

Siebert, Horst

Working Paper — Digitized Version

Liability issues in pollution control

Kiel Working Paper, No. 350

Provided in Cooperation with:

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

Suggested Citation: Siebert, Horst (1989) : Liability issues in pollution control, Kiel Working Paper, No. 350, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/497>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Kieler Arbeitspapiere Kiel Working Papers

Working Paper No. 350

Liability Issues in Pollution Control

by

Horst Siebert

Institut für Weltwirtschaft an der Universität Kiel
The Kiel Institute of World Economics

ISSN 0342-0787

Kiel Institute of World Economics
D-2300 Kiel, Düsternbrooker Weg 120

Working Paper No. 350

Liability Issues in Pollution Control

by

Horst Siebert

A 9 1336 / 89
Weltwirtschaft
Kiel
1989

January 1989

The author, not the Kiel Institute of World Economics, is solely responsible for the contents and distribution of each Kiel Working Paper.

Since the series involves manuscripts in a preliminary form, interested readers are requested to direct criticisms and suggestions directly to the author and to clear any quotations with him.

ISSN 0342-0787

LIABILITY ISSUES IN POLLUTION CONTROL

Horst Siebert *

1. Introduction

Liability laws are a very attractive policy instrument in a market economy for a number of reasons. If an individual agent inflicts a damage on another party, liability rules allow to attribute the damage costs to the agent that caused the damage. The originator of a damage will be forced to pay, and he will not be able to transplant some of the social costs of his action on someone else. Liability will tend to bring private and social costs in line. In principle liability therefore is an efficient social institution of dealing with other and third party damages.

As a rule, liability goes hand in hand with the decentralization of an economic system when important economic decisions are delegated to autonomous subsystems of the economy. Thus liability is consistent with the market system. Besides an efficient allocation of external damages, liability rules introduce an incentive to prevent damages to third parties. If the originator of a damage can expect to be liable for a damage, he or she will avoid damages in the first place.

* Paper to be presented at the European Science Foundation Workshop: "Economic Analysis for Environmental Toxicology", 24-26 May 1989, Noordwijkerhout, The Netherlands.

Liability ex post will be anticipated ex ante. Consequently, liability will introduce incentives for new technological solutions. Moreover, liability may be applied when damages are uncertain, that is when other regulations are not applicable because they cannot be defined in an uncertain world. Finally, liability rules establish an insurance market, and it can be assumed that such a market can generate more imaginative solutions than a regulatory setting.

The message of liability law is straightforward: An economic activity such as production or consumption should internalize its liability costs. An activity should not be engaged in, if it cannot support its liability costs. If a product cannot carry its liability costs, it should not be on the market. This holds for commodities already being produced as well as for new products. A private investment project should carry its liability costs; if it fails to do so, it should not be undertaken. This also holds for a public project. A waste deposit or an energy plant should carry their liability costs.

In practical environmental policy liability laws do not seem to have a prominent place among the policy instruments being used. An interesting intellectual task is to look for options to introduce liability laws and to study conditions, under which liability laws may be practical ¹⁾. For our problem, we have to keep in mind some of the properties of persistent micro-pollutants such as a long half-life of months and more (and even years), transformation in the environment such as synergisms, uptake by organisms etc.. Most of these impacts of micro-pollutants are unknown or extremely hard to observe ²⁾; they occur in the long-run.

A central aspect of liability is risk or uncertainty. We therefore have to study the risks involved in using the environment (Section 2). In a semi-Coasean world, property rights with liability rules allow to transform risk into deterministic

values (Section 3). This, however, does not hold when transaction costs do play a decisive role (Section 4). The relationship of liability law and other policy instruments is analyzed in Section 5. In Section 6, the problems of accounting for the risk of environmental degradation in setting the quality target is addressed. Section 7 develops the casuistics of the environmental problem relevant for liability. Finally, the results are summarized.

2. Using the Environment under Risk

The environment has two basic functions for the economic system: it supplies public consumption goods such as oxygen or the protective strata of the earth's atmosphere. At the same time, those waste products which are generated in the production and consumption processes are channelled back into the environment and taken in by the environment's various media, partly broken down, accumulated and altered in their structure (Siebert 1978, 1987a). The role of the environment as a receptacle of wastes can be interpreted as a private good. The pollutants ambient in the environment influence environmental quality. Due to the diffusion function a trade-off exists between the environment's function as a public consumption good and its role as a recipient of pollutants. This conflict of competing uses, which is central to the environmental issue, generates additional problems if a specific use of the environment is encumbered with risk or uncertainty.

The notion of risk implies that the consequences of a decision cannot be determined in a clear-cut way for the acting agent due to inadequate information for instance on future events. The consequences of an action are therefore "uncertain". Variables in the economic decisions of an agent are random variables. Risk can be interpreted as the deviation in either direction from an expected result, i.e. the mathematical

variance in the random variable considered plausible by the decision taker. According to Knight (1921), risk is to be interpreted as a measurable, i.e. quantifiable, variable. Economic agents can assign probabilities to events happening in the world in the future. Many authors require that probabilities be based on an empirical frequency analysis so that they acquire an objective or statistical character. In this interpretation, we are concerned with a narrow concept of risk. Uncertainty, on the other hand, may imply that no probability can be stated or deduced from reality to determine the state of the world, in other words that probability can only be stated subjectively (or not at all), and not objectively. This is a broader interpretation of risk being relevant to phenomena where not enough experience of the past exists. References in the following article are to this broader risk concept, unless otherwise indicated.

A given variance in a random variable or a given probability distribution of events does not necessarily imply the same risk for different agents. This is due to the fact that risk can only be defined in terms of the target function and restrictions of the individual agent. This applies first of all to the differences in risk preference. But even when the attitudes towards risk are identical among agents, what constitutes a risk for one party is not necessarily a risk at all or an equivalent risk for another. A given variance in water quality therefore represents different risks, depending on whether the water is used for cooling, for industrial purposes, as a component for a final product such as beer, or as drinking water. Since the target functions of agents - maximising utility or profit - vary, and since room for manoeuvre varies as a result of a large number of restrictions, an uncertain event does not in reality constitute an equal risk for all agents.

