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PRIVATE AND COMMON PROPERTY RIGHTS

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Abstract

The relative advantages of private property and common property for the efficiency, equity, and sustainability of natural resource use patterns have been debated in legal and economic literatures for several centuries. The debate has been clouded by a troika of confusions that relate to the difference between (1) common property and open-access regimes, (2) common-pool resources and common property regimes, and (3) a resource system and the flow of resource units. A property right is an enforceable authority to undertake particular actions in specific domains. The rights of access, withdrawal, management, exclusion and alienation can be separately assigned to different individuals as well as being viewed as a cumulative scale moving from the minimal right of access through possessing full ownership rights. All of these rights may be held by single individuals or by collectivities. Some attributes of common-pool resources are conducive to the use of communal proprietorship or ownership and others are conducive to individual rights to withdrawal, management, exclusion and alienation. Many of the lessons learned from the operation of communal property regimes related to natural resource systems are theoretically relevant to the understanding of a wide diversity of property regimes that are extensively used in modern societies.
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1. Introduction

The issue of the relationship between private property and common property has engaged both legal and economic scholars in a long series of controversies over the meaning, the sequence of development, and the superiority of private vs. common property. The issues debated relate to the

efficiency, equity and sustainability of private property as contrasted to common property. The scholarship in both professions has been characterized by formulations that are adopted by each generation of scholars without much effort to examine their foundations or to test them by empirical research. Both have their doctrinal aspects. And, the dominant view in both disciplines has been that private property is clearly superior to common property. Many scholars think of contemporary examples of common property as remnants of the past, likely to disappear as we enter the twenty-first century (see Atran, 1986, 1993). Recent research, however, has challenged the presumption that private property is necessarily superior to common property.

2. The Legal Debate over Private vs. Common Property

Prior to the publication in 1861 of *Ancient Law* by the distinguished English jurist, Henry Sumner Maine, the accepted view among Western jurists was that the origin of the concept of property in ancient times was the occupation of land by a single proprietor and his family (Grossi, 1981). Further, the superiority of individual property holdings was so well accepted in the legal literature of the early nineteenth century that the possibility of other forms of property existing on the European continent threatened juridical views about the origins of social order. Maine drew not only on his own extensive research in India but also on the work of Georg Ludwig von Maurer (1854, 1856) on the primitive Germanic village communities, the Mark, and of the pioneering work of William Blackstone (1766). Maine concluded that: 'it is more than likely that joint-ownership, and not separate ownership, is the really archaic institution, and that the forms of property that will afford us instruction will be those that are associated with the rights of families and of groups of kindred' (Maine, [1861] 1963, p. 252). This set off a flurry of publications challenging and supporting his conclusion (see extensive bibliographic citations in Grossi, 1981). The great debate had much more than academic importance, as major political struggles continued throughout the nineteenth century over the status of the many remaining forms of common property on the European continent. A legal and political belief system that saw the origin of property itself in the efforts of individual proprietors to occupy land gave the landed proprietor a special role in society. These beliefs helped to justify the passage of legislation to eliminate collective landholding rights and to authorize enclosures and the takeover of communal properties by individual proprietors.

The meaning of private property in comparison to common property remains a contested issue in modern legal scholarship. Ellickson, Rose and

Ackerman (1995), for example, start their recent textbook on property law with a first chapter devoted to 'The Debate over Private Property'. The second chapter addresses 'The Problem of the Commons'. In the latter chapter, they include parts of the famous article by Hardin (1968) on 'The Tragedy of the Commons', but then ask students the following questions: 'Private property is often said to avert the tragedy of the commons. But does it? Who enforces property limitations? Does another kind of "commons" problem lurk in the organization and maintenance of a property regime?'(Ellickson, Rose and Ackerman, 1995, p. 141). In an earlier volume, Rose (1994, p. 37) points to the 'kicker' in a sharp distinction between private and common property when she stresses that a private-property *regime* as a system 'has the same structure as a common property' (see also Epstein, 1979, 1985, and Dukeminier and Krier, 1993).

3. The Economic Debate over Private vs. Common Property

Economists tend to view common property institutions as having a longer history than private-property institutions and to explain the growth of modern, Western societies in part as the result of changing from common property to private property (North and Thomas, 1976; North, Anderson, and Hill, 1983). Private property is considered by most economists to be an essential ingredient in economic development due to the incentives associated with diverse kinds of property relationships (see, for example, Welch, 1983). A farmer who owns his own labor, land and other factor inputs, for example, is likely to see a direct relationship between investments and the level of benefit achieved over the long term. A farmer who belongs to an agricultural production cooperative, on the other hand, may see only a loose connection between personal contributions and benefits. The more individuals in a society whose work is only loosely connected to their benefits, the more pervasive an attitude of free riding can become. If everyone tends to free ride on the work of others, overall economic productivity will be low.

Private-property rights, however, cannot simply emerge spontaneously from a common property system. Private-property rights depend upon the existence and enforcement of a set of rules that define who has a right to undertake which activities on their own initiative and how the returns from that activity will be allocated (V. Ostrom, 1989). In other words, rules and rulers are required to establish, monitor and enforce a property system. While some rules generate incentives that greatly increase the welfare of most participants in an economy, there are always individuals who resist changes because of benefits they receive from a prior system or propose

changes that particularly benefit themselves. Rulers may also receive substantial returns from making rules that benefit some to the detriment of others. Thus, rent-seeking behavior is expected on the part of both entrepreneurs and rulers.

Common property regimes are, therefore, presumed by many economists to be inefficient. There are three sources of inefficiency. One is rent dissipation, because no one owns the products of a resource until they are captured, and everyone engages in an unproductive race to capture these products before others do (Knight, 1924; Gordon, 1954; Scott, 1955; Schaefer, 1957; Cheung, 1970; C. Clark, 1976, 1980; Dasgupta and Heal, 1979). The second is the high transaction and enforcement costs expected if communal owners were to try to devise rules to reduce the externalities of their mutual overuse (Demsetz, 1967; Coase, 1960). The third is low productivity, because no one has an incentive to work hard in order to increase their private returns (North, 1990; Yang, 1987). Common property regimes are presumably retained by rulers who do not understand the enhancement in overall economic welfare that will result from a change to private property or who are supported by those who benefit from these 'archaic' regimes. A common policy prescription is articulated by R. Smith (1981, p. 467) when he states that 'the only way to avoid the tragedy of the commons in natural resources and wildlife is to end the common property system by creating a system of private property rights'.

4. Confusions that Generate Misunderstanding

The debate about the relative merits of private and common property has been clouded by a troika of confusions that hinder scholarly communication. Different meanings are assigned to terms without clarifying how multiple aspects relate to one another. The source of confusion relates to the differences between (1) common property and open-access regimes, (2) common-pool resources and common property regimes, and (3) a resource system and the flow of resource units. All three sources of confusion reduce clarity in assigning meaning to terms and retard theoretical and empirical progress.

The Confusion between Common Property and Open-Access Regimes

In a now classic article, Ciriacy-Wantrup and Bishop (1975) clearly demarked the difference between property regimes that are *open access*, where no one has the legal right to exclude anyone from using a resource, from *common property*, where the members of a clearly demarked group have a legal right to exclude nonmembers of that group from using a

resource (see also Bromley, 1991a, 1992b). Open-access regimes (*res nullius*) - including the classic cases of the open seas and the atmosphere - have long been considered in legal doctrine as involving no limits on who is authorized to use a resource. If anyone can use a resource, no one has an incentive to conserve their use or to invest in improvements. If such a resource generates highly valued products, then one can expect that the lack of rules regarding authorized use will lead to misuse and overconsumption. Some local grazing areas, inshore fisheries and forests are effectively open-access resources, but many fewer than presumed in the literature.

Some open-access regimes lack effective rules defining property rights by default (Dales, 1968). Either the resources affected by these open-access regimes are not contained within a nation-state or no entity has successfully laid claim to legitimate ownership. Other open-access regimes are the consequence of conscious public policies to guarantee the access of all citizens to the use of a resource within a political jurisdiction. The concept of *jus publicum* applies to their formal status, but effectively these resources are open access. The state governments of Oregon and Washington intervened in the early twentieth century to prevent local salmon fishermen from devising rules that would have limited entry and established harvesting limits (Higgs, 1982, 1996). Fishing unions along the US coastal areas tried to organize inshore fisheries so as to limit entry and establish harvesting limits during the 1950s. Even though their efforts could not have had a serious impact on prices due to the presence of an active international market for fish, the fishing unions were prosecuted by the US Department of Justice and found in violation of the Sherman Antitrust Act (Johnson and Libecap, 1982). Thus, US inshore fisheries have effectively been open-access resources during much of the twentieth century as a result of governmental action to prevent local fishing groups from establishing forms of common property regimes within those political jurisdictions. In more recent times, however, both the national and state governments have reversed their prior stands and have actively sought ways of creating forms of co-management in inshore fisheries (see Pinkerton 1992, 1994; J. Wilson, 1995).

A third type of open-access regime results from the ineffective exclusion of nonowners by the entity assigned formal rights of ownership. In many developing countries, the earlier confusion between open-access and common property regimes paradoxically led to an increase in the number and extent of local resources that are effectively open access. Common property regimes controlling access and harvesting from local streams, forests, grazing areas, and inshore fisheries had evolved over long periods of time in all parts of the world, but were rarely given formal status in the legal codes of newly independent countries.

As concern for the protection of natural resources mounted during the 1960s, many developing countries nationalized all land and water resources that had not yet been recorded as private property. The institutional arrangements that local users had devised to limit entry and use lost their legal standing, but the national governments lacked monetary resources and personnel to monitor the use of these resources effectively. Thus, resources that had been under a *de facto* common property regime enforced by local users were converted to a *de jure* government-property regime, but reverted to a *de facto* open-access regime. When resources that were previously controlled by local participants have been nationalized, state control has usually proved to be less effective and efficient than control by those directly affected, if not disastrous in its consequences (Curtis, 1991; Hilton, 1992; Panayotou and Ashton, 1992; Ascher, 1995). The harmful effects of nationalizing forests that had earlier been governed by local user-groups have been well documented for Thailand (Feeny, 1988), Niger (Thomson, 1977; Thomson, Feeny and Oakerson, 1992), Nepal (Arnold and Campbell, 1986; Messerschmidt, 1986), and India (Gadgil and Iyer, 1989; Jodha, 1990, 1996). Similar results have occurred in regard to inshore fisheries taken over by state or national agencies from local control by the inshore fishermen themselves (Cordell and McKean, 1992; Cruz, 1986; Dasgupta, 1982; Higgs, 1996; Panayotou, 1982; Pinkerton, 1989).

The Confusion between a Resource System and a Property Regime

The problems resulting from confusing open-access regimes with common property regimes are particularly difficult to overcome due to a second terminological problem. The term 'common property resource' is frequently used to describe a type of economic good that is better referred to as a 'common-pool resource'. All common-pool resources share two attributes of importance for economic activities: (1) it is costly to exclude individuals from using the good either through physical barriers or legal instruments and (2) the benefits consumed by one individual subtract from the benefits available to others (Ostrom and Ostrom, 1977b; E. Ostrom, Gardner, and Walker, 1994). Recognizing a class of goods that shares these two attributes enables scholars to identify the core theoretical problems facing individuals whenever more than one individual or group utilizes such resources for an extended period of time. Using 'property' in the term used to refer to a type of good, reinforces the impression that goods sharing these attributes tend everywhere to share the same property regime.

Common-pool resources share with public goods the difficulty of developing physical or institutional means of excluding beneficiaries. Unless means are devised to keep nonauthorized users from benefiting, the strong temptation to free ride on the efforts of others will lead to a suboptimal

investment in improving the resource, monitoring use, and sanctioning rule-breaking behavior. Second, the products or resource units from common-pool resources share with private goods the attribute that one person's consumption subtracts from the quantity available to others. Thus, common-pool resources are subject to problems of congestion, overuse and potential destruction unless harvesting or use limits are devised and enforced. In addition to sharing these two attributes, particular common-pool resources differ on many other attributes that affect their economic usefulness including their size, shape and productivity and the value, timing and regularity of the resource units produced.

Common-pool resources may be owned by national, regional, or local governments; by communal groups; by private individuals or corporations; or used as open access resources by whomever can gain access. Each of the broad types of property regimes has different sets of advantages and disadvantages, but at times may rely upon similar operational rules regarding access and use of a resource (Feeny et al., 1990). Examples exist of both successful and unsuccessful efforts to govern and manage common-pool resources by governments, communal groups, cooperatives, voluntary associations, and private individuals or firms (Bromley et al., 1992; K. Singh, 1994; K. Singh and Ballabh, 1996). Thus, as discussed below, there is no automatic association of common-pool resources with common property regimes - *or, with any other particular type of property regime.* Further, common property arrangements are essentially share contracts (Lueck, 1994; Eggertsson, 1990, 1992, 1993a, 1993b) and, as such, face similar problems of potential opportunistic behavior and moral hazard problems.

The Confusion between the Resource and the Flow of Resource Units

Common-pool resources are composed of resource systems and a flow of resource units or benefits from these systems (Blomquist and Ostrom, 1985). The resource system (or alternatively, the stock or the facility) is what generates a flow of resource units or benefits over time (Lueck, 1995). Examples of typical common-pool resource systems include lakes, rivers, irrigation systems, groundwater basins, forests, fishery stocks and grazing areas. Common-pool resources may also be facilities that are constructed for joint use, such as mainframe computers and the Internet. The resource units or benefits from a common-pool resource include water, timber, medicinal plants, fish, fodder, central processing units, and connection time. Devising property regimes that effectively allow sustainable use of a common-pool resource requires rules that limit access to the resource system and other rules that limit the amount, timing, and technology used to withdraw diverse resource units from the resource system.

5. Property as Bundles of Rights

A property right is an enforceable authority to undertake particular actions in a specific domain (Commons, 1968). Property rights define actions that individuals can take in relation to other individuals regarding some 'thing'. If one individual has a right, someone else has a commensurate duty to observe that right. Schlager and Ostrom (1992) identify five property rights that are most relevant for the use of common-pool resources, including access, withdrawal, management, exclusion, and alienation. These are defined as:

Access: The right to enter a defined physical area and enjoy nonsubtractive benefits (for example, hike, canoe, sit in the sun).
Withdrawal: The right to obtain resource units or products of a resource system (for example, catch fish, divert water).
Management: The right to regulate internal use patterns and transform the resource by making improvements.
Exclusion: The right to determine who will have access rights and withdrawal rights, and how those rights may be transferred.
Alienation: The right to sell or lease management and exclusion rights (Schlager and Ostrom, 1992).

In much of the economics literature, private property is defined as equivalent to alienation. Property-rights systems that do not contain the right of alienation are considered to be ill-defined. Further, they are presumed to lead to inefficiency since property-rights holders cannot trade their interest in an improved resource system for other resources, nor can someone who has a more efficient use of a resource system purchase that system in whole or in part (Demsetz, 1967). Consequently, it is assumed that property-rights systems that include the right to alienation will be transferred to their highest valued use. Larson and Bromley (1990) challenge this commonly held view and show that much more information must be known about the specific values of a large number of parameters before judgements can be made concerning the efficiency of a particular type of property right.

Instead of focusing on one right, it is more useful to define five classes of property-rights holders as shown in Table 1. In this view, individuals or collectivities may hold well-defined property rights that include or do not include all five of the rights defined above. This approach separates the question of whether a particular right is well-defined from the question of the effect of having a particular set of rights. 'Authorized entrants' include most recreational users of national parks who purchase an operational right to enter and enjoy the natural beauty of the park, but do not have a right to harvest forest products. Those who have both entry and withdrawal use-right

units are ‘authorized users’. The presence or absence of constraints upon the timing, technology used, purpose of use and quantity of resource units harvested are determined by operational rules devised by those holding the collective-choice rights (or authority) of management and exclusion. The operational rights of entry and use may be finely divided into quite specific ‘tenure niches’ (Bruce, 1995) that vary by season, by use, by technology, and by space. Tenure niches may overlap when one set of users owns the right to harvest fruits from trees, another set of users owns the right to the timber in these trees, and the trees may be located on land owned by still others (Bruce, Fortmann and Nhira, 1993). Operational rules may allow authorized users to transfer access and withdrawal rights either temporarily through a rental agreement, or permanently when these rights are assigned or sold to others (see Adasiak, 1979, for a description of the rights of authorized users of the Alaskan salmon and herring fisheries).

Table 1
Bundles of Rights Associated with Positions

	Owner	Proprietor	Claimant	Authorized User	Auth. Entrant
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Managment	X	X	X	X	
Exclusion	X	X			
Alienation	X				

Source: E. Ostrom and Schlager (1996, p. 133).

‘Claimants’ possess the operational rights of access and withdrawal plus a collective-choice right of managing a resource that includes decisions concerning the construction and maintenance of facilities and the authority to devise limits on withdrawal rights. The net fishers of Jambudwip, India, for example, annually regulate the positioning of nets so as to avoid interference, but do not have the right to determine who may fish along the coast (Raychaudhuri, 1980). Fishing territories are a frequent form of property for indigenous, inshore fishers (Durrenberger and Palsson, 1987).

