Paradigms Lost: A Case Study Analysis of Models of Corporate Responsibility for the Environment

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In 1970 the U.S. Congress made a commitment to solve "the pollution problem." But while there was a consensus that the problem needed to be solved, experts have spent the last three decades arguing about the nature of the problem and the principles for its solution.

After three decades of modern environmental protection there still is no consensus on defining the nature of the pollution problem. Diagnosing the nature of the problem and establishing principles for its solution has been a continuing debate.

The absence of agreement on the most basic questions calls for a fundamental reexamination of the pollution problem. A proper basis for such a study would be, first, to examine actual behavior of prominent and influential business entities over a significant period, and, second, to start the study close enough to the beginning of the modern economic order to observe business behavior that is representative of modern environmental problems but undisturbed by modern regulation. Such a study is of intrinsic interest to business historians, as it addresses a fundamental question—how business decisions toward the environment are made.

This article provides a first step toward such a historical reexamination. The article first reviews two distinct views of the pollution problem. The article next examines two historical case studies relating to controversies over automobile emissions—the review of gasoline lead additive in the 1920s, and the debate over vehicle emission control in the 1960s. Finally, the article reconsiders the two views of the pollution problem.

This article finds that neither of the two views sufficiently accounts for the experience shown in the case studies. Both of the controversies examined were defining events, in that both identified problems in need of response and adopted remedies that were applied beyond the immediate circumstances. Beyond this the two controversies are distinct. Each produced its own set of doctrinal materials that reflects the properties of that defining event, and each established a new set of institutions for their implementation. Each thus created its own paradigm to govern the treatment of business responsibility for the environment. This article therefore finds that the treatment of business responsibility for the environment in the U.S. in the 20th Century falls into

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two discernable paradigms. Neither of the two views of the pollution problem has accounted for these doctrinal shifts. The case studies point to essential building blocks for a new model for examining the pollution problem.

The Two Views

The traditional model. We begin by reviewing the traditional model developed by economists. While economists have debated the details of the model among themselves, there are a few central principles on which most would agree.

The economists' model was devised in the late 19th and early 20th Centuries as part of the development of "welfare economics." Welfare economics developed as a branch of economics to reconcile theory with the social problems industrialization had brought. The goal of welfare economics is to define the social optimum and prescribe the conditions necessary to achieve it. The economists' model has three logically sequential functions:

(1) Definition of optimality. First, the model postulates a social optimum and defines the terms to use in measuring it. Welfare economists define optimality in terms of efficiency: the optimal use of resources, and the optimal level of pollution that corresponds to that use, is an allocation in which each resource is consumed at its most efficient level.

(2) Definition of the problem. Second, when the market fails to an achieve an optimal allocation, economists attribute it to one or more category of "market failure." The market failure underlying the pollution problem is explained principally by the theory of "externalities." Because individuals and firms do not take into account the entire costs and benefits of their actions, they may take actions that cause incidental damage to others and lead to inefficient allocations.

(3) Prescribed remedies. Finally, the model proposes methods to remedy the problem by internalizing the externality or modifying behavior of firms and individuals to improve the resource allocation.

Theory meets political necessity. When modern environmental controversies became matters of public concern in the early 1960s the welfare economists' model had come into wide use and was unchallenged as the sole comprehensive theory to explain the pollution problem. But U.S. environmental policy headed in an entirely different direction.

By the late 1960s a model based on new, non-economic definitions of the problem had gained currency. Events of the 1960s drove public opinion and the media toward the view that the act of emitting pollutants is a wrongful act, and therefore industry did not have the right to pollute. It followed that industry should bear the burden of fixing the problem, and that it should not now profit from pollution or be rewarded for remedial actions that could (hence should)

have been taken earlier. By 1970 it had become clear that the new "solution to pollution" was regulation.

Beginning with the Clean Air Act Amendments of 1970 Congress adopted laws based on this new model that departed significantly from the economists' model: they were not designed to achieve economically optimal pollution levels, nor were they driven by a mechanism for firms to internalize externalities. But while these laws produced very detailed regulatory requirements, they were almost completely silent about their fundamental premises. In the absence of an agreed-upon set of governing principles, environmental practitioners have taken decision-making proceedings as pragmatic, zero-sum games of environmentalists versus industry.

In consequence, legislation beginning in 1970 ushered in an era in which there exists an elegant theoretical model that has not been followed in law, and a body of law that is not the product of a comprehensive theory. This calls for an empirical review of firm behavior to discover the first principles from which a new model can be developed.