An important distinction for our analysis is between individual and social risks. Individual risks refer to individual sub-

systems of the national economy whereas social risks relate to society as a whole. We can only speak of social risks if the random variable relates to public goods (or merit goods). The quality of the environment constitutes such a public good. Environmental pollution which is not known exactly in advance can therefore be interpreted as a social risk.

Negative external effects of economic activities on the environment are loaded with risks for a number of reasons.

Pollutants such as persistent micro-pollutants accumulate over a lengthy period of time in the environment's media, in a manner which is often not foreseeable (accumulation risk). One example of this long-term effect is DDT, now banned in all industrialised countries, becoming concentrated in the body's fatty tissue via the food chain: 0.000003 parts per million were measured in the water in Long Island Sound, New York; the concentration in zooplankton, whose oils absorb DDT, is 0.04, more than 1000 times stronger. The measurement recorded for small fish in the same water was 0.5, for large fish 2.0 and in fish-eating cormorants 25.0 ppm (Siebert 1973, p.19). Other examples include the sedimentation of heavy metals in rivers and pollutants becoming trapped in the soil. Pollutants interact in the environment's media and between different environmental media (risk of synergism). We are not yet fully familiar with these synergisms, such as the formation of ozone in the troposphere. A characteristic feature of several such interdependences is their extremely slow development. For instance, it takes twenty years or more for the highly stable freon from our aerosol sprays to reach the ozone layer and interact with the ozone under the influence of sunlight. Besides accumulation and synergisms, the spatial transportation of pollutants by environmental systems is plagued by uncertainty insofar as existing calculations of their spread do not suitably reflect the actual situation. Spreading in atmospheric

systems, ground-water systems or diffusion along food chains (diffusion risk) are the cases in question here.

In addition to the accumulation of pollutants and the phenomenon of interaction, the incidence of emissions and pollutants ambient in the environment, in other words the extent of the damage, remain in part unknown (risk of incidence or damage risk). Pollution such as that affecting our forests only becomes evident after a lengthy period of time. Nitrate enrichment of the ground water or the accumulation of pollutants in the soil likewise only become apparent after a certain time lapse. The extent of the pollution remains unknown *ex ante*, and may deviate from a mean value in either direction.

Particular features which may play an important role in the uncertainty of environmental pollution are threshold effects and irreversibilities. In other words, damages frequently only become evident once certain thresholds ³⁾ are passed, causing environmental systems to pass the "point of no return". Such threshold effects may ultimately prove to be irreversible: the original state of the environment cannot be reestablished, even at immense cost or after laborious effort (irreversibility risk), for instance when a species of animal or plant becomes extinct.

3. Liability in a Semi - Coasean World

An important feature of risk in the context of environmental policy is the evaluation of risk. As a rule, using the environment as a public consumption good involves social risks; consequently the problem arises by which institutional mechanism social risks can be evaluated. Using the environment as a receptacle of wastes, i.e. as a private good, may involve private risks. The risk characteristic of environmental damage gives rise to the question how environmental risks influence the desired environmental quality, how environmental risks can

be limited and how the social risks of environmental utilization should be signalled to the sub-systems of society, for instance those causing pollution. Is liability law an appropriate institutional arrangement to allocate risks and the costs of risks reduction?

As an extreme theoretical framework of reference, we can consider a situation where the problem of free-riders using the environment is non-existent and exclusive property rights along the lines of the Coase theorem (1960) apply. Then in a world with one polluter and one pollutee and with negligible transaction costs, optimal environmental quality is attained by a bargaining process. A bargaining solution internalizes risk.

If the pollutee has the property right to the environment, the injured party will bargain along his or her marginal damage curve (in Figure 1). If marginal damage is a random variable, curves DD, D'D' or D''D'' represent different estimates of the mean of the damage. Note that each damage function reflects different probability distributions of the damage for a given level of pollution (shift of the damage function). With an increase of emissions and for a given probability function, the mean increases (movement along a damage function).

The pollutee will be keen to pass on to the polluter the environmental risks and the costs of pollution abatement to obtain a specified environmental quality, for instance OU (or OU' if he expects a higher damage). The contract between the two parties must be drawn up in such a way that the polluter commits himself to a specified level of environmental quality, and will consequently bear the risks associated with pollutants, synergisms and diffusion. The polluter then bears the risks of higher (SU') or lower (SU'') environmental quality.

If on the other hand, the polluter enjoys the property right to the environment, he will attempt to pass on all or part of the

up to a certain point (OU), and will not accept the risks associated with accumulation, synergism and diffusion. With a higher marginal damage, the pollutee has the risk of environmental degradation.