Farmers on large-scale government irrigation systems frequently devise rotation schemes for allocating water on a branch canal (Benjamin et al., 1994).

'Proprietors' hold the same rights as claimants with the addition of the right to determine who may access and harvest from a resource. Most of the property systems that are called 'common property' regimes involve participants who are proprietors and have four of the above rights, but do not possess the right to sell their management and exclusion rights even though they most frequently have the right to bequeath it to members of their family and to earn income from the resource (see Berkes, 1989; Bromley et al., 1992; K. Martin, 1979; McCay and Acheson, 1987).

Empirical studies have found that some proprietors have sufficient rights to make decisions that promote long-term investment and harvesting from a resource. Place and Hazell (1993) conducted surveys in Ghana, Kenya, and Rwanda to ascertain if indigenous land-right systems were a constraint on agricultural productivity. They found that having the rights of a proprietor as contrasted to an owner in these settings did not affect investment decisions and productivity. Other studies conducted in Africa (Migot-Adholla et al., 1991; Bruce and Migot-Adholla, 1994) also found little difference in productivity, investment levels, or access to credit. In densely settled regions, however, proprietorship over agricultural land may not be sufficient (Feder et al. 1988; Feder and Feeny, 1991; Anderson and Lueck, 1992). As land is densely settled, the absence of a title reduces the options for farmers to sell their land and reap a return on this asset. Further, without a title, farmers lack collateral to obtain credit to invest more intensively in the productive potential of their land (see Alston, Libecap and Schneider, 1996). Thus, a key finding from an overview of many studies is that no type of property-rights regime works equivalently in all types of settings. For private-property systems in land to make a difference in productivity gains, one probably needs (1) a somewhat dense population so competition for use is present and (2) the existence of effective markets related to credit, inputs, and the sale of commodities (see further discussion in Section 7). In a series of studies of inshore fisheries, self-organized irrigation systems, forest user groups and groundwater institutions, proprietors tended to develop strict boundary rules to exclude noncontributors; established authority rules to allocate withdrawal rights; devised methods for monitoring conformance; and used graduated sanctions against those who do not conform to these rules (Agrawal, 1994; Blomquist, 1992; Schlager, 1994; Tang, 1994; Lam, 1998).

'Owners' possess the right of alienation - the right to transfer a good in any way the owner wishes that does not harm the physical attributes or uses of other owners - in addition to the bundle of rights held by a proprietor. An individual, a private corporation, a government, or a communal group may possess full ownership rights to any kind of good including a common-pool

resource (Montias, 1976; Dahl and Lindblom, 1963). The rights of owners, however, are never absolute. Even private owners have responsibilities not to generate particular kinds of harms for others (Demsetz, 1967).

What should be obvious by now is that the world of property rights is far more complex than simply government, private and common property. These terms better reflect the status and organization of the holder of a particular right than the bundle of property rights held. All of the above rights can be held by single individuals or by collectivities. Some communal fishing systems grant their members all five of the above rights, including the right of alienation (Miller, 1989). Members in these communal fishing systems have full ownership rights. Similarly, farmer-managed irrigation systems in Nepal, the Phillippines and Spain have established transferable shares to the systems. Access, withdrawal, voting and maintenance responsibilities are allocated by the amount of shares owned (Maass and Anderson, 1986; E. Martin, 1986; Martin and Yoder, 1983a, 1983b, 1983c; Siy, 1982). On the other hand, some proposals to 'privatize' inshore fisheries through the devise of an Individual Transferable Quota (ITQ), allocate transferable use rights to authorized fishers but do not allocate rights related to the management of the fisheries, the determination of who is a participant, nor the transfer of management and exclusion rights. Thus, proposals to establish ITQ systems, which are frequently referred to as forms of 'privatization', do not involve full ownership.

The next two sections are devoted to a discussion of the attributes of common-pool resources that are conducive to communal proprietorship or communal ownership as contrasted to individual ownership. Groups of individuals are considered to share communal property rights when they have formed an organization that exercises at least the collective-choice rights of management and exclusion in relationship to some defined resource system and the resource units produced by that system. In other words, all communal groups have established some means of governing themselves in relationship to a resource (E. Ostrom, 1990). Where communal groups are full owners, members of the group have the further right to sell their access, use, exclusion and management rights to others, subject in many systems to the approval of the other members of the group. Some communal proprietorships are formally organized and recognized by legal authorities as having a corporate existence that entails the right to sue and be sued, the right to hold financial assets in a common bank account, and to make decisions that are binding on members. Other communal proprietorships are less formally organized and may exercise *de facto* property rights that may or may not be supported by legal authorities if challenged by nonmembers. Obviously, such groups hold less well-defined bundles of property rights than those who are secure in their *de jure* rights even though the latter may

not hold the complete set of property rights defined as full ownership. In other words, well-defined and secure property rights may not involve the right to alienation.

6. Attributes of Common-Pool Resources Conducive to the Use of Communal Proprietorship or Ownership

Even though all common-pool resources share the difficulty of devising methods to achieve exclusion and the subtractability of resource units, the variability of common-pool resources is immense in regard to other attributes that affect the incentives of resource users and the likelihood of achieving outcomes that approach optimality. Further, whether it is difficult or costly to develop physical or institutional means to exclude nonbeneficiaries depends both on the availability and cost of technical and institutional solutions to the problem of exclusion and the relationship of the cost of these solutions to the expected benefits of achieving exclusion from a particular resource.

Let us start initially with a discussion of land as a resource system. Where population density is extremely low, land is abundant, and land generates a rich diversity of plant and animal products without much husbandry, the expected costs of establishing and defending boundaries to a parcel of land of any size may be greater than the expected benefits of enclosure (Demsetz, 1967; Feeny, 1993). Settlers moving into a new terrain characterized by high risk due to danger from others, from a harsh environment, or from lack of appropriate knowledge, may decide to develop one large, common parcel prior to any divisions into smaller parcels (Ellickson, 1993). Once land becomes scarce, conflict over who has the rights to invest in improvements and reap the results of their efforts can lead individuals to want to enclose land through fencing or institutional means to protect their investments. There are tradeoffs in costs to be considered, however. The more land included within one enclosure, the lower the costs of defending all the boundaries, but the higher the costs of regulating the use of the enclosed parcel.

The decision to enclose need not be taken in one step from an open-access terrain to a series of private plots owned exclusively by single families (Field, 1984, 1985, 1989; Ellickson, 1993). The benefits of enclosing land depend on the scale of productive activity involved. For some agricultural activities, as discussed below, there may be considerable benefits associated with smaller parcels fully owned by a family enterprise. For other activities, the benefits may not be substantial. Moving all the way to private plots is an efficient move when the expected marginal returns from enclosing numerous plots exceed the expected marginal costs of defending a

much more extended system of boundaries and the reduced transaction costs of making decisions about use patterns (Nugent and Sanchez, 1995).

In a classic study of the diversity of property-rights systems used for many centuries by Swiss peasants, Netting (1976, 1981) observed that the same individuals fully divided their agricultural land into separate family-owned parcels, but that grazing lands located on the Alpine hillsides were organized into communal property systems. In these mountain valleys, the *same* individuals used different property-rights systems side-by-side for multiple centuries. Each local community had considerable autonomy to change local rules, so there was no problem of someone else imposing an inefficient set of rules on them. Netting argued that attributes of the resource affected which property-rights systems were most likely for diverse purposes. Netting identified five attributes that he considered to be most conducive to the development of communal property rights:

1. low value of production per unit of area;
2. high variance in the availability of resource units on any one parcel;
3. low returns from intensification of investment;
4. substantial economies of scale by utilizing a large area; and
5. substantial economies of scale in building infrastructures to utilize the large area.

Steep land where rainfall is scattered may not be suitable for most agricultural purposes, but can be excellent land for pasture and forests if aggregated into sufficiently large parcels. By developing communal property rights to large parcels of such land, those who are members of the community are able to share environmental risks due to the unpredictability of rain-induced growth of grasses within any smaller region. Further, herding and processing of milk products is subject to substantial economies of scale. If individual families develop means to share these reduced costs, all can save substantially. Building the appropriate roads, retaining walls and processing facilities may also be done more economically if these efforts are shared.

While the Swiss peasants were able to devote these harsh lands to productive activities, they had to invest time and effort in the development of rules that would reduce the incentives to overgraze and would ensure that investments in shared infrastructure were maintained over time. In many Swiss villages, rights to common pasturage were distributed according to the number of cows that could be carried over the winter using hay supplies produced on the owners' private parcels. In all cases, the village determined who would be allowed to use, the specific access and withdrawal rights to be used, how investment and maintenance costs were to be shared, and how the annual returns from common processing activities were to be shared. All of

these systems included at least village proprietorship rights, but some Swiss villages developed full ownership rights by incorporating and authorizing the buying and selling of shares (usually with the approval of the village). Netting's findings are strongly supported by studies of mountain villages in Japan, where thousands of rural villages have held communal property rights to extensive forests and grazing areas located in the steep mountainous regions located above their private agricultural plots (McKean, 1982, 1992a, 1992b). Similar systems have existed in Norway for centuries (Örebech, 1993; Sandberg 1993).

The importance of sharing risk is stressed in other theoretical and empirical studies of communal proprietorships (Antilla and Torp, 1996; Gupta, 1986, Nugent and Sanchez, 1993). Unpredictability and risk are increased in systems where resource units are mobile and where storage facilities, such as dams, do not exist (Schlager, Blomquist and Tang, 1994). Institutional facilities for sharing risk, such as formal insurance systems or institutionalized mechanisms for reciprocal obligations in times of plenty, also affect the kinds of property-rights systems that individuals can devise. When no physical or institutional mechanisms exist for sharing risk, communal property arrangements may enable individuals to adopt productive activities not feasible under individual property rights. A recent study has demonstrated that the variance in the productivity of land over space - due largely to the variance in rainfall from year to year - is strongly associated with the size of communally held parcels allocated to grazing in the Sudan (Nugent and Sanchez, 1995). Ellickson (1993) compares the types of environmental and personal security risks faced by new settlers in New England, in Bermuda, and in Utah to explain the variance in the speed of converting jointly held land to individually held land in each of these settlements.

A consistent finding across many studies of communal property-rights systems is that these systems do not exist in isolation and are usually used in conjunction with individual ownership. In most irrigation systems that are built and managed by the farmers themselves, for example, each farmer owns his or her own plot(s) while participating as a joint proprietor or owner in a communally organized irrigation system (Coward, 1980; Sengupta, 1991, 1993; Tang, 1992; Vincent, 1995; Wade, 1992). Water is allocated to individual participants using a variety of individually tailored rules, but those irrigation systems that have survived for long periods of time tend to allocate water and responsibilities for joint costs using a similar metric - frequently the amount of land owned by a farmer (E. Ostrom, 1990, 1992). In other words, benefits are roughly proportional to the costs of investing and maintaining the system itself.

Further, formally recognized communal systems are usually nested into a series of governance units that complement the organizational skills and

knowledge of those involved in making collective-choice decisions in smaller units (O. Johnson, 1972). Since the Middle Ages, most of the Alpine systems in both Switzerland and Italy have been nested in a series of self-governing communities that respectively governed villages, valleys, and federations of valleys (Merlo, 1989). In modern times, cantonal authorities in Switzerland have assumed an added responsibility to make periodic, careful monitoring visits to each alp on a rotating basis and to provide professional assessments and recommendations to local villages, thereby greatly enhancing the quality of knowledge and information about the sustainability of these resources (Glaser, 1987).

Contrary to the expectation that communal property systems lacking the right to alienate ownership shares are markedly less efficient than property-rights systems involving full ownership, substantial evidence exists that many communal proprietorships effectively solve a wide diversity of local problems with relatively low transaction costs (Gaffney, 1992; Hanna and Munasinghe, 1995a, 1995c; Kaul, 1996; Sandberg, 1993, 1996a, 1996b; Wilson, 1995). Obtaining valid and reliable measures of outputs and costs for a large number of property-rights systems covering similar activities in matched environmental settings is extremely difficult. In regard to irrigation, a series of careful studies of the performance of communal proprietorship systems as contrasted to government-owned and managed systems, clearly demonstrates the higher productivity of the communal systems controlling for relevant variables (Tang, 1992; Benjamin et al., 1994; E. Ostrom, 1996; Lam, 1998). Schlager's (1990) studies of inshore fisheries demonstrate that fishers who have clearly defined proprietorship are able to solve difficult assignment problems and assign the use of space and technology so as to increase both the efficiency and equity of their systems. James Wilson's (1995) studies also demonstrate that communal proprietorship systems are more efficient than frequently thought.

Performance of communal property-rights systems varies substantially, however, as do the performance of all property-rights systems. Some communal systems fail or limp along at the margin of effectiveness just as private firms fail or barely hang on to profitability over long periods of time. In addition to the environmental variables discussed above that are conducive in the first place to the use of communal proprietorship or ownership, the following variables related to the attributes of participants are conducive to their selection of norms, rules, and property rights that enhance the performance of communal property-rights systems (E. Ostrom, 1993):

1. Accurate information about the condition of the resource and expected flow of benefits and costs is available at low cost to the participants (Blomquist, 1992; Gilles and Jamtgaard, 1981).

2. Participants share a common understanding about the potential benefits and risks associated with the continuance of the status quo as contrasted with changes in norms and rules that they could feasibly adopt (E. Ostrom, 1990; Sethi and Somanathan, 1996).
3. Participants share generalized norms of reciprocity and trust that can be used as initial social capital (Cordell and McKean, 1992).
4. The group using the resource is relatively stable (Seabright, 1993).
5. Participants plan to live and work in the same area for a long time (and in some cases, expect their offspring to live there as well) and, thus, do not heavily discount the future (Grima and Berkes, 1989).
6. Participants use collective-choice rules that fall between the extremes of unanimity or control by a few (or even bare majority) and, thus, avoid high transaction or high deprivation costs (E. Ostrom, 1990).
7. Participants can develop relatively accurate and low-cost monitoring and sanctioning arrangements (Berkes, 1992).

Many of these variables are, in turn, affected by the type of larger regime in which users are embedded. If the larger regime recognizes the legitimacy of communal systems, and is facilitative of local self-organization by providing accurate information about natural resource systems, providing arenas in which participants can engage in discovery and conflict-resolution processes, and providing mechanisms to back up local monitoring and sanctioning efforts, the probability of participants adapting more effective rules over time is higher than in regimes that ignore resource problems or presume that all decisions about governance and management need to be made by central authorities.

Two additional variables - the size of a group and its homogeneity - have been noted as conducive to the initial organization of communal resources and to their successful performance over time (Kanbur, 1991; Libecap, 1989a, 1989b; E. Ostrom, 1992). As more research has been conducted, however, it is obvious that much more theoretical and empirical work is needed since both variables appear to have complex effects. Changing the size of a group, for example, always involves changing some of the other variables likely to affect the performance of a system. Increasing the size of a group is likely to be associated with at least the following changes: (1) an increase in the transaction costs of reaching agreements; (2) a reduction of the burden borne by each participant for meeting joint costs such as guarding a system, and maintenance; and (3) an increase in the amount of assets held by the group that could be used in times of emergency. Libecap (1995) found that it was particularly hard to get agreements to oil unitization with groups greater than four. Blomquist (1992), on the other hand, documents processes conducted in the shadow of an equity court that involved up to 750 participants in agreeing to common rules to allocate

rights to withdraw water from groundwater basins in southern California. The processes took a relatively long period of time, but they have now also survived with little administrative costs for half a century. Agrawal (1996) has shown that communal forestry institutions in India that are moderate in size are more likely to reduce overharvesting than are smaller groups because they tend to utilize a higher level of guarding than smaller groups.

Group heterogeneity is also multifaceted in its basic causal processes and effects. Groups can differ along many dimensions including their assets, their information, their valuation of final products, their production technologies, their time horizons, their exposure to risk (for example, headenders versus tailenders on irrigation systems), as well as their cultural belief systems. Libecap's (1989b) research on inshore fisheries has shown that when fishers have distinctively different production technologies and skills, all potential rules for sharing withdrawal rights have substantial distributional consequences and are the source of conflict that may not easily be overcome. Libecap and Wiggins' (1984) studies of the prorationing of crude oil production reveal an interesting relationship between the levels and type of information available to participants and the likelihood of agreement at various stages in a bargaining process. In the early stages of negotiation, all oil producers share a relatively equal level of ignorance about the relative claims that each might be able to make under private-property arrangements. This is the most likely time for oil unitization agreements to be reached successfully. If agreement is not reached early, each participant gains asymmetric information about their own claims as more and more investment is made in private information. Agreements are unlikely at this stage. If producers then aggressively pump from a common oil pool, all tend to be harmed by the overproduction and are willing late in the process to recognize their joint interests. Libecap's (1995) study of marketing agreements among orange growers also shows a strong negative impact of heterogeneity. The theoretical work of Mancur Olson (1965) on privileged groups, on the other hand, predicts that when some participants have substantial assets and whose interests are aligned with achieving an agreement, such groups are more likely to be organized. The empirical support for this proposition comes more from studies of global commons (Mitchell, 1995; Oye and Maxwell, 1995).

