, but that firms will need to process high volumes of the ambiguous information we describe above. These activities will be characterized by high volumes of information because environmental phenomena are not well understood. Therefore, there is uncertainty as to what information is needed. In such situations problem solvers request an over-abundance of information (Ackoff 1967).

4. Strategy and minimization of environmental uncertainty

In sections 2 and 3 we identified a series external and internal sources of uncertainty which influence a firm's ability to improve its environmental performance. Many of these sources of uncertainty have important implications for the strategic options open to the firm, and for the ways in which it evaluates and chooses among them.

Responses to external sources of uncertainty

Uncertainty about the state of the natural environment in terms of causality, scaling problems and time-averaging problems is the first and most fundamental problem to deal with, particularly because it has repercussions when dealing with some of the other uncertainties. In this area a firm has three strategic options: passivity, reactivity and proactivity.

Passivity implies that the focal firm accepts statements about the state of the environment and assertions about the impact of the firm made by other stakeholders. Passivity used in this sense is not the same as ignoring such statements (the focal firm may dispute the facts altogether, it may admit problems exist in some areas or it may adopt alternative more or less evasive tactics), but refers to the

degree to which the focal firm itself understands the three types of problem and how they bear on the relevancy of stakeholder assertions. A reactive stance goes further, primarily by emphasizing the need to understand these sources of uncertainty which gives firms the ability to question the relevancy of assertions made about its environmental impact. This is probably a dangerous strategy since it may easily be confused with evasion tactics, no matter how pertinent it really is. The final strategy is termed proactive because it seeks to set the agenda by engaging in research to clarify the problem. This is also a strategy which may easily be misunderstood, particularly if the research is not seen to be carried out independently of the funding by the firm. Furthermore, because the strategy is one where the research outcome is uncertain, the firm choosing this approach runs the risk of discoveries that are extremely adverse. For example, firms in the asbestos industry might have discovered the cancer problems associated with their product, creating a case where they might have to announce results that could wipe out the industry in a very short time. A proactive strategy in relation to the uncertainties associated with the true state of nature may also suffer from two other defects. One is that it is likely to be highly resource intensive, thereby ruling it out for most firms of small and modest size. The other defect is that it is mainly irreversible: if a product has been found to be in some way harmful (directly or through its production or disposal), this is knowledge that cannot be destroyed afterwards. Both defects are crucial because they need very strong commitment by management and shareholders if they are to be overcome.

The regulatory context is also highly variable. In crude terms it can be described change in which direction, timing, magnitude and rate varies over time. Although direction arguably does not change, the other three factors determining regulatory uncertainty remain. Short of lobbying aimed at highly specific decisionmaking for short term advantage (e.g. whether a site is to be given permission to operate), strategic responses may take two directions. One is lobbying to change the fundamental

characteristics of regulation, such as (slowing) the rate of change, or changing the institutional framework of the regulatory system. The second direction is closely linked to problems of determining the state of nature, as described above, and thereby determining the assumptions on which the regulatory framework is built. Such strategic use of public policy (Mitnick 1981; Wood 1986) grows increasingly common in the industrialized west. Literally billions of dollars are spent in the United States alone each year by lobbyists trying to influence legislation and regulation on behalf of their clients. With the consolidation of regulation across the European Union, such lobbying efforts are likely to become more frequent in Europe as well. The more that firms can dictate or influence the structure and content of regulation, the less uncertainty they are likely to face.

Another option available to managers with which to address the uncertainty of environmental regulation is to avoid it altogether. The most basic prediction Christine Oliver makes about firm responses to regulatory (institutional) pressures is that when acquiescence costs money, it is likely that firms will avoid institutional pressures (Oliver 1991). Sharfman, Ellington and Meo (1998) describes how Conoco, when faced with the enormous permitting costs under the US Clean Air Act amendments, developed technology that reduced emissions so far that the firm was no longer subject to the regulation. The permit and compliance costs for just the natural gas production facilities where the technology was developed were so great that Conoco, as Oliver would predict, had enormous incentives to find ways to avoid the regulation altogether.