Two Case Studies

We turn now to an examination of two controversies—the introduction of gasoline lead additive, and the adoption of laws to control vehicle emissions—as case studies in the behavior of business entities toward the environment. Both of these controversies concluded in defining events that significantly affected the development of environmental policy.

The discovery and introduction of tetraethyl lead. When the automobile was introduced 100 years ago it was not clear what societal function it would serve. The story of tetraethyl lead starts there.

In its first thirty years the automobile passed through six developmental phases before settling into a period of stability: the pioneering phase (1896-1899); the experimental phase (1900-1903); the standardization phase (1904-1907); the mass market phase (1908-1912); the mass production phase (1913-1920); and the mass-class market phase (1921-). The introduction of tetraethyl lead as a gasoline additive occurred in the mass-class market phase, based on the work of Charles Kettering.

Kettering was an engineer who had made his mark by developing the first reliable self-starter, introduced on the 1912 Cadillac. He realized that if he could build engines that compressed the fuel more tightly for combustion he could achieve greater thermodynamic efficiency. The barrier to doing this was engine knock: as an engine's compression ratio is raised, at a certain threshold destructive knocking begins. Based on experiments in 1916 suggesting that the problem related to the fuel, Kettering decided to look for an additive to make the fuel knock-resistant, and he set up a laboratory to conduct experiments, with Thomas Midgley in charge. In 1920 that laboratory became the nucleus of the General Motors Research Corporation.

In December 1921 Midgley discovered that an obscure compound, tetraethyl lead, when added to gasoline, was incredibly effective as an antiknock. GM quickly filed to patent gasoline containing tetraethyl lead, which Kettering named "Ethyl gasoline," and allocated resources to commercialize it. Kettering arranged for E. I. du Pont de Nemours & Company to produce the lead additive, and in February 1923 Ethyl gasoline was first sold to the public.

In 1919 Frank Howard, a patent attorney in Chicago, had recognized the strategic importance of Kettering's research. Howard warned Standard Oil of New Jersey that any company that developed an antiknock fuel could, in his words, "dominate the entire motor-fuel market." In October 1919 Standard hired Howard to establish its Development Department to begin fuel research. After learning of GM's discovery of tetraethyl lead, Standard Oil moved rapidly to patent a cheaper method to synthesize it. Since GM could not beat Standard Oil, it joined it. In August 1924 GM and Standard combined their patents to form the Ethyl Gasoline Corporation.

The Kettering Doctrine. GM took understandable pride in touting gasoline lead additive as a symbol of efficiency. The growth of a company to the size GM attained by the mid-1920s could not have occurred without public assent to its legitimacy. While many scholars have explored the strategies that came to be known as "Sloanism," less has been said about the public image GM created for itself in this period, which to a large extent is attributable to Kettering. Kettering's philosophy, which I call "the Kettering Doctrine," had two core elements: (1) research by corporations such as GM represented "progress through science;" and (2) the interest of the corporation is synonymous with the public interest. GM began to portray its interests and those of the public as synonymous, as if they had merged into one common interest.

The Kettering Doctrine sounded intuitively correct, but as a general philosophy it remained incomplete. It did not address the issue of incidental damage resulting from industry's activities, except to dismiss it as unfounded. The issue was to become critical, for it raised fundamental questions of public concern: What was industry's responsibility for chemicals that have toxic properties and cause remote damage through the ambient environment? Until events forced the issue, it would remain unrecognized.

The Bayway incident. Lead was commonly known at that time to be poisonous, and GM looked for a way to assure the public that Ethyl gasoline was safe to use. GM contracted with the U.S. Bureau of Mines to examine the hazard. As an agency of government, the Bureau's assurance of the product's safety could carry great weight.

The hazard issue became real when GM and du Pont began to experience poisonings among workers at their facilities engaged in producing and handling lead additive. GM hired Dr. Robert Kehoe, a physiologist and specialist in human exposure to metals, to work out arrangements to make the product safe. But so far the deaths and injuries had not come to the attention of the public.

In October 1924, five deaths and several dozen serious injuries to workers producing tetraethyl lead at Standard Oil's refinery in Bayway, New Jersey brought public attention to the hazards of lead additive. Up to this time GM had treated the lead hazard as a private matter, with consequences only in the occupational setting. But news accounts of the incident raised broader concerns about potential hazards to motorists and the general public, most significantly, whether lead exhausted from autos using leaded gasoline would accumulate in ambient settings and present a public health hazard.