Heterogeneity in the knowledge and acceptance of local common property regimes is likely to lead to their undoing. In frontier regions, new migrants increase the number of people sharing the return from a common-pool resource. Further, migrants are unlikely to recognize the legitimacy of extant, *de facto*, property-rights systems (see Alston, Libecap and Schneider, 1996). Thus, the common agreement necessary for the

sustenance of any property-rights system may rapidly disappear if settlement patterns undergo a rapid change. Similarly, common property systems related to inshore fisheries have also proved to be unstable when trawlers from other locations start to visit on a regular basis without recognizing the *de facto* property rights of local fishers.

7. Attributes of Common-Pool Resources Conducive to the Use of Individual Rights to Withdrawal, Management, Exclusion, and Alienation

The advantage of individual ownership of strictly private goods - where the cost of exclusion is relatively low and one person's consumption is subtractive from what is available to others - is so well established that it does not merit attention here. Industrial and agricultural commodities clearly fit the definition of private goods. Individual rights to exclusion and to transferring control over these goods generate incentives that lead to higher levels of productivity than other forms of property arrangements.

It has frequently been assumed that land also is clearly always a private good and therefore best allocated using market mechanisms based on individual ownership rights. Agricultural land in densely settled regions is usually best allocated by a system of individual property rights. Gaining formal title to land, however, may or may not increase efficiency. Feder et al. (1988) conducted an important econometric study that showed that agricultural land in Thailand without a formal title was worth only one-half to two-thirds of land with a formal title. Further, increasing the security of private-property rights also led to an increased value of the crops produced (between one-tenth and one-fourth higher than those without secure title). More secure titling also provided better access to credit and led to greater investments in improved land productivity (see also Feder and Feeny, 1991). Insecure property rights may lead potential users to arm and engage in violent conflict so as to gain control over land through force or by negotiation to avoid force. Several types of economic losses result from conflict over ownership (Skaperdas and Syropoulos, 1995; Umbeck, 1981a, 1981b).

Title insurance is another mechanism used to reduce the risk of successful challenges to ownership of land. Registering brands is still another technique used to increase the security of ownership over resource units in the form of cattle that may range freely over a large area until there is a communal effort to undertake a round-up. Gaining formal titles is, however, costly. In societies that do not yet have high population densities and where customary rights are still commonly understood and accepted,

formal titling may be an expensive method of increasing the security of a title that is not associated with a sufficiently higher return to be worth the economic investment (see Migot-Adholla et al., 1991). In addition, it should now be clear that the cost of fencing land by physical and/or institutional means is nontrivial and that there are types of land and land uses that may be more efficiently governed by groups of individuals rather than single individuals.

A commonly recommended solution to problems associated with the governance and management of mobile resource units, such as water and fish, is their 'privatization' (Christy, 1973; Clark, 1980). What private ownership usually means in regard to mobile resource units, however, is individual ownership of withdrawal rights. Water rights are normally associated with the allocation of a particular quantity of water per unit of time or the allocation of a right to take water for a particular period of time or at a particular location. Fishing rights are similarly associated with quantity, time, or location. These rights are typically 'withdrawal' rights that are tied to resource units and not to a resource system. In addition to the individual water rights that farmers hold in an irrigation system, they may also jointly own - and, therefore, govern and manage - the irrigation facilities themselves (Tang, 1992). In addition to the quotas or 'fishing units' that individual fishers may own, no one owns the fishing stock and governmental units may exercise various types of management rights in relationship to these stocks (Schlager, 1990). In groundwater basins that have been successfully litigated, individual pumpers own a defined quantity of water that they can produce, rent, or sell, but the groundwater basins themselves may be managed by a combination of general-purpose and special-purpose governmental units and private associations (Blomquist, 1992).

Implementing operational and efficient individual withdrawal rights to mobile resources is far more difficult in practice than demonstrating the economic efficiency of hypothetical systems. Simply gaining valid and accurate measurements of 'sustainable yield' is a scientifically difficult task. In systems where resource units are stored naturally or by constructing facilities such as a dam, the availability of a defined quantity of the resource units can be ascertained with considerable accuracy, and buying, selling, and leasing rights to known quantities is relatively easy to effectuate in practice. Many mobile resource systems do not have natural or constructed storage facilities and gaining accurate information about the stock and reproduction rates is very costly and involves considerable uncertainty (Allen and McGlade, 1987; Wilson, et al., 1991). Further, as Copes (1986) has clearly articulated, appropriators from such resources can engage in a wide diversity of evasive strategies that can destabilize the efforts of government agencies trying to manage these systems. Further, once such systems have allocated individual withdrawal rights, efforts to further regulate patterns of

withdrawal may be very difficult and involve expensive buy-back schemes (Örebech, 1982). Experience with these individual withdrawal-rights systems has varied greatly in practice (see McCay, 1992; McCay, et al., 1996; Pinkerton, 1992; Wilson and Dickie, 1995).

Exactly which attributes of both physical and social systems are most important to the success of individual withdrawal rights from common-pool resources is not as well established as the attributes of common-pool resource systems conducive to group proprietorship or ownership. On the physical side, gaining accurate measurements of the key variables (quantity, space, technology) that are to be involved in management efforts is essential. Resource systems that are naturally well-bounded facilitate measurement as well as ease of observing appropriation behavior. Storage also facilitates measurement. Where resource units move over vast terrain, the cost of measurement is higher than when they are contained (for example, it is easier to develop effective withdrawal-rights systems for lobsters than for whales).

Considerable recent research has also stressed the importance of involving participants in the design and implementation of such property-rights systems. When participants do not look upon such rules as legitimate, effective, and fair, the capacity to invent evasive strategies is substantial (Seabright, 1993; J. Wilson, 1995). The size of the group involved and the heterogeneity of participants also affect the costs of maintaining withdrawal-rights systems (Edwards, 1994). And, the very process of allocating quantitative and transferable rights to resource units may undo some of the common understandings and norms that allowed communal ownership systems to operate at lower day-to-day administrative costs.

8. Communal Property Regimes in the Twenty-First Century

The focus of this entry has been primarily on natural resources. Many of the lessons learned from the operation of communal property regimes in these sectors, however, are quite relevant for a wide diversity of similar property regimes that are currently in wide use and likely to have a substantial presence in the next century. A very large number of housing developments - both apartment houses and individual family dwellings - involve individual property to the housing unit itself combined with communal property to the grounds, recreational facilities, and other joint facilities. While individuals can buy and sell their individual housing units, at the time of purchase they assume a set of duties in respect to the closely related communal properties. Monthly assessments for the repair and maintenance of these common facilities are not unlike the assessments made by a community of irrigators on themselves for the maintenance of their own system. Further, purchase

and sales frequently require the permission of other members of the group. Similarly, many sports clubs allocate use quotas to members and assess members regular fees for the maintenance of the commonly owned facilities.

The modern corporation is frequently thought of as the epitome of private property. While buying and selling shares of corporate stock is a clear example of the rights of alienation at work, relationships within a firm are far from being 'individual' ownership rights. Since the income that will be shared among stockholders, management, and employees is itself a common pool to be shared, all of the incentives leading to free riding (shirking) and overuse (padding the budget) are found within the structure of a modern corporation (Ghoshal and Moran, 1996; Putterman, 1995; Seabright, 1993). Thus, where many individuals will work, live, and play in the next century will be governed and managed by mixed systems of communal and individual property rights.

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NUISANCE

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Abstract

The economics of nuisance disputes was one of the initial areas of work in the field known as law and economics. Commencing with Coase's seminal article on 'The Problem of Social Cost', the field went on to consider many of the most fundamental issues at the base of the discipline - the problems of legal frameworks, property right allocations, bargaining costs, information costs and asymmetries, institutional costs, endowments and invariance results - many of these issues were raised first by Coase in his landmark article. For good reason each of these issues now constitutes a field of research in itself. The economics of nuisance is important primarily because it provided the framework within which many of these important issues were first raised and considered.
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1. Definition

The etymology of the term *nuisance* comes from the Latin *nocere* - to do harm, to inflict injury. In strict legal terms nuisance has been commonly defined as 'a condition or activity which unduly interferes with the use or enjoyment of land' (Clerk, 1989, p. 889). Fifoot (1949) notes that nuisance is one of oldest branches of law dating back to the early assizes and that its 'very name - nucumentum - suggests the damage which he [that is the property owner] had suffered by conduct which nevertheless fell short of an actual dispossession'. The courts have identified nuisance disputes as involving a 'noxious' or 'offensive', 'unauthorised' and 'unreasonable' use of one's property that interferes, in a 'continuing way', with the use and/or enjoyment of another's property (Buckley, 1996). In economics terms, nuisance disputes may result when the choices of independent agents impact upon the outcomes affecting others, that is they are one of the possible legal consequences of *externalities*. Nuisance can be of two kinds: private and public. A *private nuisance* occurs when the externality appears in the utility function of one consumer or the

production function of one firm. If the externality affects many consumers or producers, then it is a *public nuisance*. Examples of such disputes include emissions from a factory that pollute a neighbouring property, noise that interferes with a person's sleep or unpleasant smells from one's use of his land. Generally, most cases of pollution and incompatible uses of land can be classified as nuisances, and could give rise to nuisance disputes.

2. Traditional Legal Approach to Nuisance

Scholars have identified the traditional approach to nuisance law as originating in thirteen century England (Brenner, 1974; Buckley, 1996; Ellickson, 1973; Fifoot 1949; Lewin 1986). In its English development, nuisance law was founded on property law and offered *absolute* protection to plaintiffs: either the nuisance existed and an injunction was granted or courts avoided granting an injunction by deciding that no nuisance existed.

The nineteenth century in the US brought about a significant change in the foundations of nuisance law. This reformulation of nuisance law involved the introduction of the concept of 'reasonableness' that resulted in the abolition of the absolute rights enjoyed by property owners and the adoption of the 'reasonable use' criterion. The 'reasonableness test' was employed to determine whether a specific use of land constituted a nuisance in the particular context (Lewin, 1986, p. 780). It considered the nature of the activity that brought about the nuisance suit, the character of the neighbourhood, the frequency of the activity, the 'hypersensitivity' of the plaintiff, and the defendant's motive (Buckley, 1996). Thus the 'reasonableness test' limited the scope of the pre-existing nuisance doctrine since courts could now find that certain interferences with the use and enjoyment of land were not actionable. Yet, courts still retained an absolutist attitude in their decisions regarding remedies. If a nuisance was proven, an injunction was granted routinely.

Subsequently, however, this imbalance was gradually redressed by American courts, by incorporating the 'utility' of the defendant and society within the reasonableness test. In the first *Restatement of Torts* (X, 1939) the American Law Institute (ALI) adopted the 'balancing of the equities or utilities' test. Under the 'balancing of the equities' test a nuisance would be established 'only if its harmful consequences outweighed its benefits to society' (Lewin, 1986, p. 780). However, the test was soon found to be defective in that it rendered any activity with sufficient social value absolutely immune from liability for interference with the use and enjoyment of nearby land (Lewin, 1986, p. 781).

A less drastic judicial solution to the problem of the disproportionate impact of injunctive relief was to ignore the utility of the activity in determining *liability* and consider it only in determining the appropriate *remedy* after

liability was established (Ellickson, 1973; Lewin, 1986, p. 781). Hence, the courts would first apply the reasonableness test to establish the nuisance and then apply the 'comparative hardship' or 'balancing of the conveniences test' to determine the nature of the relief. The court would then grant an injunction to the plaintiff only if the harm she experienced from the nuisance outweighed the social cost of abatement. This less drastic solution was also introduced in the first *Restatement of Torts* (X, 1939). However, the co-existence of both the balancing of the equities test and the balancing of the conveniences test was found to be contradictory and confusing, and consequently judicial practice has been confined primarily to the use of injunctive relief (Lewin, 1986, p. 782). Nevertheless, the ALI's approach to the law of nuisance as expressed in the *Restatement (Second) of Torts* (X, 1969) was not radically different than that in the first Restatement (Ellickson, 1973; Lewin, 1986; Polinsky, 1980).

3. The Law and Economics Approach to Nuisance Law

The new 'law and economics' paradigm which emerged in the 1960s recognised that traditional nuisance law faced several doctrinal and practical shortcomings. It had been characterised as 'unsystematic', 'neglected' and in a state of dismay and confusion (Brenner, 1974; Coase, 1960; Ellickson, 1973; Epstein, 1979; Newark, 1949)). Prosser (1971) comments that '[t]here is perhaps no more impenetrable jungle in the entire law than that which surrounds the word "nuisance"' (p. 516). This new approach to nuisance law can be viewed as an attempt to reformulate and systematise the traditional approach to nuisance. It is also the field in which many of the first attempts to marry law with economics occurred.

3.1 General

The 'law and economics' paradigm analyses the nuisance dispute as a case of informal joint activity arising out of conflicting land uses (Calabresi and Melamed, 1972; Coase, 1960; Kaplow and Shavell, 1996; Michelman, 1971; Polinsky, 1980; Posner, 1972). Nuisance may also be viewed as a form of externality that interferes with the enjoyment or use of another's property. These externalities are a form of inefficiency which in turn can be corrected through the *internalisation of* these external effects. Hence, nuisance laws are the framework within which this cost internalisation occurs (Cooter and Ulen, 1988, p. 170). Equivalently, nuisance laws may be seen as the framework within which joint activities by independent agents are co-ordinated.

3.2 Coase (1960)

The literature acknowledges the beginning of the modern approach to nuisance law as being R. Coase's celebrated article 'The Problem of Social Cost'. The fundamental question raised by Coase was whether allocative efficiency was invariant to the initial assignment of property rights. The answer Coase gave to this problem has been referred to as the (simple) Coase Theorem (Polinsky, 1983, p. 12): In the absence of transaction costs, the efficient outcome *will* inhere *irrespective* of the assignment of rights.

Coase's article has been viewed as a reaction to the Pigouvean approach. This approach involved the identification of the agents imposing costs on others and then requiring these agents to compensate the injured parties in the amount of the full cost of their actions (that is, to internalise the external costs). Coase emphasised the reciprocal nature of this problem - in that both of the parties to a nuisance *cause* the nuisance. In Coase's framework a nuisance dispute arises as the result of the interaction of two or more conflicting property uses, not as a cost inflicted by one onto another.

Coase's pioneering article dealt with a more general or fundamental issue in economics - the effect of the property right distribution on allocative efficiency. It was pure happenstance that many of the examples used to illustrate his innovative ideas involved nuisance and trespass disputes. In analysing these disputes under the assumption of zero transaction costs, Coase showed that the assignment of entitlements was irrelevant to the attainment of allocative efficiency. Under the zero transaction costs assumption, the party that incurs the costs from conflicting uses may acquire the entitlement to these uses from the other party at a price that is less than the costs she would suffer, if those uses of the resources are inefficient. Hence, where co-operation is not costly, the efficient allocation of resources will be achieved through private co-operation between the parties acting to maximise the value of their joint activities.

Obviously, much of the impact of this framework depends upon the usefulness of the assumption of zero transaction costs. The term 'transaction costs' includes the costs of identifying and assembling the parties involved in the negotiations, the costs of the actual negotiations and the costs of enforcing the outcome of the negotiations. Coase acknowledged that transaction costs are in reality positive. He used the examples involving nuisance disputes not to describe actual behaviour but to illustrate a point. Coase noted that in the presence of positive transaction costs the initial distribution of property rights does affect allocative efficiency, and that the courts may be in a position to assign property rights in such a way as to promote efficient outcomes. 'In a world in which there are costs of rearranging the rights established by the legal system, the courts, in cases relating to nuisance, are in effect, making a decision on the economic problem and determining how resources are to be employed'.

And the 'economic problem' in cases of nuisances 'is how to maximise the value of production' (Coase, 1960, p. 15).

3.3 Calabresi and Melamed's Framework

Following Coase's pioneering work, Calabresi and Melamed (1972) offered the next notable contribution in the evolution of the modern approach to nuisance law. They furthered the Coasean ideas to construct a *unified framework* for the analysis of entitlements in property and torts. Their breakthrough was that they stressed that property and tort laws have a common objective: *the protection of entitlements.* However, the two systems differ in the *rules* used to enforce the entitlements: *property rules* for property entitlements and *liability rules* (negligence or strict liability) for torts. The novelty of their approach lies in that they recognised that these rules can be applied even in the cases where the entitlement is given to the defendant.