A third option for firms is to examine the strategic options more carefully at the public policy level, and then to choose operating sites as well as behavior in relation to efforts to influence the policymaking process accordingly. The Conoco example described above is again illustrative. A central point made by Rugman and Verbeke (1998) is that development of environmental capabilities in firms depends on

leveraging and reversibility. Leveraging refers to the degree to which investment in environmental capabilities in a firm leads to improved industrial performance (Ghemawat 1986), while reversibility refers to the degree to which an investment can be recovered if it turns out to be a mistake (Dixit and Pindyck 1994). The Conoco investment may be described as having a high leveraging potential because compliance costs exceeded the cost of the adopted approach and especially if this approach is applicable in other contexts. On the other hand the investment is technologically specific and therefore difficult to reverse, creating an incentive not to invest. What is important to note is that the Clean Air Act amendments represent a performance standard² but does not mandate a specific technology for the attainment of the required level of performance. This distinction is important since it may be argued that the degree of regulatory specificity, through a relatively higher irreversibility of investment, plays an important role for the level of firms commitment to improving environmental performance.

The three response related sources of uncertainty are driven by rate of return and cash flow stability motives, and by the existence of a lag between societal expectations regarding acceptable environmental behavior and the details with which firms have to comply. The former two sources of uncertainty imply that both management and shareholders will have an interest in minimizing uncertainty arising from firm impact on the natural environment. These two motives can be seen as underlying explanations of why firms try to reduce uncertainty.

In contrast to these almost financial motives described here, the lag between social expectations allows observant firms to gain competitive advantage if they can correctly anticipate future regulation and thus gain first mover advantage (Porter and van der Linde 1995) . However, if the move goes in the wrong direction, there may be a large disadvantage because of the mistake.

² A standard can be expressed in several ways. It is most typically set for a substance being released from a site, but may also be set at the industry or regional level, with more sophisticated mechanisms for allocation among relevant firms in the industry or region.

Responses to internal sources of uncertainty

Three sources of internal uncertainty were identified above: financial incentives for managers, organizational values, and uncertainties stemming from information processing in the focal firm.

The possibility of going out of business or having earnings reduced makes managers conscious of two conflicting needs which are both driven by the irreversibility/leverage dimensions of environmental investment (Rugman and Verbeke 1998). On the one hand they can be so intimidated by the fear that they will make an irreversible green mistake that they simply remain passive and do nothing. This, however involves the risk of non-compliance, which in turn places their firm, the earnings (through fines) and possibly even their own employment in danger. Taking action may have the ultimate green success (high leverage and high flexibility) as its objective, but may result in one of the other outcomes: reversible green mistake (low leverage and high flexibility, green gamble (high leverage and low flexibility, which is fine if it pays off) or irreversible green mistake (low leverage and low flexibility). For the managers with poor incentives to strive for environmental excellence (embodied here by the green success high leverage and flexibility construct) the answer may be to structure incentive contracts which make their remuneration partly contingent on the direction in which the firm's environmental work moves.

When the source of uncertainty is inconsistency in or conflict over organizational environmental values, then management has two primary options – both of which are aimed at creating a cohesive value set. The first option is impose a set of values while the second is develop a set of values by consensus.

There are advantages and disadvantages to management's imposition of a set of values. The key advantages are clarity and speed. If management imposes values, then everyone in the organization should know what they are supposed to hold important. By imposing the values, time that would otherwise be spent discussing the values and the change could be used to address the environmental problems at hand.

However these advantages create their own inherent problems. By imposing the values, there is no guarantee that the rest of the organization will accept the new value structure. While the values might look good adorning the environmental annual report, unless they are accepted, the existence of the imposed value set will not change anything – particularly the uncertainty attached to the original conflict. Further, the imposition of the values may cause a backlash among the organization's members creating further conflict and attendant uncertainty.

Developing a set of environmental values by consensus mirrors the issues raised above. Although the consensus process takes much longer the likelihood of acceptance on the part of the organization is much higher. By using a consensus approach, management also runs the risk of having a set of environmental values develop that at odds with their own. The key advantage of the consensus approach is that with the newly cohesive set of values, the uncertainty that was linked to the previous value conflict or confusion is more likely to be reduced.

When the uncertainty comes from information processing concerns, management has two, related approaches that it can implement – dependent on the source of the uncertainty. If the information processing uncertainty results from so complex a problem that management cannot frame the problem correctly, then management can engage in a variety of problem formulation or sensemaking activities

designed to come to collective agreement about the parameters of the problem (cf. Dutton, Fahey, and Narayanan 1983; Thomas and McDaniel 1990). By getting collective agreement on the nature of the problem, management is more likely to have a comprehensive understanding so that the misspecification problems mentioned above are less likely to occur.