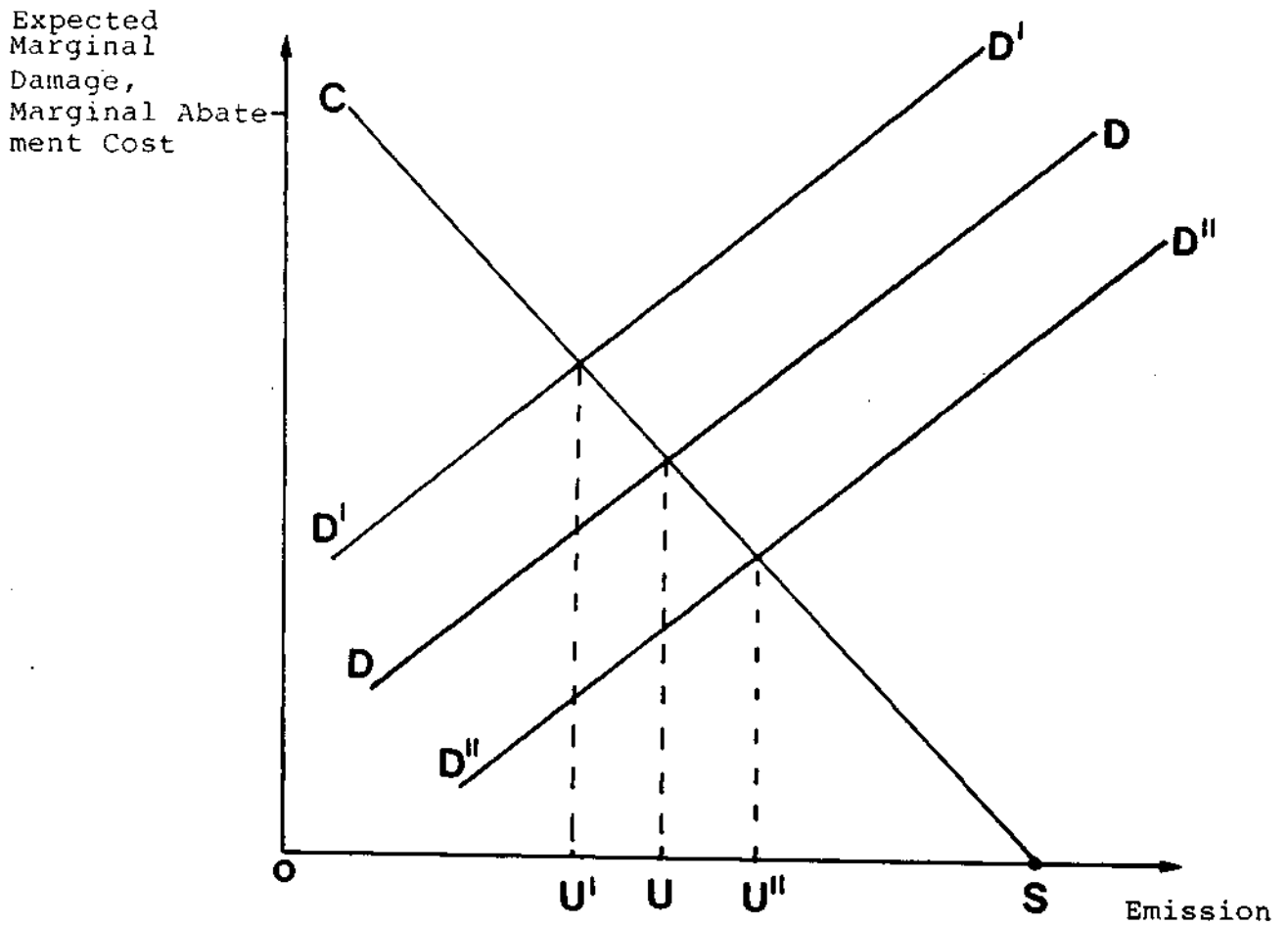


Figure 1

If future environmental pollution is to be interpreted as a risk in the narrower sense, in other words if economic agents have objective probabilities for the likelihood of various conditions arising in the world and if polluter and pollutee have an identical risk preference, these measurable stochastic environmental states are converted ex ante into deterministic values. Environmental risks are fully anticipated, resulting in optimum environmental allocation which takes quantifiable risks into account appropriately ⁴).

If clearly-defined liability rules for utilising the environment exist, the polluter bears the costs of abatement and compensation payments for damage caused to the environment. Even when environmental pollution only occurs at a point in the future, the polluter is held unequivocally responsible for the pollution. If clearly-defined rules of liability are applied, the polluter will anticipate the pollution expected in the future, and make an effort to avoid causing emissions and pollution. It is then in the polluter's very own interest to prevent environmental pollution. Strict adherence to the "polluter pays" principle ensures that the principle of prevention is observed. In an ideal institutional arrangement, the polluter behaves as if he were the victim himself (Adams 1986, p. 144).

If environmental policy were based on the liability principle, firms (and households) would be prompted to take out insurance against causing environmental pollution; this would therefore stimulate considerable demand for insurance services. An insurance market would introduce incentives to avoid pollution, for instance by appropriate insurance fees. It is rather realistic that private firms have better information on abatement technologies than governments. An insurance market will take advantage of this informational asymmetry in favor of decentralised subsystems.

4. Transaction Costs, Incentives and Liability

In the semi - Coasean world of the previous section, transaction costs are not explicitly taken into account. Transaction costs become especially relevant in the context of persistent micro-pollutants. With transaction costs, a decentralized application of liability laws will give rise to the following problems.

Incentives for Optimal Care. The problem of liability law is to find an institutional setting in which the polluter takes optimal care - as if he were the pollutee (accounting for differences in tastes and economic conditions between polluter and pollutee). The principal (the environmental policy maker) and the agent (the polluter) have asymmetric information. It can be assumed that the polluter has the better information on abatement costs; the principal as a representative of the pollutees is supposed to have better information on marginal damage. The incentive system must prevent moral hazard problems, both with respect to abatement behavior and with respect to providing information.

Forms of Liability and Incentives. The behavior of the polluter depends on the forms of liability.

- Strict Liability implies that parties have to pay damages irrespective of their negligence. Then they have an incentive to consider all potential harm.
- Negligence rule require a prescribed level of "due" care, and a party is held liable if due care has not been applied.
- Liability with standards. Liability only refers to pollutants surpassing a standard. In this case, the individual polluter only is liable for pollution beyond the standard.

- Limits of liability may arise from legal statute or from the liable assets of the firm. Such limits represent an upper bound on the care taken.

The "burden of proof" is an important aspect of liability law. In the case of strict liability, the burden of proof is with the polluter. He therefore has to carry the transaction costs. In the case of negligence, the government or the pollutee have the burden of proof.

Legal Costs. Liability law will attribute social costs only ex post. With a well functioning institutional mechanism, ex post allocation of social costs to the polluter will be anticipated and correctly internalized ex ante. If however, social costs are only allocated with a considerable time lag, the property of efficiency is impaired. Liability law involves the legal process. Especially in the case of continuously occurring emissions, for instance from production, the transaction costs of the legal system tend to be high. It is the characteristics of a market economy that competing uses are not decided by bureaucracies and courts but by markets. The environmental problem is a scarcity problem, and consequently we should attempt to introduce markets. There is the danger that liability law, although establishing insurance markets, increases the role of non-market mechanisms of allocation.

Identifying the Polluter. Liability rules require that the polluter can be identified without doubt. Here, however, serious problems arise:

- There are many polluters; moreover the potential cause of a damage may stem from different pollutants.
- Damage is caused by pollutants ambient in the environment; at the origin, we can only measure emissions. Although diffusion processes obey laws of nature, it is difficult to associate pollutants ambient in the environment to emissions.
- Damages only occur with considerable time lags.