Calabresi and Melamed (1972) suggest that the resolution of a nuisance dispute involves two steps: first, a decision must be made to determine who should receive the entitlement (choice of entitlement) and second, a decision must be made on how to protect that entitlement (choice of remedies). Within this general framework, Calabresi and Melamed (1972) noted that courts have traditionally considered the following rules or solutions in nuisance disputes: (i) the plaintiff is awarded the entitlement which is protected by a property rule (that is an injunction is awarded). The defendant must halt its nuisance-generating use of the property, unless the plaintiff agrees a price at which it will transfer its entitlement to the defendant; (ii) the plaintiff is awarded the entitlement which is protected by a liability rule. The defendant, on payment of the court-determined damages, may continue the use of his property in the manner that brought about the nuisance dispute. In effect, the court determines the price at which the entitlement may be transferred; (iii) the defendant is awarded the entitlement which is protected by a property rule (that is the defendant has thus the right to pollute and no injunction against its use will be granted). The defendant may continue its use of the property, unless the defendant agrees a price at which it will transfer its entitlement to the plaintiff.

However, for 'reasons of symmetry' they introduce an additional fourth rule: (iv) the defendant is awarded the entitlement which is protected by a liability rule. In this case, the plaintiff may acquire the entitlement from the defendant at a judicially determined price. Stated differently, the plaintiff may obtain an injunction against the defendant's activities only if he pays 'damages' to the defendant at a judicially determined price.

Lewin (1986) notes that this is the first explicit and thorough presentation of the concept of the 'compensated injunction', an injunction that the plaintiff could obtain only by paying damages to the defendant (p. 790). The fourth rule is also commonly referred to as the 'reverse liability rule' (for example Kaplow

and Shavell, 1996) and has been the subject of extensive commentary and research (Ellickson, 1973; Rabin, 1977; Polinsky, 1983; Ayres and Talley, 1995; Kaplow and Shavell, 1995). Remarkably, the first judicial application of this rule appeared shortly after the time of the submission of their article, in the case of *Spur Industries, Inc. v. Del. E. Webb Development Co.* (Lewin, 1986, p. 790).

3.4 The Importance of Transaction Costs

Within the framework established by Coase (1960) (that is, assuming zero transaction costs), efficiency will result irrespective of which entitlement-remedy combination is chosen (that is, no matter which of the four rules is chosen) (Posner, 1972; Polinsky, 1980, 1983). However, it is equally acknowledged that transaction costs are in reality not zero and, thus, the assignment of property rights must have serious implications for allocative efficiency (for example Calabresi 1970; Calabresi and Melamed, 1972; Michelman, 1971). The subsequent literature has tried to analyse the impact of various forms of transaction costs on the efficiency of the outcome, and the implications of these impacts for the efficiency of various rules.

Echoing these lines, Polinsky (1983) notes that 'if there are positive transaction costs, the efficient outcome may not occur under every legal rule'. In these cases, 'the preferred legal rule is the rule that minimises the *effects* of transaction costs' (Polinsky, 1983, p. 13). The idea is to advance legal rules that work well in the world of the 'second-best': a world in which perfect bargaining in the context of perfect information is unlikely to occur.

The initial development of these ideas came from Calabresi (1970), Calabresi and Melamed (1972) and Michelman (1971), who put forth the criterion of 'the least cost abater' as a means for promoting allocative efficiency when transaction costs hinder (Coasean) bargaining between the parties. The rationale for this criterion is that, by assigning the responsibility for abatement to the party who can do so at the least cost, the need for Coasean bargaining is made redundant. Calabresi (1970) and Michelman (1971) show how allocative efficiency is promoted by the use of the 'least cost abater' criterion since it both eliminates the transaction costs of bargaining and also the risk of the failure of that bargaining process (that is, its failure to reach the efficient solution).

A follow up to the 'least cost abater' criterion is what commentators have referred to as the 'best briber criterion' (Calabresi and Melamed, 1972; Lewin, 1986). This criterion has been proposed as a second best option when imperfect information and strategic behaviour do not allow the determination of the least cost abater. Under such circumstances, transaction costs might still be reduced and efficiency attained if the party who can least expensively bribe the other party is made liable (Calabresi, 1970; Calabresi and Melamed, 1972; Michelman, 1971).

In essence, the conclusion of the 'classical' literature on nuisance was that the design of legal rules does in fact matter. In a second-best world redolent with market imperfections and transaction costs, the best criterion for rule selection will be either to attempt to circumvent the (costly) bargaining process altogether (least cost abater criterion) or to attempt to reduce its costliness (least cost briber criterion). Much of the remainder of the literature in this area concerns the impacts of various forms of costliness on the choice of the legal rule.

4. The Magnitude of Transaction Costs and the Choice of Remedies

The optimal choice of remedies (judically-set damages or assigned entitlement) will depend upon the relative costliness of using centralised (judicial) or decentralised (bargaining) methods for price determination. Kaplow and Shavell (1996) and Krier and Schwab (1995) observe that there is a trend in the literature that holds that 'property rules are best when transaction costs are low - assumedly because the use of property rules will induce parties to bargain and reach desirable outcomes - whereas liability rules are best when transaction costs are high - supposedly because the use of liability rules will induce injurers to act desirably, mimicking the outcomes that would otherwise have been reached through bargaining' (Kaplow and Shavell, 1995, p. 718).

4.1 High Transaction Costs

When the costs of bargaining are high, the implication is that the centralised approach to conflict resolution might be preferred; however, this must depend upon the nature and magnitude of the costs of centralised decision making. This will depend upon *inter alia* the availability of information to that decision maker, or the costs of resolving informational asymmetries (between the regulator and the regulated). The enquiry to the costs of centralised decision making in the context of informational asymmetries resulted in the development of an entirely distinct field of economics, known as the problems of 'principal-agent' theory. Within the nuisance literature, the issue has been focused on the question of the amount of information required by the judiciary in order to make an informed determination of the dispute.

High Transaction Costs with Perfect Knowledge of the Level of Damages In the presence of high transaction costs, liability rules (damages) are superior to property rules (injunctions) when courts have knowledge of the actual level of damages resulting from the conflict (Calabresi and Melamed, 1972; Posner, 1992; Barnes and Stout, 1992; Kaplow and Shavell, 1996). The argument is that if damages are assessed perfectly, then the defendant will stop the nuisance and abate only when it is more costly to pay the (correct level of) damages. If

there was a property rule in effect (and high transactions costs prevented a negotiated resolution to the conflict) then the defendant would have to abate even if the abatement costs were greater than the damages (resulting in inefficiency).

High Transaction Costs with Imperfect Information Polinsky (1980, 1983) states that if the court lacks knowledge of both the damages to the plaintiff and the abatement costs to the defendant then no clear cut solution can be specified *a priori*. Kaplow and Shavell (1996), however, disagree with this view and demonstrate that 'even when courts are uncertain about the magnitude of harm, liability rules are superior to property rules' (p. 719). They demonstrate that when courts are faced with imperfect information when setting damages equal to an 'average' level of damages for cases characterised by similar facts, the outcome under the liability rule will be superior on average to that under the property rule (under the assumption that courts do not systematically underestimate or overestimate damages). This implies that courts do not require perfect information in order to establish an appropriate price for continuing nuisance, they only require sufficient information so as to allow them to determine an unbiased estimate of that price.

This criterion makes sense. It states that courts do not have to have perfect information in order to be a reasonable alternative to a costly decentralised price-setting mechanism; they will be as effective at price setting as the information that they have at their disposal. The more information that courts accumulate concerning a certain form of conflict, the more unbiased will be their estimate of its costliness and the more accurate will be their assessment of the appropriate price (damages). Talley (1994) also supports the proposition that liability rules with a 'properly' chosen level of damages are superior to property rules in the presence of high transactions costs**.** Therefore, the question of judicial efficiency as a regulator has to do with its unbiasedness as an estimator of damages, not the perfection of its information base.

4.2 Low Transactions Costs

Many commentators state that the decentralised mechanism (bargaining) is always the most efficient method for conflict resolution when transaction costs are low. Examples of this trend include Posner (1972), Calabresi and Melamed (1972). For example, Merrill (1985) argues that trespass law should be used when transaction costs are low while the law of nuisance (implying payment of damages) should be used when transaction costs are high. However several commentators (for example Ayres and Talley, 1995; Kaplow and Shavell, 1996; Polinsky, 1980, believe that this tendency is ill-founded. The general theme in this criticism is that even when transaction costs are low, *both* property rules *and* liability rules can induce bargaining and in fact in certain cases more efficient solutions can be attained under liability rules.

Very Low Transaction Costs Polinsky (1980) applies the Coase Theorem and shows that under zero transaction costs both property rules and liability rules lead to equally efficient outcomes. This reasoning is followed by several subsequent commentators (for example, Kaplow and Shavell, 1996). The reasoning is that, if bargaining is virtually costless, then the parties will be able to resolve the conflict irrespective of the process within which the bargaining is embedded. In short, institutional questions only become interesting when private cooperation is faltering as a coordination mechanism, that is when the costs of private transactions are significant.

Low Transaction Costs and Imperfect Information The invariance result of the Coase Theorem is not robust over a very wide range of institutional costliness. Once there are at least some transactions costs and information costs, the optimal choice of rule or criterion is more complicated. Polinsky (1980) argues that under imperfect information it is uncertain whether liability rules or property rules are superior.

Kaplow and Shavell (1996) state that liability rules may not be better than property rules under conditions of imperfect information but that (if constructed in an unbiased manner) they *tend* to be better. They base their argument on the idea of the court's unbiased estimation of damages set forth above, and the court's capacity to use accumulated information to resolve current conflicts. Ayres and Talley (1995) also argue that liability rules may be superior to property rules under imperfect information but offer a different basis for their argument. They argue that in cases of imperfect information and costly bargaining 'liability rules possess an "information-forcing" quality' that may induce and facilitate more efficient bargaining (pp. 1032-1033). In their approach the price announced by the court separates the pool of all plaintiffs into those adequately compensated and those inadequately compensated. This separation is the information-forcing characteristic of liability rules that facilitates bargaining (whereas such bargaining is not induced under property rules). In effect the plantiff's response to the judicial price initiates the bargaining process by providing information on that party's bargaining position.

Therefore, judicial intervention has been portrayed as a potentially useful form of centralised activity, even when the costs of decentralised conflict resolution are low. It can be an efficient method for accumulating and applying information on previous similar conflicts to current ones (informational efficiency gains). Or, it can be an effective approach to initiating bargaining between parties where asymmetric information creates bargaining costliness (bargaining efficiency gains).

5. Other Important Factors in Determining the Appropriate Remedy

The comparative costliness of centralised solutions (judicially-determined prices) versus decentralised solutions (negotiation-determined prices) depends upon factors other than simply the costs of bargaining. There are also the costs of the institution, the costs of implementation and enforcement, and the impacts on other legitimate societal objectives. A substantial literature surveys the range of costs that must be considered when the resolution of a nuisance conflict is being undertaken.

5.1 Enforcement

When the defendant cannot pay assessed damages then Kaplow and Shavell (1996) show that the 'liability-related incentives to take precautions [to reduce or avoid nuisance] will be compromised'. Hence, a property rule solution protecting victims would be preferable. 'Alternatively, it may be possible to retain the advantages of the liability rule in some contexts by requiring injurers to pay in advance for *expected* harm rather than to pay for *actual* harm after it occurs.' Finally, another way to overcome the judgement proof problem is to require potential injurers to offer proof that they have the ability to pay the damages before any damage has occurred (for example, by purchasing insurance) (Kaplow and Shavell, 1996, pp. 740-741).

5.2 Numbers: Public versus Private Nuisances

The principal reason public nuisances are dealt with separately is because they involve 'free-rider' and 'hold out' problems. Regarding remedies, Calabresi and Melamed (1972) imply that injunctions are more efficient than damages when there is only one victim and one injurer. When there is a public nuisance (that is, many victims) Calabresi and Melamed (1972) argue that damage remedies tend to be more efficient. Ellickson (1973) has disputed this argument. Posner (1972) argues that damages should be awarded when transaction costs are high and injunctions should be assigned in the opposite case. Yet, Posner states that transaction costs could be high in both the public nuisance and private nuisance disputes (in the latter case due to due to strategic behaviour). Michelman (1971) also suggests that the damages remedies should be used in the case of one injurer and many victims unless the injurer is the 'cheapest cost avoider'. For other commentators, however, the public nuisance case is seen as a less serious theoretical challenging since, it can be reduced to a private nuisance analysis by aggregating the parties in a class action (for example, Polinsky 1980, 1983).

5.3 Institutional Costs

Institutional costs mean the costs of the chosen approach to governance. In the context of nuisance disputes, the institutional costs are the costs to the judiciary

of its involvement in the resolution of the dispute. Clearly, one of the most significant advantages to property-based resolutions is that the judiciary's involvement is minimised. It needs only identify which party to the dispute holds the entitlement. This is the reason that any movement toward increased judicial intervention must be justified by balancing the benefits of that intervention against the costs that they entail.

This is the essence of the approach taken by Calabresi and Melamed (1972) who argued in favour of injunctions when administrative costs were low (p. 1118). They argued that a property-based resolution avoided two costs: (a) the administrative costs of judicially valuing the damages and (b) the costs of enforcing the judgement against plaintiffs who have to exchange their right at prices to which they may not consent. But Ellickson (1973) argues that Calabresi and Melamed (1972) fail to see that a combination of rules may entail lower administrative costs than a simple injunction (even when administrative costs are low). He argues that injunctions may involve three additional administrative costs: 'the costs of difficult searches for subjective values, delays in initiation of cost-justified nuisance activities, and added administrative costs in determining what remedies are in a specific case' (p. 747).

5.4 Entitlements and Wealth Effects

Much of the analysis thus far has assumed that the externality was unilateral in nature, whereas Coase had pointed out that most nuisances are best conceived of as situations of reciprocal externality. If plaintiffs are able to elect behaviour that exposes themselves to a nuisance (as in cases of 'coming to the nuisance') or able to mitigate the effects of a nuisance (for example, through the use of an air purifier), then the externality is best thought of as a joint cost determined by the joint activities of the two parties. In this case, it is probably inappropriate to think of the remedy as simply the framework for determining the price at which a unilateral transfer is effected. It is more appropriate to think of it as the framework within which the parties must work to move away from the non-cooperative outcome and toward the cooperative outcome. In this light, the important issue becomes the differential wealth effects of different entitlement rules. That is, irrespective of the remedy used to enforce the rule and the ultimate achievement of allocative efficiency, the choice of entitlements will effectively endow one party rather than the other with the wealth represented by the joint use. These wealth effects may have many other impacts within society, and on society's goals other than allocative efficiency. This is the essence of the *bonus payment argument* in favour of damages remedies, summarised by Polinsky (1980) as follows: once damages have been awarded then 'it is possible to pursue additional distributional goals by making the defendant's liability more or less than the plaintiff's actual damages' (for example, Calabresi and Melamed, 1972; Ellickson, 1973). For example, if the

plaintiff is less well off than the defendant and a more equitable distribution is desired, then the damage awarded could be augmented by a bonus payment by the amount that will bring about the distribution preferred (Polinsky, 1980, p. 1078). 'Under the injunctive remedy,
on the other hand, distributional outcomes are uncertain' (Polinsky, 1980, p. 1078).

Property-based rules disallow any consideration of these other objectives, that is, the distributional effects of the entitlement. The court only decides which party will receive the entitlement, and leaves it at that. A liability-based system of remedies allows the court to balance these other objectives, when determining the price at which the entitlement may be transferred. In effect, the court is better able to 'balance the equities' of the situation in determining both issues of entitlement and its price.

6. Determining Entitlements: The 'Coming to the Nuisance' Doctrine

Most often the allocation of an entitlement within a nuisance dispute rests on the relative impact of one use of land on the other, that is, on the degree of interference with the reasonable uses of another parcel of land. When a specific use of one parcel of land disqualifies many other reasonable uses of another parcel, then the offending use is deemed to be the 'nuisance'. Equivalently, the other landowner is deemed to hold an entitlement to pursue a reasonable range of uses on its land without interference. The exception to this rule has been where the landowner is deemed to have 'come to the nuisance'. This doctrine involves a defendant who has used his property in a specified way for a prolonged period of time without complaint, and then receives a complaint when the plaintiff introduces a new use on a neighbouring parcel of land. In this case, the defendant may claim that it is entitled to its use by reason of prior appropriation, while the plaintiff is not entitled to its new use of the neighbouring land.

'Coming to the nuisance' has been considered as a defence in nuisance disputes. The doctrine of coming to the nuisance has very old roots in the general ancient maxim of *volenti non fit injuria* (no legal wrong is done to him who consents). 'The person coming to the nuisance implicitly consents by his voluntary choice of establishing a residence or business in the neighbourhood of a pre-existing producer of negative externalities' (Wittman 1980). Yet, it is considered that the influence of the coming to the nuisance principle has gradually diminished in modern judicial decision making (Epstein, 1979; Tromans, 1982; Wittman, 1980).

Several proponents of the law and economic paradigm argue that the weight of 'being first' ought to be considered in judicial practices since it has implications for allocative efficiency (Posner, 1972; Wittman, 1980; Rob, 1986;

Snyder and Pitchford, 1996). If entitlements are allocated on the basis of being first, there is an efficiency cost associated with establishing oneself 'there' first. For example, unnecessary or inappropriate timing of investment may occur in order to establish prior rights (Posner, 1972; Wittman, 1980).