The first modern environmental health controversy. After GM's efforts to resolve the controversy with the Bureau of Mines were criticized by public health advocates, the parties turned to the U.S. Surgeon General, Dr. Hugh S. Cumming. But the Surgeon General was no more prepared to address the controversy than GM was, as the problem was unprecedented in American experience. The use of gasoline lead additive presented a hazard that was at once:

(1) *Industrial-* a product or condition not occurring naturally or produced by traditional or agrarian technologies, but invented for synthesis and manufacture by industry, and/or a condition resulting from mass production and wide dispersion of a product;

(2) *Chemical-* a substance identified as a chemical agent whose effects were thought to result mainly from its chemical rather than its physical properties;

(3) *Toxicological-* an agent whose harms were experienced as specific health effects—rather than as aesthetic detriments, public or private nuisances, or hygienic conditions that were merely unhealthful or unsanitary—and which had new and/or exotic properties that were toxic to humans exposed to them; and

(4) *Ambient-* a pollutant whose exposure pathways were through the ambient media, rather than by a direct connection between the causal agent and the party(ies) injured or at risk.

None of the resource or public health controversies that preceded the Bayway incident had presented this combination of characteristics. All these characteristics had appeared previously, either individually or in combination, but no controversy had embodied all four. Indeed, the term "environmental" now used to describe such controversies had not yet come into use. The Bayway incident presented a new kind of problem for which no remedy had been established.

The Surgeon General's proceedings. Under pressure to come up with a way to address this new kind of problem, Surgeon General Cumming announced a conference of the parties.

The conference, held May 20, 1925, brought together all of the major interests, including the proprietors of lead additive and a broad slate of public health officials, academics, and representatives of other industries, though

none of the injured were invited. Its design suggests Surgeon General Cumming's reticence to assert control: It was an informal process in which the views of the parties were to be aired openly and in a collegial way so that a consensus on scientific principles might emerge, and all issues were deferred to the parties to be decided by their vote.

In his opening remarks, Surgeon General Cumming cautioned that the U.S. Public Health Service ("PHS") had no authority to control tetraethyl lead, and that in his view even state controls would be unnecessary given the assurances the companies had made. Having no regulatory power of his own, his purpose was not to prescribe controls but to find a basis for resolving the controversy by investigating the facts and informing the public. He was counting on the process itself to generate a solution, which would have to be volunteered by the industries. But reaching consensus on the facts was not going to be easy, for much was at stake.

The disagreements peaked in the afternoon session. Dr. Yandell Henderson of Yale observed that there were two distinct perspectives being presented—the industrial perspective and the public health perspective. He characterized the industries' view as being that a little industrial poisoning should not stand in the way of a great industrial advance, and he charged that the industries had failed to take the public health considerations into account. He asked that the contrary approach be taken—that lead additive be found harmless before being allowed in general use, a position that was supported by several other public health advocates in further testimony.

Though Henderson's characterization of the industries' view was generally accurate, as it restated views that Kettering himself had recently asserted, his allegation that GM had failed to take the public health into account was something that Robert Kehoe was not going to let stand. Earlier that spring, as Ethyl's public image had deteriorated, GM President Alfred P. Sloan had called Kehoe in for a meeting. Sloan was concerned that the continuing lead controversy was causing damage to GM's image, which Sloan was making great effort to build. Sloan instructed Kehoe that GM could not allow itself to be seen as being responsible for a significant health hazard. Thus, to rebut Henderson's allegation Kehoe stated that for some time GM management had placed control of the hazards of tetraethyl lead in the hands of medical men who had the interests of the public at heart, and that GM management was only interested in the facts. Kehoe concluded by making what would be the most decisive statement of the day:

> [I]f it can be shown ... that an actual danger to the public is had as a result of the treatment of the gasoline with lead, the distribution of gasoline with lead in it will be discontinued from that moment. ... [B]ut ... when a material is found to be of this importance for the conservation of fuel and for increasing the efficiency of the automobile it is not a thing which may be thrown into the discard on the basis of opinions. It is a thing which

> should be treated solely on the basis of facts. [Dr. Robert Kehoe, U.S. PHS, 1925, p. 70]

Dr. Kehoe's statement was a turning point. It was in effect an offer by the proprietors of lead additive to control the hazards that could be proved. That was a significant concession, for it committed the proprietors publicly for the first time to take actions to protect the public health. Ultimately, the proprietors were unwilling to be on record as being indifferent to the public health. This provided the voluntary action that Surgeon General Cumming was counting on to solve the problem.