These arguments suggest that in the case of many polluters and many pollutants liability rules have to allow an attribution of damages to polluters on a statistical basis, that is using statistical probabilities. A problem of long-run damages is that firms only have limited assets and that they may change their legal status or may cease to exist. It is an open question to what extent liability laws define exit conditions for firms.

Strategic Behavior of the Polluter. The individual polluter has the option to act as a free-rider by not providing all relevant information faithfully. The policy maker devising an institutional setting does not have access to the same information as the individual polluter. Information between principal and agent is distributed assymmetrically. It is rather in the interest of the polluter to play down his or her role in causing environmental pollution. The situation therefore boils down to finding such institutional arrangements of risk allocation as will avoid distorting information and fending off the free-rider approach of using the environment as a recipient for waste. The institutional arrangement must be fit to transform stochastic into deterministic variables. If the polluter has the option to behave strategically, environmental quality tar-

gets are not correctly signalled to the subsystems of an economy. Moreover the individuals using the environment or a public consumption good may behave as a free rider when asked to reveal their "true" preferences and their willingness to pay.

The Extent of Damage. Pollution will not only cause a damage for a specific pollutee, but for a number of pollutees. Here the problem arises whether the damage is to be evaluated individually or by some method of aggregation, that is whether a horizontal or a vertical aggregation of the individual's willingness to pay has to be applied. Legally and constitutionally, the problem arises who has the right to go to court and whether a collective court action is allowed. Besides a damage for more than one person, ecological damages may arise that are not particular to a specific person, at least not today. Liability laws must find a way to account for ecological damages.

Insurance Markets. An important ingredient of liability law is that an insurance market actually will develop. Then incentives will be introduced into the economic system to prevent pollutants and damages, and with efficient insurance markets, technological information will come to the fore. If environmental damages cannot be attributed to the individual polluter, if the diffusion and the accumulation of pollutants over time are not clearly tracable and if institutional substitutes to specify causality cannot be developed, insurance firms may be reluctant to take over environmental risks. It is a prerequisite for establishing an insurance market that risks can be calculated and that stochastic variables can be transformed into deterministic values. "Creeping" damages (Allmählichkeitschäden) that only develop over time and damages of which a statistical mean cannot be determined do not represent a relevant basis for the insurance industry. These damages are not insurable. Another aspect of insurability is that damages are

not too specific so that risk can be spread by insurance over many cases. Yet another issue is that the risk to which a polluter is exposed is limited by the assets of a firm or other institutional restraints.

The Japanese Solution. Liability issues have the systematic difficulty that there is only a statistical relationship between emissions and damages. One method of solving the problem of the responsibility of a specific polluter in practice is simply by determining the level of emissions of individual sources, but not the actual damages. This approach is adopted in the environmental compensation principle applied in Japan. The legislation from 1973 requires that compensation is paid for certain environmental illnesses according to the severity of the disorder. Damages are not allocated on a causal basis to the polluter. Companies pay a levy into a fund on the basis of their emissions. Those entitled to payments include for instance persons who live in a region where a significant, statistical relationship between air pollution and specific illnesses has been established.

5. Liability and other Policy Instruments

An important aspect is how liability law can be integrated into the institutional arrangements of other policy instruments such as emission taxes, discharge permits or regulation.

Consider a representative firm with a continuous flow of emissions that it can abate with a cost function $C(S^r)$ where S^r are emissions reduced. Let α be the probability of an accident with damage D with $0 < \alpha(S^r) < 1$, $\alpha'(S^r) < 0$ ⁵). The firm can reduce the probability of a damage. The risk neutral firm minimizes (Shavell 1984, 272)

$$C(S^r) + \alpha(S^r) D \quad (1)$$

so that optimal abatement is given by

$$\frac{dC}{dS^r} = - \frac{d\alpha}{dS^r} D \quad (2)$$

which implicitly defines optimal abatement as a function of D , $S^r(D)$, where S^r increases with D .

Figure 2 shows potential damage D and optimal reduction of given emissions OS . Optimal reduction of emissions increases with damage (Curve SB). Note that curve SB depends on the institutional setting: if liability cannot be enforced, the curve shifts upward.