A notable contribution on the issue is that by Wittman (1980). Wittman suggests that in order to avoid such strategic behaviour a two-staged procedure must be followed in cases of coming to the nuisance: first, the court must establish, based on efficiency criteria, who *should* have been first instead of who *was* first and then, once the efficient sequence is determined, the court must 'determine the liability or property rule that promotes the efficient sequence' (p. 559). In searching for the most efficient sequence the court must take under consideration the costs and benefits of the two parties involved (the 'first party' and the 'newcomer'). Wittman (1980, p. 561) points out that no efficient sequence would allow for the compensation of relocating the 'first' party if that party *should* not have been first.

Another concept related to issue of coming to the nuisance is that of 'foreseeability': in certain cases, the party that is first can, based on the characteristics of the location, foresee that the location is prone to generate a nuisance dispute. Consequently, that party *should* not have been there first and their prior appropriation should not give rise to an entitlement (Wittman, 1980)**.**

In essence, the law and economics analysts agree that the timing of the use should not dictate the allocation of an entitlement. The object of allocative efficiency will only be advanced if the person who arrives first happens to pursue the use that is best from the social perspective. This can only be determined by reference to social costs and benefits, not timing of arrival. In addition, the rule of 'first come, first served' entails its own costliness because it provides incentives for inefficient races and contests for appropriation. Therefore, the allocation of entitlements should not be based upon notions of prior appropriation, but rather on broader considerations of social welfare and efficiency.

7. Alternative Approaches to the Resolution of Nuisance Disputes

The law and economics literature on nuisance has focused on a fairly limited (but fundamentally important) institutional choice, between judically-determined damages and party-negotiated outcomes. There are - of course - an entire range of possible institutions, ranging from free markets in all sorts of securitised property rights to wholly centralised regulatory institutions. A few commentators have pointed to these alternatives, and the overall limitations of the classic approach to nuisance disputes.

7.1 More Decentralised Approaches

Knetsh (1983, ch. 10) argues that the case-by-case approach adhered to by the law and economics literature to resolving nuisance disputes increases the uncertainty associated with investment in property since the maximisation-efficiency doctrine may grant an entitlement or choose a remedy 'depending on the circumstances' (Polinsky, 1983) that maximise efficiency. Uncertainty of these 'circumstances' and of how the court will react to these, reduces the security in investment in property. Knetsh (1983) proposes an alternative market-based approach that aims to reconcile security in investment with allocative efficiency whereby the nuisance-causing party would be required to buy off the 'easements' from neighbouring landowners so as to compensate them. Future purchasers of land would have to 'buy back' the easement if they required the termination of the nuisance. Such a system, Knetsh argues, brings about certain and unambiguous entitlements. Another example of a private mechanisms for the resolution of nuisance disputes is the use of *restrictive covenants* (for example, Ellickson 1973).

7.2 More Centralised Approaches

Burrows (1980) offers a more general attack on the mainstream framework developed from Coase (1960) and Calabresi and Melamed (1972). Burrows argues that more centralised methods of intervention are required in nuisance disputes, such as pollution control (see Burrows, 1980, 1985). He argues that (a) it is contradictory to resort to the best briber when by assumption bargaining is difficult and (b) (in the case of imperfect information regarding the efficient level of nuisance), identifying the least cost abater is an insufficient criterion. Burrows (1980) further argues that the Calabresian criteria are *irrelevant* if transaction costs are considerably low. In fact, under such a situation there is no need for *any* criteria since the 'efficient decentralised process will ensure that the least cost avoider does the abating, and that he does so to an efficient level' (Burrows, 1980, p. 156). If transaction costs are high (or other obstacles to bargaining exists) then Burrows argues that the criteria are ambiguous. In this case, the transaction costs are 'too high to allow decentralised transactions whichever of the four legal rules is selected' (1980, p. 156). Burrows concludes that 'if progress is to be made in the direction of efficiency and justice in the pollution context, we must look to more *centralised* policies of pollution evaluation and control' (p. 163) and proposes that future research should focus on the development of a 'systematic statutory approach' to nuisance control (p. 164).

7.3 Ellickson on Zoning

Influenced by Coase (1960) and Calabresi and Melamed (1972), Ellickson (1973) argued for decentralised mechanisms to deal with conflicts among

neighbouring landowners. Ellickson criticised the system of zoning 'as an ideal model for highlighting the economic consequences of all mandatory [centralised] regulation' (p. 691). Other notable contributions that critically examine centralised mechanisms for resolving conflicting land uses in the manner of Ellickson (1973) include Crecine, Davis and Jackson (1967), Davis (1963), Note (1969) and Siegan (1970, 1972).

Ellickson (1973) notes that the usual practice in traditional nuisance law (to resort to the property rule solution) resulted in the belief that zoning was necessary. In his view zoning is not desirable on efficiency grounds since it fails to reduce the costs of the nuisance, but also increases the preventive and administrative costs associated with it. With respect to equity, zoning does not correct the changes in the wealth distribution it causes (p. 699). Hence zoning as a means of controlling nuisance is seen as neither efficient nor equitable as compared to other alternatives. Ellickson thus concludes that other less centralised remedies must be used.

Ellickson (1973) proposes the use of covenants (consensual agreements among landlords that limit the uses of one's property) as a means to deal with nuisance disputes. Again, he argues on efficiency grounds: 'Covenants negotiated between landowners will tend to optimise resource allocation among them. In other words, the reduction in future nuisance costs to each party will exceed the sum of the prevention and administrative costs each agrees to bear, with all costs discounted to present value' (p. 713). Though Ellickson acknowledges that '[n]ot all conflicts between neighbours can be solved by covenants', covenants 'generated by market forces will tend to promote efficiency' (p. 714) and that 'assuming equal bargaining power and information, consensual covenants will not involve inequitable gains or losses to any party' (p. 714). Covenants are problematic 'when they impose external costs on *third* parties, creating suboptimal resource allocation and unfairness' (p. 714) (for example when certain racial minorities are excluded from specific zones). Though old judicial practices and high transaction costs of the past have limited the use of covenants, Ellickson (1973) urges that the new emerging judicial attitude (influenced by the new 'law and economics' school) and the standardisation of legal procedures can bring about the reduction of transaction costs and thus facilitate the use of covenants.

More recently, Ellickson (1991) has advanced these ideas and has further argued for the use of informal mechanisms as effective means for resolving nuisance disputes. He shows how non-legal informal social controls are likely to supplant legal rules when transaction costs are high. He argues that in certain cases of conflicting uses of property, individuals often resort to such informal means of settlement not only because they tend to be administratively cheaper but also because they are more likely to promote efficiency (social wealth maximisation).

Where the application of covenants or other non-formal legal mechanisms are not feasible, due to high administrative and information costs, then a remedy for nuisance dispute can be found by altering the property rights amongst landowners. Ellickson (1973) held that a remedy settling a nuisance dispute will be efficient to a party if its preventive costs (the costs to avoid the nuisance) and administrative costs (the costs of litigation and bargaining) are less than the costs from reduction in nuisance. Legal rules cannot affect preventive costs, since the latter are affected only by technological innovations. Legal rules, however can affect administrative costs involved in the execution of a specific measure and thus property rights ought to be assigned so as to minimise administrative costs that will lead to the increase in the number of preventive measures that the parties perceive to be in their self interest. Ellickson (1973) developed a framework comprised of four guidelines for the choice of a nuisance remedy: (a) assign the entitlement to the party with the greater *knowledge* of the risks involved; (b) assign the entitlement to the party with the better *organisation* for dealing with the risk; (c) assign the entitlement to the party with the better *control* over implementing the most efficiency preventive measures; (d) use the most *simple* rules of liability since they are less costly than complex rules.

Using these guidelines, Ellickson (1973) proceeds to generate efficient remedies for nuisance dispute. He strongly advocates the use of damages over injunction. He proposed the elimination of traditional injunctive relief in nuisance disputes. In the context of the framework established by Calabresi and Melamed (1972) he proposed that only rule ii (that is, damages) and rule iv (compensated injunction) were granted (Ellickson, 1973, pp. 115-122). Ellickson argued against the use of injunctive relief on the basis that the balancing of equities or conveniences tests were uncertain and costly and hence allow the possibility of inefficiency arising from granting an injunction that poses costs to the defendant greater than the benefits gained from the plaintiff. A novelty in Ellickson's (1973) work is that it implies that compensated injunctions could be granted to a plaintiff that would *not* have been entitled to damages. For example, in the cases where the plaintiff would not be entitled to damages on the grounds that they were 'hypersensitive to injury' or had 'come to the nuisance', the plaintiff could nevertheless purchase a compensated injunction in cases 'involving personal safety or fundamental freedoms' (Ellickson, 1973, p. 740). What is more, a plaintiff that has been protected by a liability rule could also purchase a compensated injunction (rule iv) if they were not satisfied with the damages awarded (rule ii) (Ellickson, 1973, pp. 745-746). Ellickson is thus seen by commentators as proposing a remedy that is a 'hybrid of Rule Two and Rule Four remedies' (Lewin, 1986, p. 796).

7.4 Merrill on Trespass

Merrill (1985) discusses *trespass* and *nuisance* law and how they differ in the remedies that can be effective. He considers trespass and nuisance law in the context of the *right to exclude intrusions* by others. He argues that this right is not one right but a 'bundle' of rights. In case of intrusion in the form of trespass the strict liability rule readily applies. Intrusion as a nuisance, however, is more complex in both establishing the nuisance (actionability) and to decide on the appropriate remedy. Whereas in nuisance law deciding on actionably and remedy involves weighing cost and benefits, this is not required in the case of trespass. Merrill (1985) further develops the 'mechanical-judgmental' distinction: trespass law as entailing limited judicial discretion in the determination of remedies (they are determined 'mechanically'). Nuisance law involves discretion and entitlements are established judgmentally. Merrill further analyses the economic underpinnings of the difference between nuisance and trespass law. His main thesis is that 'when the costs of transacting are low, the legal system will gravitate towards rule that determine entitlements at a low cost - such as the strict liability rule of trespass ... In contrast, when the costs of transacting are apt to be high, the legal system will incline toward rules for the determination of entitlement that are more expensive - such as the balancing or cost-benefit approach of nuisance'. That is, in the presence of high transaction costs market transactions are more prone to fail and thus 'these more expensive entitlement-determination rules are necessary in order to give judges the needed discretion to adopt what they perceive as the best 'compromise' solution (the efficient solution) to land use disputes' (Merrill, 1985, p. 14).

8. Comparative Nuisance: Differing Systems in Different Jurisdictions

Regarding the relative trends in the *application* of injunction and damages remedies, most commentators hold that damage remedies have been used increasingly by American courts (Ellickson, 1973; Note, 1979; Rabin, 1977; Polinsky, 1980) over the past four decades. On the other hand, courts in England have traditionally shown a preference for injunctive relief based on the high esteem they have held for private property, despite the fact English law prescribes that injunction is a discretionary remedy (Atiyah, 1980; Brenner, 1974; Tromans, 1982). Yet, it has been argued that there may be '[s]ome easing in the judicial attitude' regarding this preference (Ogus and Richardson, 1977, p. 310).

For comparison of English and UK judicial treatments of nuisance see Stephen (1998), while Lang (1979) offers a comparative discussion of the development and application of private law in cases of harmful externalities in England, France and Germany. Ogus and Richardson (1977) examine certain

judicial practices in the area of nuisance law and how they compare to the economic models developed by the law and economics tradition.

9. Conclusion: the End of Nuisance?

Much of the literature in the area of nuisance is now quite dated, and this is for good reason. Many of the most important issues of law and economics arose out of the article by Coase, and hence by happenstance they arose within the context of the nuisance dispute. The problems of legal frameworks, property right allocations, bargaining costs, information costs and asymmetries, institutional costs, endowments and invariance results - all of these issues were raised first by Coase in his landmark article on social cost. For good reason each of these issues now constitutes a field of research in itself. Some of it could continue to occur within the confines of the nuisance dispute, but most of the issues are far more fundamental and far-reaching than this one context. For this reason the law and economics literature on nuisance is incredibly rich at its outset, and incredibly limited at present. It is a field of research far more notable for its past than it could ever be for its future.

Nevertheless nuisance disputes continue to provide a context for substantial analysis and academic interest. The fundamental nature of the nuisance dispute - individual activities with joint outputs by reason of physical proximity - raises many of the interesting issues involved in the coordination of society. The alternative approaches to their resolution - centralised or decentralised pricing and transfers - raises many of the most fundamental questions of governance. The field will continue to provide an interesting context for the consideration of these fundamental issues.

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2200
ZONING AND LAND USE REGULATION

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Abstract

Zoning confers an interest in the property of each landowner to those who control the political power of the locality. This allows municipalities to shape their residential environments and their property-tax base. Voters in most communities will accept developments that raise the value of their major personal asset, their homes. The efficiency of zoning thus depends on the transaction costs of making mutually advantageous trades between existing voters and development-minded landowners. High transactions costs of selling zoning plus the endowment effect that zoning confers probably create land-use patterns with excessively low densities in American metropolitan areas.
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1. Zoning is a Municipal Property Right

Zoning is the most important method of land use regulation undertaken by local governments. It divides a jurisdiction into geographically contiguous 'zones'. The local zoning ordinance prescribes what may be done in each zone and what may not be done. The great majority of the population of the US lives in communities that are zoned. This chapter will treat related local land-use regulations as part of zoning. Thus subdivision regulations, in which developers' projects are subjected to review and conditions by a planning board, and historic preservation rules, which are often reviewed under a separate ordinance, are regarded here as part of zoning.

Zoning comprises a protean set of constraints on land development. Most land-use law can be amended and classifications changed without the consent of affected property owners. Among the most frequently observed strands of the regulatory web are minimum area per lot, use to which the lot may be put (for example, agricultural, residential, commercial, or industrial), maximum height of the buildings, maximum number of units that can be placed on the lot, minimum setbacks for a building from its

neighbors and the street, off-street parking requirements, and demands that developers pay for (arguably) related public infrastructure such as roads and sewers. Single-family homes are typically placed at the top of the list of uses to be protected. Early 'cumulative' zoning ordinances allowed homes to be placed in commercial districts but not vice-versa. Modern ordinances (since about 1950) typically establish exclusive zones, so that homes are not allowed in commercial areas.

In order to provide a focus for this survey, I shall advance a particular point of view about zoning. I regard zoning as a collective property right that is used by the municipality to maximize the net worth of those in control of the political apparatus (Nelson, 1977; Fischel, 1985). The establishment of zoning and subsequent changes in its rules redistribute control over land from its nominal owners to the dominant political faction in the jurisdiction, who may include many of the owners themselves in a collective role as residents.

In some cases, this redistribution may increase aggregate land values (and, arguably, aggregate wellbeing) in the community by offering a method to overcome free-rider problems in providing local public amenities (Hochman and Ofek, 1979). In other cases, the redistribution of property rights may have less efficient consequences. In all cases, however, zoning is viewed through my analytical lens as the product of rational calculation.

It is not an arbitrary constraint, even though landowners subject to it may sometimes view it as such. Nor is zoning usefully viewed as the product of far-sighted planners whose objective is to correct the misdeeds of the private market, an idea even planners have given up (Popper, 1988). Zoning is the product of a political process, and it serves the interests of those who control that process. The discussion of the scholarly literature in this article is informed by this viewpoint.

2. Zoning is Decentralized but not Unpredictable

The study of land use regulation in law and economics has been inhibited by a lack of consensus about the 'stylized facts' upon which economic theorizing normally builds. There are more than 25,000 local jurisdictions in the US that have the power to adopt zoning laws, and their authority to regulate land is derived from the legislatures and constitutions of 50 states, not from the federal government. Almost all states grant considerable latitude to local authorities. This section will nonetheless attempt to show that there are regularities in zoning which make it possible to theorize about it. The end of this section contains a brief discussion of sources to enable readers to explore institutional details and cases.

Zoning laws are similar from state to state because of the continuing influence of the Standard State Zoning Enabling Act promulgated by the US Commerce Department (under Secretary Herbert Hoover) in 1928. Nearly every state adopted the act or significant parts of it, and the corpus of judicial opinions that form the case law of zoning was developed largely in response to its application. Casebooks on zoning and land-use law have little trouble appealing to a national market. Differences among the states are more the result of differences in state-supreme court opinions than in the structure of their statutes or the behavior of the municipalities (Coyle, 1993).

Zoning has remained almost entirely a state-law issue despite periodic national commissions decrying its parochialism (National Commission on Urban Problems, 1968; Jackson, 1972; President's Commission on Housing, 1982; Advisory Commission on Regulatory Barriers, 1991). Proposals to have the federal government penalize local governments for unreasonable zoning standards have all died on the vine. The US Supreme Court gave a boost to the fledgling zoning movement in *Euclid v. Ambler*, but it has largely eschewed substantive review of zoning controversies since then.