Dr. Kehoe's offer was reinforced by Frank Howard of Standard Oil, who testified that currently the companies lacked guidance in determining their standard of care. Implicit in asking to be told what their duty was was the promise that they would solve the problem once such guidance were given.

Dr. Kehoe's offer was stated as contingent on determining if a hazard was presented by the facts, but that was a proposition with which all present could agree. The public health advocates had previously insisted on an independent review to determine the facts. Thus, at the end of the day the attendees voted unanimously to adopt a resolution calling for the Surgeon General to appoint a committee of seven recognized authorities to review the health hazard in the retail distribution and general use of gasoline lead additive.

Eight months later, in January 1926, the "Committee of Seven" made its report, concluding that it had found "no good grounds for prohibiting the use of [leaded] gasoline," so long as it was properly handled. The Committee recommended a set of regulations to control the lead hazards in the work place where gasoline lead additive was produced or blended, but as to the ambient hazards of lead emissions from cars the only restriction was that refiners not increase the concentration of tetraethyl lead above 3 cc per gallon, the amount GM was already planning to use.

The proprietors of gasoline lead additive had an interest in implementing the regulations, as leaded gasoline could not survive commercially if it were perceived by the public to be unsafe. Therefore, the industries accepted the recommended regulations and established mechanisms to implement them under the supervision of Dr. Kehoe. This seemed to remove the pressure on states to adopt the regulations themselves, as no state enacted them into law.

On May 1, 1926, having taken all the steps deemed necessary by the PHS, the industries reintroduced leaded gasoline and by 1927 it was available nationwide.

Elements of the Surgeon General's remedy. The Surgeon General's review of tetraethyl lead was the first of its kind. It had three significant elements.

Procedural element: the conference proceeding. Use of the conference proceeding to resolve the Bayway incident elevated the government's role from merely serving industry in its work, as had been the function of the Bureau of Mines, to providing a process for judging the merits of industry's actions. As

the first of its kind the process explored uncharted waters, and rather than steer it himself Dr. Cumming let the process find its own course. In consequence, the process moved forward spontaneously, reacting to new, often unanticipated issues as they arose, and the remedy took shape unpredictably, without explicit consideration. By their end the proceedings had produced a set of regulations that the resolution had not called for.

Doctrinal element: the Kehoe Rule. The conference recommended appointment of the Committee of Seven to determine the facts, proceeding under the assumption that a scientific fact-finding by independent experts would resolve the matter. But facts alone would not suffice. First, the facts about the lead hazard that were available information were overwhelmed by the uncertainties. Second, while Dr. Kehoe's offer was contingent upon the finding of a hazard, it also required determining the standard of care Frank Howard sought. Thus, what the conference had voted for, apparently without recognizing it, was to delegate to the Committee significant matters of policy judgment without giving it guidance on the critical questions. Nevertheless, the Committee did not hesitate to produce conclusions.

Since the Committee did not state its reasoning, the logic underlying its decision can be found only by inference. The Committee's conclusion was that there were "no good grounds for prohibiting" leaded gasoline. Given the overwhelming uncertainties, the Committee would have been equally justified in adopting the opposite decision rule, i.e., that there were no good grounds for allowing leaded gasoline. But the promise of economic benefits, as stated by the proprietors and factored into Dr. Kehoe's offer, favored the former rule.

Dr. Kehoe's offer can be analyzed into its component factors and restated in their logical relationship: "No controls are warranted if the economic benefits from using the product (discounted by the probability of occurrence of those economic benefits), exceed the cost or detriment to the public health (discounted by the probability of occurrence of those health costs)." When applied to the situation confronting the Committee, this expression generates two distinct outcomes. On the one hand, the Bayway incident had made the occupational hazard undeniable, and thus controls were obviously warranted. On the other hand, when the specific values Kehoe assigned to the ambient hazard were applied to the terms of this expression it yielded the decision, "No controls are warranted because the economic benefits are large and certain, while the costs or detriments to public health are small and speculative or highly improbable." (To be clear, the Surgeon General's regulations did impose a control of sorts to address the ambient hazard, in the form of a tetraethyl lead maximum per gallon, but since the standard was set at the amount the proprietors intended to use it did not function as a control.)

Since the Surgeon General's action was in effect the adoption of a decision rule whose principles were first articulated by Dr. Kehoe, and because this decision rule would become synonymous with his professional activities over the next four decades, we will refer to it hereinafter as "the Kehoe Rule." The Kehoe

Rule established the framework for making the decision on whether a product or activity is prohibited, and if allowed what would be the standard of care.