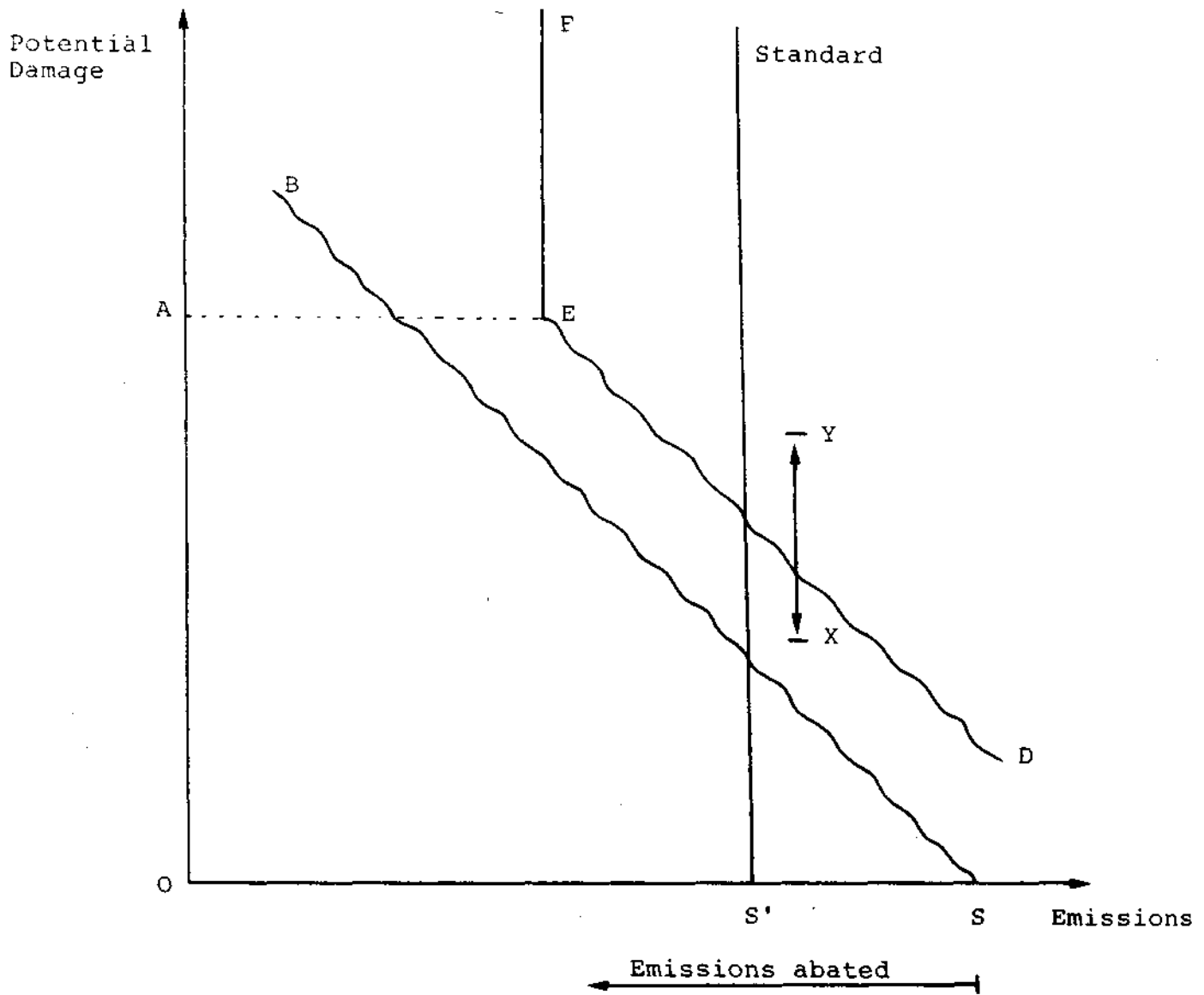


Figure 2

If the assets of the firm place an upper limit on liability, the effort of the polluter will be reduced to a curve DEF where OA is determined by the assets of the firm. The assets of the firm place an upper limit on the effort curve and shift it upward relative to the optimal abatement case (Shavell 1984, p.274). For a given potential damage, less abatement is undertaken.

Instead of liability, an emission standard SS' limiting the quantity of emissions can be established. Such a standard, however, presupposes that firms to be regulated are rather homogeneous and are clustered around a potential damage XY. If such a distribution exists, a mean of permissible emissions can be defined (if information on the clustering is available). Of course, an emission tax yielding SS' or emission rights may be applied instead. These price instruments have the advantage of stimulating technological progress in abatement.

Environmental policy may use both a standard and liability law. In Figure 3, a standard SS' is binding. Beyond the standard, liability law applies where the vertical branch EF is determined by the assets of the firm.

Figure 2 and 3 may also be interpreted with respect to product norms where SS' represents a product norm and DEF represents pollutants being reduced from products in response to product liability.

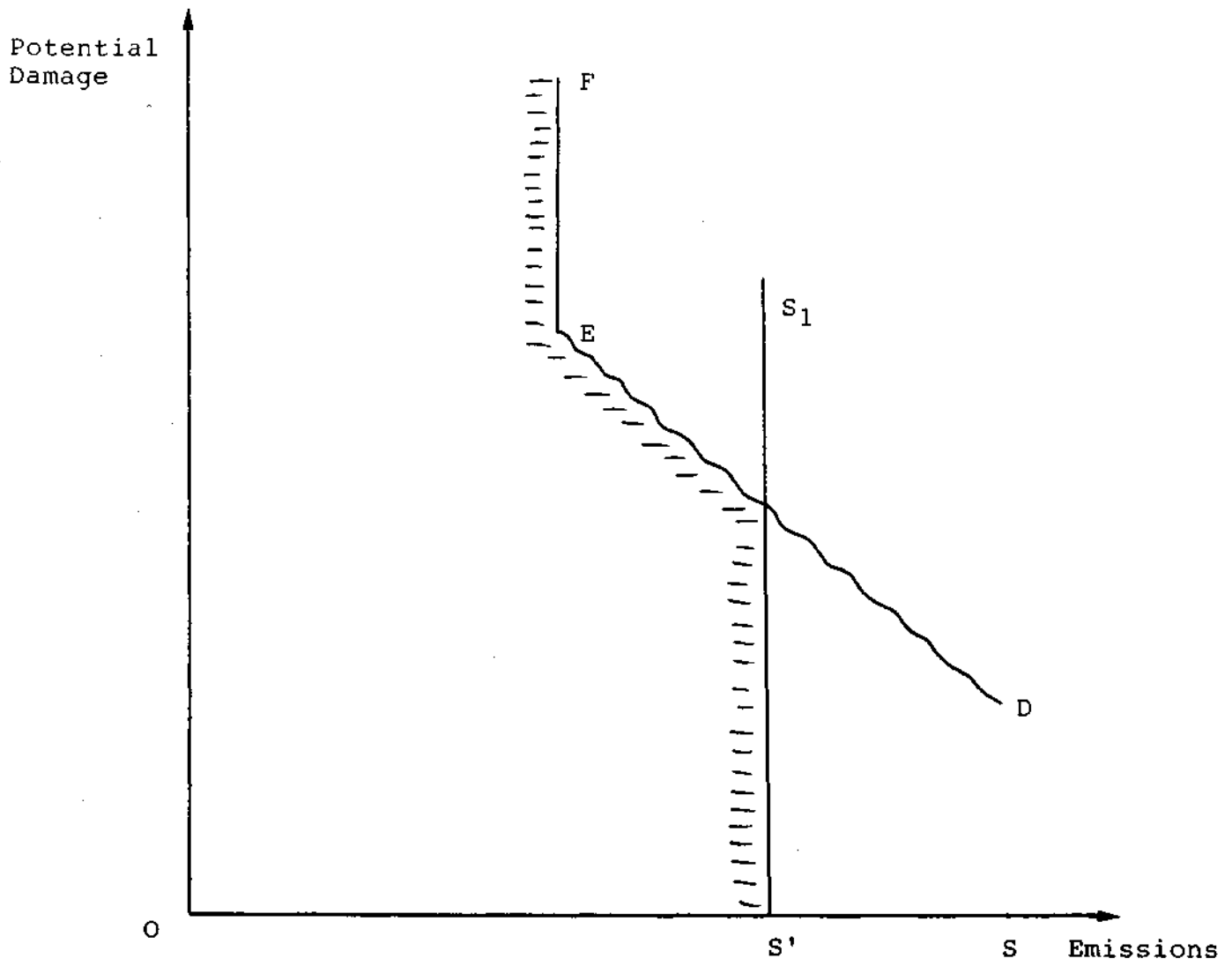


Figure 3

6. Environmental Liability and the Risk of Degradation

If we move away from the semi-Coasean world allowing for transaction costs and limited information of the environmental policy market, the problem arises which environmental quality target is set in a world of uncertainty and how a quality target loaded with uncertainty can be signalled to the subsystems of an economy.