If the uncertainty comes from the firm's inability to process the volume of information attached to the problem then new information processing systems may be in order (Shaft, et al, 1997). As hardware and software technology have advanced, management's ability to process huge volumes of complex information has increased accordingly. New technologies for mining vast quantities of information will allow management to process what might have been previously an insurmountable load of information.

5. Implications for public policy

Both the individual sources of uncertainty in the firm/environment relationship described in sections 2 and 3, and the possible strategic reactions this may engender on the part of firms, as described in section 4, have potentially important implications for the design of public policy.

The first group of uncertainty sources concerned the state of the natural environment and particularly the limited ability to correctly identify the cause and importance of observed changes in the environment. Just as this was important for shaping corporate strategies, these sources of uncertainty holds at least two direct implications for public policy. One is that the process of developing public environmental policy is as much subject to these uncertainties³, and the other is that policymakers must accept that firms react differently to different forms of uncertainty.

The second group of uncertainties was attributed to different dimensions of regulation itself. Causality and cross-regulatory effects in the regulatory process, particularly as they apply to the process leading from the identification of an environmental issue or problem (notwithstanding the first kind of causality and measurement problems) to the enactment or promulgation of more or less detailed regulation, refers to the firm's ability to determine what considerations have shaped the resulting rules. The question is one of how transparent the regulatory process is and the question facing regulators is whether less or more information will affect firm efforts to influence this process.

The specificity of the regulatory framework was argued to have important implications for the degree to which firms would commit themselves in terms of environment-related investment. On the one hand, regulation which leaves it up to firms to decide how to manage the details of their environmental effort carries inherent uncertainty with it. On the other hand, a relatively low degree of regulatory specificity may make it easier for firms to find those solutions which are both flexible and have high leverage. The policy implication is inconclusive as a result: the authority determining policy needs to balance the need for reduction of ambiguity against the need to keep the scope for firm level action and innovation as widely open as possible. Whereas this dilemma seems present at an overall strategic level, the style regulators adopt in their monitoring of compliance has strong and direct implications for the relationship between firms and regulators. Kagan (1994), for example, suggests that a "tit-for-a-tat" enforcement approach, where regulators are very quick to detect and punish a breach of what is essentially trust between the parties.

³ However, it may be argued that the public sector as a whole has greater resources at its disposal and therefore a greater obligation to try to resolve these uncertainties.

An entirely opposing view of regulatory specificity is that it improves environmental performance because it requires action and helps firms overcome search cost barriers⁴. Under conditions of high regulatory specificity, compliance with a regulatory mandated technology requires little of firms in terms of finding solutions to their specific problems, even if it may be an inadvisable policy in general.

6. Concluding remarks and suggestions for further research

This paper has examined the issue of uncertainty as it relates to the relationship between firms (and other organizations), the natural environment and those who are stakeholders in this relationship. We have identified the major sources of uncertainty present, but there may be more, both large and small, which does not necessarily fit the framework we have proposed.

The existence of uncertainties have implications for the two main actors on the environmental stage, firms and regulators. The nature of uncertainties may have strong effects on how firms behave, and on how efficiently they address environmental problems facing them. Because this is the case, it can also be argued that the actions of regulators must take likely firm behavior into account when regulations are developed. In particular, it is important to have a broad understanding of the nature of significant sources of uncertainty facing firms. Without such an understanding, regulators run the risk of developing regulations which are inconsistent and unable to precipitate the desired behavior among firms, let alone the expected end result in terms of improvement in the quality of the natural environment.

Almost all of the different sources of uncertainty discussed in the previous sections require further research. One area in particular may be singled out, however. This is what can be termed regulators'

⁴ This is the Porter and Van der Linde argument that firms in countries with tight environmental regulation have a form of

ability to learn. Regulators are often analyzed in terms of how and when regulatory change happens, an approach that also takes in the regulatory agency's ability to influence the process. However, it would also be interesting to know more about how regulatory agencies adapt and react in the face of everyday running of the regulatory system and through interaction with the regulated firms within its jurisdiction. The fundamental question in such a research program would be to determine whether a regulatory agency is able to learn, and if so, how does the learning process take place.

The framework we provide in this paper will help managers determine the types of uncertainties they face in addressing environmental problems. In addition, we have provided suggestions for management if they wish to address the uncertainties they face. Given the random nature of business in general, if there are sources of uncertainty that management can both accurately identify and subsequently reduce, the firm's ability to cope with an every-changing world is improved. We have developed the model we present in this paper towards that end.

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