Administrative element: voluntary self-regulation. Having decided under the Kehoe Rule that some controls were warranted, and having adopted a set of recommended regulations, an implementation mechanism was necessary.

The proprietors of lead additive would have preferred to deal with the lead hazards voluntarily and privately, with the government serving it in a supporting role as they had done initially. But after the Bayway incident the role of government as the supporter of industry was no longer appropriate. Elevating the government's role meant that the treatment of the lead hazard was no longer private. But whether it would remain voluntary was unclear.

Here again the outcome reflected the process. In his testimony Henderson had made clear that he favored mandatory standards. In response, Dr. Kehoe offered that the proprietors would prevent any hazards that could be proved. While this concession assigned a responsibility the proprietors had not previously accepted, it preserved the companies' self-governance and made mandatory standards unnecessary. Individual states took no regulatory action of their own, trusting that public pressure on the companies was sufficient to assure their compliance.

The harmonious order. Oddly, the elements of the Surgeon General's remedy were never articulated in a decision document. And yet, so well understood were its precedents that they were followed for decades in the practices of industry, in the policies of government, and in the expectations of the public.

For the next four decades various industries took the outcome of the Bayway incident as a signal of their environmental responsibilities. The harmonious resolution of the Bayway incident supported Kettering's portrayal of GM's interests as having merged with the public interest. So in 1953 GM president Charles Wilson would be only restating the obvious when he told the U.S. Senate (to paraphrase) that "What is good for General Motors is good for the U.S." But, as the public would soon find, while the actions GM took were good for GM, they were not necessarily good for the U.S.

The modern era: breakdown of the harmonious order. Over the course of four decades, a depression and a war overturned social policies in a number of other areas, but the Surgeon General's paradigm remained stable. A breakdown of public confidence would bring a new paradigm and end the harmonious order.

Smog. In the late 1940s, smog became recognized in Los Angeles as a public health problem. In 1950, Dr. Arie Haagen-Smit identified the chemical reaction of hydrocarbons ("HC") and oxides of nitrogen ("NOx") as the cause of the smog.

In 1953, an inventory of emission sources was conducted, and L.A. County officials realized that the largest aggregate source of HC was automobiles. Automakers were quick to recognize that this finding put them in jeopardy of

regulation. In 1954, automakers reached agreement that (1) they would jointly license any pollution control technologies they might develop, and (2) they would not make any public announcement of breakthroughs in emission control technologies without prior approval of all other signatories. In 1955 they wrote these terms into a formal agreement. As explained to the public, the automakers' agreement would allow them to pool their resources for research. But the agreement had the effect of eliminating any competitive incentive to develop emission controls, as it made it impossible for any automaker or supplier to gain a competitive advantage by introducing an innovation individually.

The automakers' agreement did not receive widespread public attention until late 1965, when Ralph Nader published *Unsafe at Any Speed.* Although the book focused on auto safety, it also contained a chapter describing automakers' efforts to stifle the development and use of emission controls. Nader made three allegations: (1) that automakers had available or could develop emission control technologies; (2) that automakers were withholding these technologies from the market; and thus (3) that auto emissions resulted not from impersonal forces but from a planned and coordinated strategy. Nader alleged that the pollution problem was not the work of the market's "invisible hand" but the product of a calculated corporate tactic. By acting as if their externalities were unintentional and the result of impersonal forces beyond their control, when in fact theirs was a strategy to externalize their costs, the automakers had betrayed the public trust. Clearly, if GM was concealing its intentions from the public, what it was doing could not be good for the U.S. In short, Nader defined the pollution problem as a wrongful act.

The dominance of voluntary self-regulation ended in January 1969, when the U.S. filed suit against the automakers for conspiracy in restraint of trade. The complaint alleged that the automakers had colluded to stifle the development of emission controls under their 1954 agreement. In January 1970 GM president Ed Cole declared GM's support for catalytic converters and unleaded gasoline to serve them, a major commitment to emission control. But the turnaround was too late to recover public opinion: by 1970 the public had already lost confidence in the automakers and industry in general to take responsibility for control of their externalities.

A new doctrinal approach. Nader's allegations made a fundamental break with the welfare economists' model. Nader took the model, to which economists had attached no moral connotations, and made from it a moral paradigm, which can be called the "Nader Paradigm":

(1) Definition of optimality. Nader defined optimality not only in efficiency terms but also in equity terms.