When future environmental quality is uncertain, risk allocation relates to two different problems: who will bear the risk of environmental degradation, and who will bear the additional costs of abatement if there is a decline in environmental quality? The answer to these questions varies according to the approach to environmental policy.

When the environment is used free of charge, the pollutee (the general public) bears the environmental risks; there is no incentive to abate or prevent pollution, i.e. the costs of abatement are not attributed to the polluter. The other extreme of environmental policy, the principle of the common burden, implies that the government bears the costs of environmental risks because abatement of unexpected environmental pollution must be financed by the government ⁶).

The government also bears the costs of correcting environmental risks if environmental policy follows a licensing approach according to the state of the art. This is because in such a policy approach uncertain effects of the environment in the future cannot normally be blamed on the polluters. The government may then be forced to subsidise abatement. Only if precautionary measures have been taken in the form of a preventive environmental policy can the government succeed in passing on all environmental risks to the polluter. With emission taxes

and transferable emission rights, it may be easier to signal new and unexpected scarcities.

If environmental policy is to avoid the responsibility for environmental risks falling to the government, it is essential for future environmental risks to be anticipated and built into current scarcity prices. The principle of preventive environmental policy means that ideally pollution must be prevented (O'Riordan 1985; Rehbinder 1985; Simonis 1984). Environmental policy must set incentives before problems evolve. The risk of future environmental pollution is of particular significance where the environmental pollution can no longer be cleaned up by future generations at any expense (irreversibility). On the other hand, if environmental pollution is reversible, preventive policy only becomes an attractive course of action if subsequent costs of cleaning up are greater than the current cost of avoiding pollution.

The principle of preventive policy must primarily relate to the target of environmental quality. For determining the target, the principle of preventive policy means that environmental policy must assess long-term pollution when determining the desired environmental quality and set a tougher target of environmental quality for expected environmental risks, because such risks indicate that, other things being equal, it is more improbable that a particular target of environmental quality will be reached. With a higher risk of damage (curve D'D' in Figure 1), a better environmental quality must be the target. The evaluated future pollution must be incorporated into current environmental scarcity prices. If environmental risks exist, scarcity prices must be pushed up now (Siebert 1987a) ⁷⁾.

The basic question behind the principle of prevention is that uncertain states in the world cannot by definition be foreseen. This causes problems in securing a desired environmental qua-

lity. Moreover, measures for environmental quality are plagued by uncertainty as far as the behaviour of the polluter is concerned. In addition, the economic art of applying the principle of prevention consists in avoiding a frequent variation in the attribution of abatement costs not foreseeable by the polluter. Constancy in the incentive schemes and in the institutional setting is an important prerequisite of environmental policy. In the case of uncertain environmental pollution, just how far the principle of preventive policy can in practice resolve the conflicting targets of avoiding environmental risks on the one hand and revising environmental measures *ex post* on the other must remain open.

7. Liability and the Casuistics of the Environmental Problem

Environmental policy approaches to persistent pollutants very much depend on the specific environmental problem at hand. It is therefore promising to develop a casuistics of the environmental problem of persistent pollutants and to discuss the role of liability law in the different cases. Then the following cases have to be distinguished (Siebert 1987a, p.19).

Continuously arising Emissions in Production. In this case, licencing (air quality management) and emission taxes (water quality management) have been applied. Transferable emissions rights proposed by economists have been used in the "bubble concept".

Licensing processes enable the government to lay down the maximum permissible level of persistent emissions. In that approach, the government has to control individual stacks. This method is a typical means of air quality management in many countries (Federal Republic of Germany, USA). Companies are normally required to apply state-of-the-art abatement technologies. Permits are issued for as long as the environmental qua-

lity in any particular region does not violate the legal limits of ambient quality. Yet this requirement only applies to newly-established companies, not to long-established ones (Siebert 1985a) for which grandfather-clauses apply. Regulations cannot be changed rapidly if unexpected pollution arises; for example the state of the art stipulated in the 1973 Federal German Clean Air Act was not altered until 1986.

If environmental risks exist for persistent pollutants, the government's expectations of these risks may be a reason to set stricter quality targets. It can then issue additional permits in the future. If the environment were to deteriorate more than expected, the government might be forced to pay subsidies in order to induce abatement. This would hold true if the institutional setting cannot be changed quickly. If this is the case, the government bears the abatement costs of environmental risks.

In a world of uncertainty and economic change, the social opportunity costs of a permit approach vary with the transferability of the permit. Transferable emissions licences or the "bubble concept" in U.S. environmental policy offer the polluter scope for reducing the cost of abatement. The emitting party in the bubble is left to decide which amounts of emissions are to be disposed of at which source with the aid of which technological process. Environmental policy is not oriented to the individual stack, but tied to the emission amounts stipulated for the bubble as a whole. Such a flexible approach introduces incentives to improve the abatement technology; consequently, it puts less pressure on environmental policy to bear the abatement costs of uncertain environmental determination.

In principle, liability law introduces an incentive to improve technologies of abatement into a permit system. However, if emissions arise on a continuous basis in production activities,

liability law is difficult to apply. Often, the individual polluter is not known, a specific damage can have many causes, and transaction costs are high. It is hard for the pollutee to provide proof. If strict liability shifts the burden of proof to the polluter, he has to show that damages are not caused by him. If it is correct that there is only a statistical connection between emissions and damages, then this proof usually cannot be successful. I follow Adams (1986) that such a reversal of the burden of proof with continuously arising emissions may lead to an "excess liability" of the polluter. Emission licences, preferably transferable, or emission taxes may be the relevant policy instrument.