Zoning is universally regarded as part of the government's 'police power' (Freund, 1904). The police power is the authority to make regulations. It is seldom defined in state constitutions, because the police power is regarded as one of the inherent powers of government. It is often treated in parallel with two other inherent powers, taxation and eminent domain. Property devaluations caused by police-power regulations are not compensable except under the infrequently-invoked doctrine of 'regulatory takings' (Epstein, 1985; Eagle, 1995; Miceli and Segerson, 1996). The much-discussed 1987-1993 US Supreme Court decisions that have revived this doctrine from its nearly moribund condition pose little threat to the vast majority of zoning ordinances (Fischel, 1995b).

It is typical for new zoning ordinances to 'grandfather' nonconforming, pre-existing uses rather than require them to discontinue. Early zoning ordinances envisioned the discontinuance of previously established, nonconforming uses without compensation (Weiss, 1987). The notorious case of *Hadacheck v. Los Angeles*, in which a long-established brick factory was surrounded by new homes and then ordered to be shut down (and its uncompliant owner put in jail), proved to be an early anomaly. Zoning laws adopted since the 1920s almost always allow pre-existing uses to stay if they are not overly noxious. This doctrine was not one required by the courts (both the California and US Supreme Courts ruled against Mr Hadacheck), many of which remain tolerant of rules that provide for uncompensated discontinuance of nonconformers after a somewhat arbitrary period of 'amortization' of capital costs has occurred (Berger, 1992).

Grandfathering permits existing community residents, who control zoning, to establish more rigorous standards for new development than that which applies to their own. (Another method is simply to create a new, more restrictive zone for undeveloped land; regulations must be uniform within districts, but not among districts.) A new zoning law that establishes three-acre minimum lot size does not require owners of homes on quarter-acre lots to tear down their homes or acquire more land. This obviously-reasonable bow to settled expectations is an important means by which zoning practice transfers rights from owners of undeveloped land to resident-homeowners. Because the existing residents do not bear any out-of-pocket costs, it is easier to impose stringent regulations on undeveloped land.

Grandfathering also provides an incentive for owners of undeveloped land to anticipate regulatory changes and perhaps build excessively early to protect their rights. (Some jurisdictions allow development rights to be vested merely by obtaining permits to build, but such permits are usually time-limited.) There is anecdotal evidence that such anticipation does induce premature development (Dana, 1995), and some theoretical models of regulatory takings have incorporated it (Mills, 1990; Riddiough, 1997).

Urban economists have sometimes attempted to model zoning as a single-valued constraint, such as minimum lot size. Such exercises can often be useful in working out implications of land-use constraints in an urban economics model (M.J. White, 1975; Rubinfeld, 1978). They can, however, be misleading when their models allow for simple evasions of the single constraint (Henderson, 1985). Zoning laws do not permit developers to evade a minimum lot size constraint by simply erecting larger amounts of capital on the larger lot. Height, setback and single-use requirements usually stand in the way, and where they do not, discretionary actions such as sewer connections can be withheld from an uncooperative or opportunistic developer. Monitoring is not a major administrative problem for zoning, and errors that do become grandfathered are easily avoided for future land uses by amending the zoning ordinance.

Sources of information on legal background include legal casebooks on land-use such as Ellickson and Tarlock (1981) and Callies, Freilich and Roberts (1994) and the leading property-law casebook, Dukeminier and Krier (1993). A monthly journal, *Land Use Law and Zoning Digest*, summarizes recent cases and legislation and provides experts' commentary on them. Influential law-journal articles are selected annually in *Land Use and Environment Law Review*. The leading planning journal is the *Journal of the American Planning* Association. Economics journals with numerous titles related to zoning and land use include *Land Economics*, *Journal of Urban Economics*, and *Urban Studies*. I treat institutional issues in chapters 2-4 of Fischel (1985). Some fine-grained stories about zoning by lawyers

with a national practice are contained in Babcock and Siemon (1985). A collection of law-review articles on property and land use is Ellickson, Rose and Ackerman (1995).

3. Local Political Authorities Control Zoning

The view of zoning as a municipal property right can help researchers avoid fruitless theorizing and misguided empirical work. The view assumes, however, that one can identify some people whose objectives are clear and who can control the zoning process to their benefit. Since zoning is embedded in local government politics, this requires an inquiry into the nature of that politics.

Many observers are impressed by how much neighbors affect zoning hearings. Tideman (1969) found that nearby residents had almost complete veto power over proposed variances to permit commercial activity in a Chicago suburb. (The veto power is necessarily de facto; courts have overturned zoning laws that formally permitted neighbors to deny variances, Michelman, 1977.) Nelson (1979) employed the view of zoning as a neighborhood entitlement as a springboard to reform that would explicitly acknowledge it and permit its sale to developers.

Although neighborhoods are influential where minor changes are proposed, it is misleading to focus on the administrative actions of zoning boards when evaluating the entire institution of zoning. To be valid in most US jurisdictions, zoning must be imposed on the entire municipality, though, of course, there are different zones within the municipality. The comprehensiveness of zoning makes it a property right embedded in the entire community. Legal doctrine is also hostile to rezonings that affect only one or two small parcels, condemning it in many cases as ‘spot zoning’. Most economic theories and empirical work have evaluated zoning as something that affects entire municipalities.

Locating zoning at the municipal level leads to the question of who controls municipal politics (Danielson, 1976). The leading theoretical contenders are (a) the median voter; (b) the bureaucracy, including the planning profession; (c) interest groups, including developers, real estate interests, building-trades unions, and advocates for the poor; (d) higher levels of government, such as state legislators and the interests they serve.

There is no widely accepted choice among these alternatives because, I submit, the size (both area and population) of the municipality makes a difference as to which model is relevant. The evidence in support of the median-voter model of politics has come almost entirely from cross-section studies of local government (Holcombe, 1989). Within these studies, there is

evidence that smaller municipalities behave more along the lines of median voter theory than the larger cities (Bloom and Ladd, 1982; Holtz-Eakin and Rosen 1989).

The small suburb is the paradigm of much zoning research. The larger the government unit, the more likely interest groups will influence the process (Komesar, 1978), and thus the more likely the 'property rights' embodied by zoning will belong to them. But even in large cities, homeowners often have substantial influence on zoning because of ward representation (as opposed to at-large, citywide elections) on city councils (Clingermayer, 1993).

This leaves an interesting question of political choice. If the median voters (local majorities) really get their way at the local level, in contrast to the interest groups and bureaucrats who are said to dominate the statehouse, what determines the division of authority between local governments and the state? As a constitutional issue, the rule is that local governments are creatures of the state, and the state can modify the locals' power over land use by altering the instruments of their creation (Briffault, 1990). This would sometimes mean a change in the state constitution for cities with 'home rule' charters, but most state constitutions are easily modified and, even where they are not, judges are reluctant to overrule state legislative infringements on local authority. Indeed, in the tradition of 'Dillon's Rule' of statutory construction, judges have encouraged state supervision of municipal activity (Rose, 1989).

As a political issue, however, the choice between state and local authority is more complex. Nearly every state - Hawaii is the main exception - delegates substantial authority over land use to local governments. This is not because states have not thought to do otherwise. To mention only the most recent proposal, states were urged in the 1970s to assume much more control over land use. Dubbed the 'Quiet Revolution' in an influential book by Bosselman and Callies (1971), the idea was to have state and regional bodies take over much of land use regulation from local governments. A parallel movement, pursued more by the courts than by legislators, has attempted to override suburban zoning decisions because of their exclusion of low-income groups (Haar, 1996).

Neither of these two centralizing attempts has gotten very far. Judicial efforts to open up suburbs to housing for poor people have stalled in the face of substantial popular and legislative opposition (Fischel, 1991). Many state and national environmental laws add constraints on the discretion of local zoning, but very few have made locals accept projects that they do not want (Popper, 1988). Activist states such as Vermont and Oregon have largely established a double-veto system, in which developers can go from 'yes' to 'no' in working their way up the regulatory ladder, but not from 'no' to 'yes'.

4. Externalities and Nonconvexities May Warrant Zoning

The rationale for zoning typically offered in the economics literature is that some activities cause spillover effects on their neighbors and that the best way to deal with these spillovers is to employ police-power regulations to separate uses (Mills, 1979; Ihlanfeldt and Boehm, 1987). Both of these propositions have been subject to scholarly questioning.

The idea that urban spillover effects are pervasive was first challenged empirically by Crecine, Davis and Jackson (1967) for the city of Pittsburgh. Similar results were obtained for samples in Rochester, NY, by Maser, Riker and Rosett (1977) and in Vancouver, BC, by Mark and Goldberg (1986). These studies estimate the value of property, most often single family homes, using regression analysis. Among the explanatory variables (the right side of the equation), the studies include some measure of the property's proximity to the bête noir of zoning, the nonconforming use. The studies conclude that nonconforming uses do not seem to have much effect on homes, contrary to zoning principles, and thus zoning is not justified.

Numerous other studies (more often using suburban samples) have found that proximity to nonconforming uses does reduce home values (Li and Brown, 1980; Stull, 1975). But the more telling critique of the former studies is their inattention to institutional process (Grieson and White 1989; Fischel, 1994). How did the nonconforming use get into the residential neighborhood in the first place? Most larger cities have had zoning since the 1920s. The nonconforming uses were most likely let into the neighborhood by a zoning process. To satisfy objections of nearby neighbors who appear at zoning hearings, the nonconformers may have adjusted their plans to mitigate spillovers or compensate for them. If this process works well, one could find that nonconformers do not adversely affect average neighborhood property values. But this is not because zoning fails or is irrelevant; it is because zoning worked to allow an efficient outcome.

A similarly indeterminate outcome is reached when one looks at the evidence that nearby nonconformities do reduce single-family home values. It is possible that the nonconforming uses compensated previous homeowners with a lump sum payment, and subsequent buyers of the homes were compensated for the nuisance by paying lower prices. There is nothing necessarily inefficient in this process: The new, nonconforming shopping center, say, may have added more value to the location than it subtracted from the homeowners' value. For small areas, at least, it is likely that the only way to tell if a given land use regime is efficient is to see if it maximizes the land value of the area as a whole (see Section 6 below).

The second prong of the traditional economic argument for zoning holds that the best means of internalizing spillover effects is the coercion of the

police power. The source of doubt about this proposition is the extensive literature on private (that is, consensual) alternatives for dealing with localized spillovers. Among the best-known studies of alternatives is Siegan's (1972) survey of Houston, Texas, the only large city in the US that lacks zoning. Houston does, however, have private covenants, and its overall pattern of land uses is not markedly different from other cities. Houston does appear to have lower housing prices than other places (Peiser, 1981), but, as will be seen in Section 6, it is not clear whether this is a compliment to, or criticism of, its lack of zoning.

Another well-known study of covenants and nuisance laws as alternatives to zoning is by Ellickson (1973), a law professor whose economically-informed investigations will reward any scholar of land use. Ellickson concludes that small-scale neighborhood effects would best be dealt with by a combination of consensual arrangements and a revival of nuisance law in which fines are the preferred remedy. (Preferred because they give the maker of the necessary nuisance a continuum of choices to correct his behavior.) Private covenants need not be rigid. Residential private governments such as homeowner associations are often adopted even when zoning is available (Reichman, 1976; Ellickson, 1982a; Hughes and Turnbull, 1996). (Private covenants can prohibit activities that zoning permits, but covenants cannot permit owners to undertake activities than zoning prohibits on their land.)

Ellickson's (1991) book on the ways that extra-legal activity and informal norms govern small-area relations is also useful in considering justifications for zoning. His finding that small-area groups often choose to deal with neighborhood effects by using home-grown remedies even when the law is available should shake economists' unthinking acceptance of the idea that formal laws actually govern people's behavior (see also Rudel, 1989). Several historical studies have also shown that pre-zoning land use patterns do not differ much from those that developed after the 1920s, when zoning became widespread (Cappell, 1991; McMillen and McDonald, 1993; Warner 1962).

In order to justify zoning on efficiency grounds, one might look to a larger land area than the immediate neighborhood of a given property. The theory of nonconvexities suggests that land developers might overlook value-maximizing opportunities even though they are able to bargain with immediate neighbors to internalize spillover costs (Crone, 1983). Nonconvexities cause a number of local land-value peaks that individual developers might easily mistake for the global maximum. I have pointed out, however, that private developers are capable of building large-scale communities and are willing to accept neighborhood spillovers in order to maximize aggregate land values (Fischel, 1994). Nonconvexities are a good

reason for employing intelligent land-use planners to see the larger picture, but such planners could be employed by private developers as well as by government bodies.

It must be conceded, however, that most American communities are developed piecemeal by numerous developers who seldom coordinate their efforts beyond their immediate neighborhoods. To the extent that such lack of coordination may be corrected by public zoning, the nonconvexities argument may be the most important rationale for zoning. Some historians of American cities have emphasized that municipalities have long been the vehicle for entrepreneurial development schemes (Monkkonen, 1988), and modern urban economics has emphasized how cities create agglomeration economies in which government direction may be important (Henderson, 1988; Jacobs, 1969). Nonetheless, the link between zoning and 'solving' the nonconvexity problem is not thoroughly explored, and the evidence on growth controls (Section 7 below) suggests that some forms of zoning may work against efficient metropolitan development.

5. Rezoning Transactions are Facilitated by Exactions

If development-minded landowners value a rezoning (usually for a more intensive use) more than the municipal voters (or whoever controls the political process) value the parcel's current zoning, economists would expect that an exchange would make both parties better off. Developers would simply pay the community a sum that could be put in the municipal treasury and used to reduce local taxes or spent on additional public services. Hostility to such seemingly Pareto-improving moves is nonetheless widespread (Mills, 1989). This section will describe the subterfuges that facilitate zoning deals.

Some early zoning laws in fact allowed for private trades of zoning. They specifically permitted zoning changes (or at least zoning variances) if the landowner got the consent of all or nearly all of the neighbors to the property. The US Supreme Court struck down private dealmaking, however, in *Seattle Title Trust Co. v. Roberge*.

Nelson (1977) advanced a reform of zoning as a neighborhood entitlement that would explicitly permit its sale to developers by neighborhood groups. I have advocated increased fungibility of zoning, with the sales going to the municipal treasury (Fischel, 1985). Members of the planning profession are typically puzzled or horrified by this idea, but in fact many courts tolerate municipal dealmaking if it is not too blatant (Wegner, 1987). Informal dealmaking at the neighborhood level is a feature of many large-scale projects, and developers' advisory organizations such as the

Urban Land Institute offer guidance for negotiating with neighborhood groups and environmental organizations (Levitt and Kirlin 1985).

Dealmaking for rezoning is normally carried on at the municipal level. But there is lingering hostility to such transactions by the judiciary. Courts may strike down straightforward exchanges on the grounds that the police power must be inalienable (*Andres v. Village of Flossmore*; Kmiec, 1982). The California courts have likewise been unwilling to enforce deals on which communities subsequently reneged (often as the result of a voter initiative). Subsequent California legislation permitting 'Developer Agreements' has, however, apparently met most of the judicial objections to limiting the police power over time (Porter and Marsh, 1989).

The more subtle inducements to rezonings are called exactions. Developers whose projects are larger than a few units are routinely required to pay for new public infrastructure that benefits their projects. (This payment is often overlooked by critics who regard municipal provision of services to suburban development as a subsidy.) Although exactions were traditionally limited to highly localized costs, modern courts have expanded the range of services that developers may be required to pay for or provide directly. (The 'impact fee' is a somewhat more regularized form of exaction, but the border that separates the terms is imprecise.)

Exactions have received substantial attention in the scholarly literature. A well-rounded review is Altshuler, Gómez-Ibáñez and Howitt (1993), and a collection of essays is Babcock (1987). Whether exactions themselves restrict the supply of housing within a municipality by imposing additional entrance fees, as is commonly alleged, is not entirely clear. On the one hand, the prospect of lucrative exactions may persuade a restrictive community to allow development that it would otherwise have excluded (Gyourko, 1991).

On the other hand, the lure of filling municipal coffers might induce an otherwise prodevelopment community to adopt regulations just for the sake of exchanging them for exactions (Sterk, 1988). The example is not fanciful - the Mayor of New York once proposed just that, but the plan was overturned by *Municipal Art Society v. New York*. It is the latter possibility that seems to make American courts uneasy about exactions. The US Supreme Court in *Dolan v. City of Tigard*, attempted to limit exactions to the public costs attributable to the private project rather than allow the municipality to set the terms of trade. Whether this rule will actually benefit developers remains to be seen.

Issues of horizontal equity raised in the law and economics literature by Ellickson (1977) and Been (1991) do not categorically condemn exactions. Land-tax enthusiasts in the Henry George tradition favor exactions as a partial measure towards their goal off collective control of natural resources (Tideman, 1988), but the fairness of such selective taxation is questioned by

others (Epstein, 1993; Levine, 1994). Donald Hagman's balanced 'windfalls for wipeouts' proposal, which would require exactions when rezoning favored owners and compensation when rezoning penalized owners, is still worth serious attention (Hagman and Miscynski, 1978).