(2) Definition of the problem. Rather than defining a problem such as air pollution as an inefficient transfer, as the welfare economists had, Nader asserted that it was an intentional action by automakers to shift their costs onto the public. By focusing on the dis-

tributional aspect, Nader changed the basis from efficiency to equity and recast the model as an allegation of "intentional externalizing."

(3) Remedies. Nader's remedy, implicit in his problem definition, was to bring the facts to light and use the force of law to reverse intentional externalizing. Regulation would force companies to do what they were not willing to do voluntarily; this would in turn solve the problem of social cost.

While the smog hazard had the same characteristics (i.e., industrial, chemical, toxicological, and ambient) as the lead hazard in the 1920s, this time the approach taken would be entirely different. Nader's impact on the approach is shown in Congress' choice of regulatory instruments: (1) In the belief that automakers were withholding readily available, low-cost emission control technologies, Congress mandated that automakers make a 90 percent reduction in auto tailpipe emissions. (2) Congress felt no need to shield industry from the costs of fixing the problem and set health-based ambient air quality standards without any consideration of their cost. (3) Finding that voluntary self-regulation had been discredited by revelations of concealed information, and defining pollution as a wrongful act, Congress adopted command-and-control instruments to be implemented through the force of law.

Summary of findings. The case studies show that over time the nature of the pollution problem has stayed very much the same, but the perception of the problem has led to doctrinal shifts. This study has identified two distinct paradigms that have governed corporate responsibility for the environment:

(1) *Voluntary self-regulation under the Kehoe Rule (1925-1970).* The period following the Bayway incident was governed by the Surgeon General's review of tetraethyl lead. While no single document stated its principles, they were implicit in the outcome and reflected in the practices that followed it. Ultimately the paradigm came under criticism for its insistence that the entire public interest could be achieved through the actions of private enterprises.

(2) *Regulation under the Nader Paradigm (1970-).* The period following Nader's first confrontation of GM was governed by the Nader Paradigm. Beginning in 1970 its principles were codified in legislation that reversed the Kehoe Rule, and which were administered and enforced by legal institutions, including new agencies of government.

The case studies indicate that both of the paradigms arose in response to events that publicized failures of the regime that preceded them, and that both established practices that continued to bear the stamp of those events in their application.

The case studies also provide insight into contemporary environmental conflicts. It can be inferred from the arguments advocated by industries in modern regulatory proceedings that the adoption of the Nader Paradigm beginning in 1970 did not extinguish its predecessor. The continuance of the Surgeon General's paradigm into the modern period created the coexistence of two paradigms designed to achieve opposite results. It is this paradigm conflict that gives the impression that there is no single set of governing principles underlying modern environmental protection.

Conclusions

The history of automobile emissions is an essential case study in business behavior toward the environment. This shows that both of the two principal current views of the pollution problem—the theoretical welfare economists' model and the contemporary practitioner's view—fail to accurately describe the phenomenon.

The contemporary view. By 1970 the vision of the automakers conspiracy was fresh but the memory of the Surgeon General's review of tetraethyl lead was almost entirely gone. Because the principles decided in the 1920s had never been articulated officially the pollution problem was considered new, rather than a failure of the existing paradigm. As a result, a doctrinal treatment of the underlying principles did not develop. Thus, the contemporary view has the advantage of being based upon experience, but it is untutored by the insights of history. Knowledge of the history would restore the lost pieces of the experience.

The economic model. The economic model is more troublesome. Though welfare economics was originally developed to reconcile theory with observed conditions, it fails to account for much of the behavior exhibited by parties in the case study.

First, by taking efficiency in allocation as the basis for optimality the economic model does not give sufficient weight to non-economic motives of firms. The case studies show that factors such as equity and the public perception of intent were critical in their decision-making. Automakers' failures to reduce emissions were tolerated or excused so long as the public saw them as incidental to industrial progress, but the public's view changed radically when pollution appeared to be part of a conscious corporate strategy. Clearly, public opinion is an important factor in firm behavior.

Second, because environmental decisions are characteristically made under conditions of uncertainty the decision rules chosen—and not the facts themselves—dictate the outcomes. The historical periods correspond to shifts in the decision rules regarding the standard of care. Thus, doctrine is an important factor in firm behavior.

The failure of the economic model to account for these factors calls into question the adequacy of that model as a predictive device. Given the historical record, economists' view that the pollution problem originates in market failure seems very limiting. These non-trivial anomalies suggest that the economic theory is better adapted to addressing 19th Century pollution problems than to modern environmental health controversies. In sum, the case studies suggest it is time to broaden the model used to define the pollution problem.

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