Thus, in the case of activity liability, the existing policy instruments cannot be easily substituted by liability law. A different approach would be to give liability rules a more prominent role in the context of a licencing approach. One way is to apply liability once standards are surpassed. This approach has the disadvantage that technological incentives are not institutionalized within the given standard. Moreover, in setting the standards, the government carries the risk of environmental degradation because standards cannot be easily changed. The more important question is whether arrangements can be found in which liability laws are made more biting without doing away with the licencing approach ⁸⁾.

Emission taxes have been used in water quality management when a continuous flow of pollutants occurs. Emission taxes can also be applied to air pollutants. Levying a tax on emissions discharged into the environment (for instance per ton of SO₂) is designed to correct the discrepancy between individual and social costs. At the same time, an incentive is introduced into the market economy to treat the environment as a recipient of pollutants with greater respect. The advantage of emissions taxes is that they define the conditions of the environmental scarcity better and introduce price leverage in order to solve

environmental problems. Firms are inspired to devise new methods of abatement. One important condition for introducing emissions taxes is that such a tax can only provide the correct incentive if linked to the amount of emissions, e.g. per ton of SO_2 . A general environment tax such as a forestry levy does not provide any incentive to avoid creating pollutants; such as a tax is merely a financing method.

The government bears the costs of correcting environmental deterioration when emissions taxes are imposed if the emissions tax or scarcity price cannot be adjusted quickly in the political process to new scarcity conditions. The discussions surrounding the German Waste Water Act and its introduction have shown that it can take 10 years or more to plan, pass and enforce such an act. However, a change in scarcity prices must not take such a long time. Arrangements whereby the desired environmental quality is determined by parliament and emissions tax rates by the government should therefore be considered. Such a solution could entail environmental policy automatically correcting allocations for unforeseen environmental pollution in the form of adjustments to emissions taxes. In such a scenario the costs of correcting environmental risks would quickly be attributed to the polluter. At the same time, incentives would be introduced to improve environmental quality.

In the case of emission taxes, a similar problem arises as in the licencing process. It is difficult to imagine that liability can dominate the emission taxes because the transaction costs of the liability system will be too high.

The better environmental policy succeeds in adapting instruments of environmental policy such as emissions standards, emissions licences and emissions taxes to new or unexpected environmental shortages, the shorter the period for which the state bears the costs of unexpected environmental deteriora-

tion. When these instruments cannot be rapidly adapted, the state is left bearing the costs of environmental risks ⁹⁾.

Continuously arising Emissions in Consumption. When pollutants arise in consumption activities (traffic, heating), it seems to be difficult to apply emission licences or emission taxes due to extremely high monitoring costs. Then product norms (for cars, chimneys) tend to be the appropriate policy instrument. Liability law seems to be impracticable, mainly due to the transaction costs. In this case, it is extremely difficult to alter environmental policy if unforeseen environmental disruptions show up. Thus, in the case of emissions from production and consumption, activity liability does not seem to be a too promising approach.

Pollutants bound in consumption goods. When pollutants are contained in consumption goods, they may represent a health hazard to consumers. Liability law would show up in the form of product liability. As a policy instrument, product liability competes with product norms.

Pollutants bound in Discharged Goods. When pollutants are contained in durable consumption or in investment goods and are returned to the environment when discarded (the icebox with freon), liability law would have to be framed as environmental liability. The problem then is who can go to court in environmental disputes.

Environmental Accidents. When pollutants are discharged into the environment on an accidental basis as in the Bhopal, Seveso, Sandoz cases, the effects and the occurrence of an accident are unknown. Consequently, environmental accidents cannot be regulated ex-ante because an accident cannot be clearly defined. Accident liability brings out the advantage of liability law.

Vintage damages. A special problem arising from the liability principle relates to "old" or historic damages. First, it may no longer be possible to trace the polluters, for instance of the large number of dumps closed at the end of the seventies in the United States and the Federal Republic of Germany. Second, it may no longer be possible to bring polluters to justice because they ceased to exist, for instance those who exploited lead mines back in the Middle Ages. Vintage liability is not possible.

Other modes of financing old damages such as the "super fund" in the USA do not constitute an application of the liability principle. They are rather a means of establishing as broad a base of financing as possible, and are therefore not excessive for the individual company. A feature of such proposals is that they provide no incentive to avoid pollution.

8. Summary

Liability is a fascinating environmental policy instrument because it allows a decentralized way of internalizing externalities. Moreover, liability rules can be applied when other policy instruments cannot be clearly defined due to an uncertain state of the world. In a semi-Coasean context with clearly defined property rights, stochastic variables are transformed into deterministic values. In reality, however, transaction costs play an important role. Legal costs, identifying the polluter, asymmetric information on abatement costs between the policy maker as principal and the polluter as agent are cases in point. Besides transaction costs, the role of liability must be evaluated in the context of other environmental policy instruments with respect to two questions: How do firms react to liability? And: Who carries the social risk of environmental

degradation when different policy instruments are being used. A casuistics of the problem of persistent pollutants is developed where activity liability, product liability, accident liability and vintage liability are distinguished.

- 1 This is in line with the actual German environmental policy which attempts to use liability laws as a vehicle to introduce more emission - saving incentives into environmental policy.
- 2 See Govers, Hegemann and Aiking, this volume
- 3 Economists are used to marginal analysis in the neighbourhood of an equilibrium. If an independent variable is changed a little bit, how is the dependent variable on the system as a whole affected? The natural scientist is acquainted with a phenomenon that a marginal variation may lead to a change in quality, for instance altering water into vapor.
- 4 Then DD is the mean of environmental damage for different levels of emissions.
- 5 Note that S^F here only affects the probability α . It can also be assumed that S^F reduces D as well.
- 6 If the common burden principle is applied, it may nevertheless happen that the government passes on the environmental risks to the general public if it remains inactive. Subsidies evoke similar arguments to the common burden principle. Subsidies also mean that the costs are not allocated to the polluter; instead, they almost always promote the commodity produced by pollution-intensive methods. The state carries the risks of environmental pollution, since decentralised units expect extra subsidies once new risks take effect. Moreover, experience has shown that subsidies are difficult to eliminate. The more environmental policy is dominated by the common burden principle and subsidies, the weaker the incentive to avoid pollution, the greater the environmental risks to society and the lower the demand for private insurance cover.
- 7 The political discussion on fundamental principles of environmental policy will occasionally create the impression of a contradiction between the polluter principle and that of prevention. If the principle of preventive policy is interpreted with regard to the target environmental quality, this constitutes applying the "polluter pays" principle for future environmental pollution. Both principles are consistent with each other.
- 8 I do not see a practical way to introduce liability into the licencing procedure when transaction costs are taken into account.
- 9 However, it must be granted that the spatial dimension of the bubble - controlled trading - may be negatively affected by risks, unless we solve the issue whether the buyer or the seller of the licence is liable. Transferable emission licences for the bubble concept may have a basic advantage in incorporating liability aspects: They may be instrumental in getting the polluters used to think in terms of environmental scarcity and in terms of prices of transferable emission licences. If so, the government may be able to transmit new scarcities in the case of unforeseen environmental effects quickly to the polluter.