A further form of exchange of zoning is barter arrangements called 'Transferable Development Rights' or TDRs. Instead of the community proffering development rights in exchange for the developer's cash, the landowner is offered the right to develop elsewhere in exchange for acceding to new restrictions on her property. Because they amount to barter-like exactions, TDRs are in principle efficiency-enhancing, at least when compared to an inalienable zoning regime (Mills, 1980; Carpenter and Heffley, 1982).

When historic preservation was a young idea, many attorneys believed that the courts would require compensation for owners of property who were burdened by the restriction, and Transferable Development Rights were advanced as a low-budget means of compensation (Costonis, 1974). As the case law developed, however, landmark designations have seldom required compensation (*Penn Central Transportation Co. v. New York City*). TDRs have languished as a result, with only a few unusually restrictive agricultural and historic-district zoning schemes offering TDRs to landowners.

A final (but not the only remaining) means of exchange of zoning is through the property tax system. Developers of commercial property often point to the additional property tax revenue that the community will gain if their projects are allowed to proceed. To the extent that such revenues exceed the cost of services occasioned by such development, excess property tax revenues can be viewed as a side payment by which the community can be compensated for the local disamenities of commercial development (Fischel, 1975; McHone, 1986). The promise of increased employment and wages can also be a method by which developers persuade officials to make favorable rezonings, though this method works only when the community is geographically large enough or isolated enough to internalize much of the potential labor market.

My judgment is that, on the whole, sales of development rights are ubiquitous, but they involve higher transaction costs than the sale of other municipal assets. Communities that want to sell redundant school buildings may have a slightly harder time doing so than otherwise similar private entities. The variety of opinions by voters and other political interests adds to the transaction costs. But such transactions nonetheless occur regularly because of the obvious opportunity cost of failing to do so, and because few people regard selling an old school building as antithetical to the purpose of schooling. Zoning transactions do occur, but only after overcoming the additional transaction costs of hostility to the very idea by many citizens, public officials, judges and professional planners.

Exchanges of zoning probably happen often enough to lend credence to various studies that suggest that zoning 'follows the market' (Wallace, 1988; McMillen and McDonald, 1991; Wheaton, 1993). But following the market by allowing exchange is not the same thing as saying that the land market would be the same in the absence of zoning. Even under highly fungible zoning, communities would withhold those land use entitlements that they collectively valued more than developers did. As will be argued in Section 7 below, such a collective entitlement can also have an important effect on real property markets via the endowment effect.

6. The Tiebout Model with Zoning Makes Local Taxes more Efficient

Land use controls in the US are regarded as a necessary condition for the model of local government embraced by the economics profession. Tiebout (1956) suggested that the free-rider problem could be overcome for public goods that are confined to small geographic areas. For local public goods, Tiebout argued that preferences could be truly revealed if households could select among many geographically contiguous communities assumed to provide a wide range of public services. Because most large US metropolitan areas - in which most Americans live - have scores if not hundreds of municipalities, and because most people move several times during their lives, American cities approximate the necessary conditions for Tiebout's model.

Hamilton (1975, 1976) added the local property tax and 'fiscal' zoning to Tiebout's model. A criticism of Tiebout holds that the property tax system - the mainstay of American local government - encourages developers to build low-value housing in communities with high levels of public services. This creates two kinds of deadweight loss. The property tax itself discourages housing consumption, since a larger house increases one's tax bill but usually not one's benefits from public services. Second, willingness to pay for local services is not accurately revealed, since some low-demand immigrants can receive higher levels of local services than they are willing to pay for in property taxes. As a result, the Tiebout model's efficiency advantages are undermined.

Hamilton showed that both of these inefficiencies could be overcome if the original residents (or developers) of the community established a zoning regime that required subsequent development to generate property tax revenues that covered each household's expected cost of local public services. Such zoning is called 'fiscal zoning', though it is empirically indistinguishable from any other brand (Bogart, 1993). In the Tiebout-Hamilton system, the property tax has no deadweight loss, and the level of

public services is efficient because mobility by households among communities allows them to choose a known level of public services for which they must pay. Mobility allows households to choose the mix of services and housing they prefer and also encourages communities to keep costs down (Martinez-Vazquez and Sjoquist, 1988).

In proposing this model, Hamilton implicitly embraced the view of zoning as a municipal property right. Economists often view the local government fisc in the same terms as the national fisc. Levels of spending and taxes are, in the conventional view, determined by an entirely political process. But in the Tiebout-Hamilton world, local governments are much different; they must respond as purveyors of public services to the regional property market. As Oates (1969) first showed, if local governments provide high-quality local services at a lower level of property taxes - that is, if they operate like efficient firms - they reward their established residents with higher owner-occupied housing values. (Oates's study has been replicated many times; a survey and additional evidence on capitalization of local fiscal variables in home values is Yinger et al., 1988).

The same incentive that homeowner-voters have for supporting efficient levels of taxes and spending - maximizing the value of their own homes - also influences their support for local zoning. Zoning laws (and changes in zoning) that increase resident homeowners' net worth will be favored, assuming residents control the local political process, and policies that decrease it will be opposed. Zoning is also a means of controlling other municipal costs by limiting the types of development that may raise taxes or require public expenditures (Oates, 1977).

There is ample evidence that owner-occupied housing in well-planned communities is more valuable than similar units in poorly controlled areas. For example, Lafferty and Frech (1978) found that suburban communities in the Boston area that kept their commercial areas within closely contiguous zones rather than letting them scatter about had higher single-family home values (see also Burnell, 1985). Speyrer (1989) found that houses protected either by covenants or by zoning in the Houston, Texas, area were more valuable than houses in sections of Houston that were both unzoned and uncovenanted. (Sprawling Houston, which is unzoned and has areas in which covenants have lapsed or were never established, surrounds two small cities that do have zoning.)

The fact that more stringent zoning restrictions can increase housing values raises the question of why all communities do not zone to the most restrictive degree possible. One reason is that zoning may be sufficiently fungible that homeowners can be compensated for devaluations of their property. Suppose a proposed office building is opposed by nearby homeowners, who credibly complain that their property will be devalued by

the traffic, the building's shadow and other spillovers (Thibodeau, 1990). If the developer can compensate them with cash or in-kind payments, the existing residents may 'take the money and run', leaving behind houses that are devalued but neighborhoods whose aggregate property values (for both housing and office buildings) are higher. Thus the finding that spillovers devalue nearby housing is consistent with efficient land use.

The implication of the foregoing is that the efficiency of land-use controls is best evaluated by looking at aggregate land values, not simply owner-occupied houses (Lind, 1973; Sonstelie and Portney, 1978; Brueckner, 1990). But even this standard must be qualified. If the municipality possesses some monopoly power (*vis-à-vis* other communities) in its provision of developable land, maximization of aggregate land value may be inconsistent with Pareto efficiency (M. White, 1975; Pines and Weiss, 1976). While there is empirical evidence in support of the 'monopoly zoning' hypothesis (L. Rose, 1989; Thorson, 1996; Bates, 1993), it is nonetheless impressive how many local jurisdictions there are in US metropolitan areas (Fischel, 1981). At any rate, Congress in 1984 specifically exempted local governments from financial liability under the Sherman Act, thus staunching anti-monopoly litigation against municipalities (Deutsch and Butler, 1987).

7. Growth Controls and Endowment Effects Raise Housing Costs

The positive connection between zoning restrictions and housing prices (often pejoratively characterized as 'housing affordability') is often raised as a criticism of zoning (Schwartz, Hansen and Green, 1981; Katz and Rosen, 1987). Critics often point to the delays and cost-creating regulations involved in zoning. Such criticisms overlook that privately-planned communities often impose at least as many barriers to additional housing units and other changes in the status quo (Reichman, 1976). Moreover, as noted in Section 6 above, a benign residential zoning policy that makes the community more attractive would raise the rental price and the purchase price of both pre-existing and newly built housing units.

The foregoing optimistic view of zoning's effect on housing prices must be tempered by two observations. One is the previously mentioned monopoly possibilities. But even in areas with numerous local governments, it appears that local zoning laws can increase housing prices of entire metropolitan areas (Black and Hoben, 1985; Pollakowski and Wachter, 1990). It is also arguable that California's local growth controls contributed to that state's extraordinary housing price rise that began in the 1970s (Frieden, 1979; Ellickson, 1982b; Fischel, 1995). Monopoly and public-sector efficiency

cannot be the only reasons for the higher costs of housing associated with growth controls.

In order to explain how a competitive system of local government might cause inefficiently high housing prices, it is useful to start with the Coase Theorem's framework. If transaction costs are zero and the effect of initial entitlements on each party's willingness to pay (the endowment effect) may be neglected, Coase pointed out that it does not matter who possesses the initial entitlement. In the case of the owner of undeveloped land (landowner) versus the existing residents (community), the Coase theorem says the following: it does not matter whether the landowner has the right to erect 100 units of housing or the community has the right to keep it in open space (zero units). If only 60 units of housing are optimal, the community (assumed to speak with one voice here) will pay the landowner to refrain from building 40 of them if the landowner has the right to build. If the landowner lacks the right to build, she will pay the community for the right to erect 60 houses (but not 61 or more). (This idea is developed graphically in Fischel, 1985.)

Coase set out this theory in order to induce economists to investigate the consequences of dropping the assumption of zero transaction costs. As mentioned in Section 5 above, there are more-than-normal transaction costs involved in developers' purchasing rezonings. As a result, fewer than 60 housing units might end up being developed. Transaction costs act in this instance the same as an excise tax on housing. If this condition applies to all communities in the metropolitan area (as it normally would), housing prices will be higher than otherwise, even if there is no municipal monopoly power.

The 'higher than otherwise' needs some qualification, however. It cannot reasonably mean that housing prices are higher than they would be if there were no land use controls at all. In that case, the owner in the example might end up putting up too many houses (more than 60) because the community is unable to organize to purchase the 40 development rights. That is, one must consider the effect of transaction costs on the other side. One might, as in much blackboard law and economics, suppose that some third party can (without cost) determine what the optimum would have been in the absence of transaction costs, but that supposition hardly addresses issues in which transaction costs are pervasive.

A better way to think about the appropriate benchmark for determining whether zoning is too restrictive (and thus housing too expensive) is to ask whether another system of law could provide much the same benefits of zoning with fewer of the costs. The 'comparative systems' approach was recommended by Demsetz (1969), and its chief practitioner in the land-use area is Robert Ellickson, as mentioned in Section 4 above.

Aside from focusing research on the effects of transaction costs, the Coase theorem also raises the issue of the 'endowment effect' (Coase himself

brushed this aside). Even if transaction costs are zero, which party has the initial endowment - the development-minded landowner or the anti-development community - might still make a difference in final equilibrium because having the initial endowment affects their subsequent willingness to exchange. Economists have traditionally considered initial endowments as amounting to the same thing as income or wealth elasticity of demand. That is, if the community is entitled to restrict the landowner's development, the existing residents are richer than they would be if they had to pay the landowner (out of increased property taxes, say) to forswear development.

But this effect does not explain much. It can only work when the entitlements are first established. The owners of land favorably affected by zoning got a capital gain when it was first adopted, or, more precisely, when it was first known that it would be adopted and expected to last. Subsequent buyers had to pay more for the land as a result. New occupants of houses in restrictively zoned communities have to pay for the initial entitlement in making their purchase, leaving them no richer than if there had been no favorable zoning to begin with.

A more likely explanation for the reluctance to trade induced by the endowment effect is the 'offer/ask' disparity, which appears to exist independent of the amount of wealth (Hoffman and Spitzer, 1993). Many psychological experiments indicate that possession - in either a physical sense or from longtime usage - of an entitlement leads people to value it more than they would if they did not initially own it. The initial entitlement effect leads to disparities between willingness to pay (or 'offer') and willingness to accept (or 'ask') on the order of at least 1:1.5 and often 1:5 and higher (Knetsch and Sinden, 1984). The high-side disparities are especially pronounced when public goods, such as neighborhood amenities, are the subject of the experiments (Knetsch, 1990).

In light of the evidence on the endowment effect, it seems likely that community possession of the entitlement to develop should result in subsequent trades that are far more restrictive of development than if landowners had to be persuaded not to develop. The greater restrictiveness caused by the endowment effect cannot be considered inefficient by the usual economics standard. Pareto efficiency can be achieved for any initial distribution of wealth. The fact that there is more than one efficient outcome in the land-use game is no more remarkable than that there are many points on a contract curve in an Edgeworth box.

It is for this reason that economists cannot simply say that the restrictive zoning and resulting higher housing prices are inefficient. One could step back to challenge the legitimacy of the transfer of development rights from nominal owners to the community (Epstein, 1985). This is problematic, however, given the large number of historically involuntary transfers

(especially involving land) that are now regarded as legitimate, and given that there was never an age or a place in which private landowners had the untrammeled right to develop as they pleased (Ellickson, 1993). Zoning is only a recent stage in governmental restrictions on land use, and it has been widespread for more than 70 years.

One way out of this box for economists is to invoke the contractarian approach of Buchanan and Tullock (1962) and Rawls (1971). Their approach allows economists to consider the distribution of initial entitlements rather than just the opportunities for exchange. It assumes a 'veil of ignorance' in which the people affected by zoning are to make rules about its operation without knowing what their position will be after the 'veil' is lifted and they go about their business. Thus persons making decisions about the proper distribution of entitlements do not know whether they will be landowners, initial community residents, or later community residents who would arrive after the zoning laws are established. (This mirror's one of Frank Michelman's (1967) approaches to the question of just compensation, to which Fischel and Shapiro (1989)applied a formal economic model.)

The people at this convention would balance the benefits of having a nice, low-density community against the benefits of being able to purchase housing in the same community at a reasonable cost. They would do this because they face a risk of being outsiders to the community (and thus have to pay more for housing) as well as being insiders to the community (and thus worry about preserving residential amenities). They might also be concerned that they would end up being owners of undeveloped land, which would induce them to ask themselves whether it is fair for them to bear most of the cost of providing the benefits of a low-density community. This invocation of the Golden Rule offers only a starting point for evaluating questions about land use, but it at least avoids arguments about the 'original intent' of the millions of people whose formal and informal actions over hundreds of years crafted today's property regimes.

8. Decentralized Zoning can Cause Metropolitan Sprawl

Behind the question of whether zoning is 'justified' on efficiency grounds is the question of why spatial proximity matters for the economy. Zoning would be both unnecessary and uncontroversial if all sites had close substitutes. People dissatisfied with neighborhood conditions would just move, and developers shut out of a site by zoning would yawn and go to the next community. Both of these are not what one observes at zoning hearings, and so economists of the law and economics persuasion should understand

some principles of urban economics. (Urban economics texts that also discuss zoning are Mills and Hamilton, 1993 and O'Sullivan, 1995.)

The first is a geography lesson. Urban activities, which account for most of the value-added in the economy, occupy only a tiny fraction of the land area of the United States. Less than 5 percent of the 48 contiguous United States' land area is urbanized by even the most generous definition of 'urban', which includes urban parks, commercial activity, factories and the transportation network as well as house lots (Fischel, 1982). If Americans feel crowded, it is because they seem to prefer crowded places to the 95 percent of the country that is barely occupied.

The concentration of capital and labor on a small land area defies the law of diminishing returns in that urban wages are higher than rural wages, and wages in larger cities are higher than in smaller cities. Firms and other employers can pay higher wages only if there are some agglomeration economies that offset the higher costs. Agglomeration economies - the higher productivity of conducting business in close physical proximity to other businesses - are the reason that cities exist and, arguably, the reason that modern economies are productive.

The impact of zoning on urban agglomeration economies is necessarily ambiguous. In an optimistic view, zoning can be seen as a means by which city dwellers reduce the public diseconomies of crowding while maintaining relatively high concentrations of housing and businesses. Zoning may be the least costly - in terms of minimizing efficiency losses from location conflicts plus administrative costs - means of dealing with urban disamenities. If this is so, then cities and the nations composed of well-zoned cities can become even more productive than they would be.

Making cities more livable attracts more people to live in them and allows for even higher densities, thus taking greater advantage of agglomeration economies (Henderson, 1974). In this sense, zoning is just like an effective sewer system, which allows for larger cities by making high densities healthier and more amenable. Zoning in this light is simply a public good-housekeeping rule: a place for everything, but everything in its place. (But see the arguments that alternative systems might work better, discussed in Section 4 above.)

The less optimistic view holds that zoning does its job of separating 'incompatible' uses too well. The modern enthusiasm (since circa 1970) for 'growth controls' is an example. Growth controls employ zoning powers to restrict the overall development of the community rather than to channel development to particular zones. The supposedly incompatible uses - which often include new housing much like that occupied by the majority of existing residents - are excluded entirely from the municipal boundaries. Because of the multiplicity of zoning instruments and the amount of

discretion involved, it is difficult to distinguish a 'growth control' ordinance from a 'good housekeeping' ordinance. Nonetheless, the qualitative distinction remains clear to most participants.