References

- Adams, M. (1986), Zur Aufgabe des Haftungsrechts im Umweltschutz, Zeitschrift für Zivilprozeß, 99, 129-165.
- Adar, Z. and J.M. Griffin (1976), Uncertainty and the Choice of Pollution Control Instruments, Journal of Environmental Economics and Management, 3, 178-188.
- Beavis, B. and I. Dobbs (1987), Firm Behaviour under Regulatory Control of Stochastic Environmental Wastes by Probabilistic Constraints, Journal of Environmental Economics and Management, 14, 122-127.
- Brown, J. P. (1973), Toward an Economic Theory of Liability, Journal of Legal Studies, 2, 323-350.
- Coase, R. (1960), The Problem of Social Cost, Journal of Law and Economics, 3, 1-44.
- Cohen, M.A. (1987), Optimal Enforcement Strategy to Prevent Oil Spills: An Application of a Principal-Agent Model with Moral Hazard, Journal of Law and Economics, 30, 23-51.
- Green, J. (1976), On the Optimal Structure of Liability Laws, Bell Journal of Economics, 7, 553-574.
- Fishback, P.V. (1987), Liability Rules and Accident Prevention in the Workplace: Empirical Evidence from the Early Twentieth Century, Journal of Legal Studies, 16, 305-328.
- Klöpfer, M. (1988), Umweltrisiken und Haftungsregeln - Rechtspolitische Aspekte, Zeitschrift für Umweltpolitik und Umweltrecht, 11, 243-258.
- Kwerel, E. (1977), To Tell the Truth: Imperfect Information and Optimal Pollution Control, Review of Economic Studies, 44, 595-602.
- Knight, F.H. (1921), Risk, Uncertainty and Profit. Boston.
- Misiolek, W.R. (1988), Pollution Control through Price Incentives: The Role of Rent Seeking Costs in Monopoly Markets, Journal of Environmental Economics and Management, 15, 1-8.

- OECD (1986), Responsibility, Liability and Insurance in the Context of Hazardous Waste Management.
- O'Riordan, T. (1985), Anticipatory Environmental Policy. Impediments and Opportunities, Internationales Institut für Umwelt und Gesellschaft (International Institute for Environment and Society), Berlin, IIUG dp 85-1.
- Rehbinder, E. (1985), Reformmöglichkeiten hinsichtlich des Instrumentariums zum Schutz der Umwelt: das Vorsorgeprinzip (Scope for Reforming Methods of Environmental Protection: the Principle of Preventive Action), IV Future Congress of the State Government of Baden-Württemberg, December 17-18.
- Segerson, K. (1988), Uncertainty and Incentives for Nonpoint Pollution Control, Journal of Environmental Economics and Management, 15, 87-98.
- Shavell, S. (1984), A Model of the Optimal Use of Liability and Safety Regulation, Rand Journal of Economics, 15, 271-280.
- Shavell, S. (1984a), Liability for Harm versus Regulation of Safety, Journal of Legal Studies, 13, 357-374.
- Siebert, H. (1973), Das produzierte Chaos. Ökonomie und Umwelt (Manufactured chaos. Economics and Environment), Kohlhammer, Stuttgart.
- Siebert, H. (1978), Ökonomische Theorie der Umwelt (Economic Theory of the Environment), J.C.B. Mohr (Paul Siebeck), Tübingen.
- Siebert, H. (1985a), TA Luft '85: Eine verfeinerte Politik des individuellen Schornsteins (1985 Clean Air Order: a Refined Policy Based on the Individual Stack, Wirtschaftsdienst Vol. IX, 452-455.
- Siebert, H. (1985b), Umwelt als knappes Gut (The Environment as a Scarce Good), 4th Future Congress of the State Government of Baden-Württemberg, December 17-18.
- Siebert, H. (1987a), Economics of the Environment. Theory and Policy, 2nd edition, Springer, Heidelberg.

- Siebert, H. (1987b), Nutzung der Natur und zukünftige Generationen, in: R. Henn (Hrsg.), Technologie, Wachstum und Beschäftigung, Festschrift für Lothar Späth, Springer-Verlag, Heidelberg 1987, 950-961.
- Siebert, H. (1989), The Completion of the Common Market. Chances and Limits of Decentralizing Environmental Policy, Paper to be presented at the Task Force Meeting on "The Environment in the Context of the Internal Market 1992", held by the Commission of the European Communities, Brussels, March 1989.
- Simonis, U.E. (1984), Preventive Environmental Policy. Concept and Data Requirements, Internationales Institut für Umwelt und Gesellschaft (International Institute for Environment and Society), discussion paper 84-12.
- Sinn, H.-W. (1983), Economic Decisions under Uncertainty, Amsterdam, North Holland.
- Sinn, H.-W. (1986), Risiko als Produktionsfaktor, in: Jahrbücher für Nationalökonomie und Statistik 201, p.557-571.
- Töpfer, K. (1988), Die politische Verantwortung der Umweltpolitik für das Umwelthaftungsrecht, Zeitschrift für Umweltpolitik und Umweltrecht, 11, 287-302.
- Vogel, K.R. (1987), The Coase Theorem and California Animal Trespass Law. Journal of Legal Studies, 16, 149-187.