Laws that discourage all development would seem self-destructive if they were adopted by entire metropolitan areas. This may explain why such laws are seldom seen on a statewide basis. Discouraging development has high political costs because of reduced employment, wages, and state tax revenues. Most American metropolitan areas are, however, composed of many municipalities, each of which can adopt its own zoning laws. One sees some municipalities adopt growth controls while others either do not or positively encourage growth (Dowall, 1984). The net effects are not obvious. Development discouraged in one municipality can end up in another part of the same metropolitan area. The general pattern of land use may be unchanged and, given the Tiebout-driven heterogeneity of tastes among communities, the patchwork may be tolerably efficient.

Despite the foregoing concession to institutional self-ordering, I believe that zoning, at least the growth control variety, has a distinct and (I say with less confidence) deleterious effect on the larger economy (Fischel, 1990). Growth controls are most popular among high-income suburban homeowners (Ellickson, 1977; Dubin, Kiewit and Noussair, 1992). The peculiar pattern of development of modern American cities puts high-income people farthest away from the traditional central city. The uniformity of the 'noose' of high-income suburbs around the central city has been exaggerated, but it is nonetheless a perceptible phenomenon.

Because the majority of homeowner-voters in fragmented metropolitan areas work in other communities, they do not perceive an employment cost to adopting growth controls. This gives rise to a prisoner's dilemma: even if suburbanites were concerned that the sum of local growth controls harm the economic health of the metropolitan area and threaten their own jobs, they would be foolish to make the 'cooperative' move and relax their own zoning standards. The flood of development would overwhelm their community while nearby municipalities took the gains (higher wages, more jobs) without bearing the costs.

The net result of suburban slow-growth policies is that residential and commercial development is forced somewhere else. Although central cities are sometimes eager to take what the suburbs do not want, the jilted developers more often prefer a location with less crime, congestion and corruption. As a result, the development heads to more rural locations, though still arguably in the metropolitan area. The net result of growth controls, I submit, is suburban sprawl. (For theoretical urban models that obtain this result, see Moss, 1977; Sheppard, 1988; and Turnbull, 1991)

Suburban sprawl has been so overblown in the academic planning literature, much of which seems to cast all suburban development as presumptively-excessive sprawl, that economists are apt to discount it entirely. American cities began suburbanizing well before zoning was in fashion, and suburbanization is a worldwide phenomenon. The belief that land-use controls can reverse this trend so as to march businesses back to a single central district and herd commuters into subway cars can charitably be described as naive.

Nonetheless, there is evidence that American cities are more suburbanized than those in otherwise comparable countries, including Canada (Mieszkowski and Mills, 1993). The suburbanization gap cannot be entirely accounted for by America's subsidies to housing (obtainable in high- as well as low-density configurations), its higher income (not so much higher), or large stock of land. Farmland value, not the stock of land itself, is the more relevant economic constraint on the outward edge of suburbanization (Brueckner and Fansler, 1983).

America's freer land market leads to speculation, but that should lead to higher densities, not to lower density 'sprawl' (Ohls and Pines, 1975; Mills, 1981). Speculators buy up land at the urban fringe well in advance of development. They decline to sell to initial developers with low-density plans and wait until higher-density uses materialize. This creates a pattern of leapfrog development followed by higher-density infill, with the long-run result directing higher-density uses closer to city centers (Peiser, 1989).

Simply to say that American cities are more sprawling is not to say that local zoning-induced sprawl is inefficient. It could be that other nations' metropolitan areas are inefficiently dense as a result of national land-use policies (Hannah, Kim and Mills, 1993; Mayo and Sheppard, 1996). What leads me to the suspicion of sprawl's inefficiency is that numerous studies have found that the instruments of low-density zoning cause substantial losses to owners of undeveloped land (J. White, 1988; Brownstone and Devany, 1991). Only a few have attempted to compare these losses to the gains that simultaneously accrue to owners of previously-developed land (Frech and Lafferty, 1978), but there are no cases in which the apparent gains exceed the losses. Given that localized net benefits of public activity should to some extent appear in urban land values, there is reason to suspect that American growth controls are inefficient.

In attempting to explain this alleged inefficiency, one must look at some larger issues that distinguish American cities (here to mean metropolitan area) from those of the rest of the world. The distinctive differences are American cities' more fragmented government, their higher violent crime rates and, compared to most developed nations, the wider variation in income, most probably associated with America's history of racial inequality.

High-density housing (especially publicly-financed housing) and commercial development are widely associated in the public mind with higher crime rates, higher taxes and lower quality public services, all of which lower the value of existing owner-occupied housing. While many courts and statewide policies are hostile to selective exclusion of the poor (Haar, 1996), they usually look benignly on general exclusion in the name of open space, small-town character, and farmland and wetland preservation. Rational suburbs have embraced the latter causes to help pull up the drawbridge. The frequent local alliance between promoters of farmland preservation and environmental protection - the former activity usually less tolerant of species diversity than a typical housing subdivision - may be accounted for by their joint effect of forestalling development and preservation of open space.

The success of exclusionary policies in turn encourages the maintenance of local government fragmentation. There have been many studies that have decried the inequalities that suburban fragmentation brings. Their authors, most notably Downs (1973, 1994), have proposed policies that would reduce the fragmentation of metropolitan governance. But if fragmentation is the result of rational concern about crime and the quality of public services by a majority of voters, it seems unlikely that such reforms will succeed.

I think that anxiety about crime and related social disorder is the most powerful reason for excluding growth (Skogan, 1990; Cullen and Levitt,1996). Policies that have made local services and property taxes more uniform - especially California's Serrano decisions and Proposition 13 - have not produced any apparent reduction in suburban exclusivity. If a 'first cause' of suburban exclusiveness could be identified, I would suppose it to be anxiety about crime and related public disorderliness.

The consequences of excessive decentralization are widely regarded as involving excessive commuting and the external effects that come with automobile traffic. Evidence suggests, however, that automobile commuting has not risen much, largely because employment has become nearly as suburbanized as residences (Gordon, Kumar and Richardson, 1989). But decentralization of firms may itself have adverse effects. On a distributional level, it may make it more difficult for members of minority groups, who may find it more difficult to purchase residences in the suburbs, to find employment (Gabriel and Rosenthal, 1996). On an efficiency level, excessive decentralization of firms may reduce the agglomeration economies that make cities productive places. Changes in communications technology may be making such agglomeration economies less important, so it is difficult to evaluate the extent to which decentralization, whatever its cause, is inefficient.

9. Localism Trades Environmental Quality for Fiscal Benefits

The previous section addressed concerns that local zoning is too restrictive of development, especially in limiting the extent and type of housing. But there is another group of critics who have argued that zoning is not restrictive enough. Advocates of environmental protection express exasperation with local decisions that permit developments whose adverse effects spill over to the rest of the region (Reilly, 1973). This gives rise to at least two issues.

The first has it that competition among municipalities for commercial and industrial property will create a 'race to the bottom' in environmental quality, causing the environment of both the community and its region to be degraded. The second issue concerns itself with relations between the community and its immediate neighbors. It is commonly asserted that communities pursue a 'beggar thy neighbor' policy by zoning land on municipal borders for such unlovely uses as landfills, shopping centers, sewage plants and industrial parks. Because such policies may invite retaliation, the story goes, beggar they neighbor also reduces the quality of the regional environment. I shall treat them in reverse order.

The ratio of evidence to assertion of the beggar-thy-neighbor idea is remarkably small. Sewage plants are, by casual observation, often close to municipal borders, but that is most likely because water runs downhill. The least costly place to put such a plant is at the lowest point in the community, and that is often the point at which a river leaves the jurisdiction and enters another. (As I tell my undergraduates, if it were practicable to require municipalities to take in drinking water downstream and release sewage in the same river upstream, each community would have the optimal incentives to treat its sewage. For less fanciful, common-law approaches to disputes among municipal neighbors, see Ellickson, 1979.) But it is worth unpacking this proposition because of the light it may shed on intercommunity relations and their consequences for environmental issues.

Imposing unilateral costs on one's immediate, permanent neighbors is perhaps one of the least profitable activities in the world, as any homeowner knows. The reason is that one has to live for a long time with such neighbors and, over the long run, there will be many opportunities for the neighbor to retaliate. The retaliation at the municipal level could be unfavorable treatment along other borders, but it more likely would be lack of cooperation in other intermunicipal activities. They include mutual aid agreements for fire and police protection, cooperation for specialized school programs and coordination of regional development activities.

This does not mean that all intermunicipal spillover will be internalized by a self-interested spirit of neighborliness. But self-interested

neighborliness is observed often enough in other activities that it would be strange to rule it completely out in the municipal land-use context. Where one would expect it not to succeed is when the costs can be imposed on a highly diffuse and remote group of communities. Upper-atmosphere and large-river pollution would not necessarily rise to being an affront to one's immediate neighbors. But hardly anyone disputes the idea that such spillovers require the attention of larger-area governments, and that most of the controls should be aimed at the activity that gives rise to the pollution, not the specific location of the polluter.

The 'race to the bottom' claim is a more common and more important criticism of local land-use autonomy (Esty, 1997). There is little doubt, as an empirical matter, that municipalities do seek to have commerce and industry locate within their borders in order to promote local employment and improve the local tax base (usually property taxes). Because many communities do so, it is likely that some of the competition takes the form of relaxed environmental standards, if one understands such standards to include all conceivable infringements on residential amenities.

Much of the criticism of this process comes from those who at least assert that any public sacrifice of environmental quality in exchange for other goods is unacceptable. It is generally agreed that some forms of exchange are desirable and that the presumption of a catastrophic 'race' to an environmental Armageddon is not warranted (Oates and Schwab, 1988; Revesz, 1992). But less extreme criticisms of regulatory federalism are possible. The more plausible anxieties focus on failures of the local political process to value the foregone amenities (Esty, 1997). Within the homeowner-dominated community, one would expect that amenities would be capitalized in the value of homes. Lower property taxes (or other ongoing fiscal benefits from firms) increase their home values, but the disamenities of firms that pay the extra taxes would tend to lower them.

Several theories hold that this trade-off provides efficient incentives in the homogenous homeowner community in which the median voter prevails (Fischel, 1975; Fox, 1978). The implication of this view is, incidentally, that most 'property rich' communities have in fact paid for the fiscal benefits of an industrial tax base in foregone amenities; the larger tax base is not a windfall. This does not mean, of course, that homebuyers in such communities received no gains from the exchange, only that redistribution of tax bases would cause some regret (and capital losses) among communities that had been willing to accommodate industrial uses (Gurwitz, 1980; Ladd, 1976).

All of this is not to suggest that there are no asymmetries in the local process. Voters who are renters might be indifferent to improvements captured in property values, so they might be more inclined to vote for land-use policies that increased their wages even if property values shrank. (This

could be partly offset by rent control, which gives renters a stake in property value changes.) On the other hand, compensatory payments by firms may be inhibited by the transaction costs of working through the public sector, thus biasing the result towards a residential status quo.

The more troubling issue in this vein is the charge of 'environmental racism' (Been, 1993). The charge is that communities with minority populations are forced to endure disproportionately large amounts of unpleasant commercial and industrial development. The evidence for this is typically that the poor, who are disproportionately minority-group members in the US, are more often close neighbors to commercial and industrial development than the rich. The larger question is whether this is the result of a political process that is biased against the poor generally and minorities specifically.

The difficulty with the environmental-injustice charge is that evidence of it hinges on a particular historical sequence of events. Some sequences would seem benign. Been (1994) developed evidence that low-income and minority households establish residence near waste incinerators after they have been established - they moved to the pre-existing nuisance. But how did the 'nuisance' get placed there in the first place? Was it forced upon local governments or did the locals actually invite it for tax or employment reasons?

It is known that low-income communities are often more willing to accept - not forced to accept - fiscal and employment benefits in exchange for permission to develop commercial and industrial properties (Fischel, 1979b). This means that poor communities, which often have disproportionately large minority population, would, under a median voter model, end up with disproportionately large amounts of unpleasant commercial and industrial development. They would get it because they wanted the fiscal and employment benefits. (The lower participation rate of low-income voters in the local political process does, however, raise the question of whether silence means consent.)

Within larger, more heterogeneous municipalities, the issue would seem to turn on the efficacy of logrolling and neighborhood representation in siting unwelcome but necessary uses. One could imagine a process in which mutually advantageous logrolling results in industrial development largely in the low income areas whose residents value the employment benefits more. Less optimistically, one could also imagine underrepresented minority areas getting the short end of the stick, all of the costs without much benefit. Hinds and Ordway (1986) found that commercial rezonings, often not desired by residential neighbors, were once more likely to occur in black districts in Atlanta than in predominately white districts. They noted, however, that the disparity was eliminated once black neighborhoods were

better represented on city council as a result of eliminating at-large elections and adopting council districts.

10. Conclusion: Municipal Corporations are Key Institutions

It has been my contention that viewing zoning as a municipal property right provides better insights into zoning than other approaches to zoning that neglect property rights issues. This has been a somewhat one-sided test, though, since I have not explicated other theories. Most other approaches are based on the principle that externalities in the land market can be corrected by government planners (Pogodzinski and Sass, 1990). The property rights approach attempts to unpack that sentence by asking what, precisely, constitutes an externality, and what institutions are best for dealing with conflicts among neighbors, whether they be adjacent property owners or cities and their suburbs.

The development of a law and economics approach to land use controls has been hampered by scholarly neglect of the role of the municipal corporation, which is in contrast to the vast literature on private corporations. Many law and economics treatments of land use proceed as if the nature of the problem were private, as between two adjacent landowners, and the only recourse the parties had was to a common-law court that had a choice between equitable (injunctive) and legal (damages) remedies (Cooter and Ulen, 1988, ch. 4). I believe that the private-law focus of mainstream law and economics has resulted from the application to practical issues of the theoretical treatments of the property rule/liability rule issue, which often uses land-use disputes as an example (Polinsky, 1979; Krier and Schwab, 1995). The touchstone of the property rule/liability rule issue is Calabresi and Melamed (1972), who also used land-use conflicts as examples, and the two pre-eminent examples of the distinction are the leading case in nuisance law, *Boomer v. Atlantic Cement*, and its forlorn but fascinating cousin, *Spur Industries v. Del Webb*.

Boomer concerned the nuisances of blasting and cement dust that the cement company inflicted on Mr Boomer and a group of pre-existing neighbors. Spur concerned a smelly Arizona cattle feedlot next to which Del Webb built a retirement city. The legal remedies - cast as ‘property rules’ and ‘liability rules’ - in both cases are much discussed in the literature, but such remedies are in fact almost entirely beside the point in the real world. The reason is that such uses are subject to zoning in most communities. (Indeed, the Spur court pointed out that Del Webb, the developer of houses adversely affected by the feedlot, was less deserving because he had skipped

out of the zoned area of Phoenix, and for that reason Del Webb had to pay Spur to move its feedlot.)

The problems of organization, information gathering, strategic bargaining, decision making and other transaction costs that are said to hobble private bargaining are in fact almost always channeled through municipal corporations. The channeling does not 'solve' such problems, but it does cast them in a different light for scholars. All municipalities possess the powers of eminent domain, taxation, and police-power regulation. Almost all of them are subject to democratic governance procedures, and the extent of their authority is broad (Ellickson, 1982b; Briffault, 1990). No applied theory of zoning or discussions of general land-use policies should neglect this long-standing institution.

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2300
ENVIRONMENTAL REGULATION

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Abstract

This chapter discusses the economics of environmental regulation by first focusing on the use of cost-benefit analysis in environmental law and policy and in environmental standard setting. Then the various legal instruments to control environmental pollution are discussed as well as the theory of regulation. Also the combined use of regulation and other policy instruments such as liability rules, is discussed. Finally issues of environmental federalism and specific environmental problems such as the nuclear risk and marine oil pollution were discussed.
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1. Introduction

The goal of this chapter on environmental regulation is to provide some insight in the law and economics literature dealing with the policies aimed at solving environmental problems. For several reasons it is difficult to designate the boundaries of this topic. First of all the legal regimes dealing with environmental pollution may be quite diverse, varying from liability rules to environmental taxes or environmental criminal law. Some of these topics will be dealt with in other chapters such as in Chapter 2000 on common property and regulation of the environment. We will try to provide a rather global overview of the law and economics literature concerning the environment, but topics that are explicitly addressed in other chapters will obviously just be touched upon briefly. This is the case for nuisance (Chapter 2100), zoning (Chapter 2200), compulsory insurance (Chapter 2400), pollution tax (Chapter 2500) and several issues relating to liability law (Chapter 3000). Some of these topics, for example liability, law will nevertheless be discussed, especially as far as it concerns literature that is explicitly dealing with the problem of environmental liability.

A second reason why it might be difficult to provide an overview of law and economics literature regarding environmental regulation is that there is, on the

one hand, a large body of legal literature dealing with environmental law, not addressing pollution from an economic point of view and, on the other hand, literature on environmental economics, which studies the effects of economic instruments and the implementation by firms and households. Some of this literature on environmental economics can obviously be of interest to environmental *law* and economics in as far as the legal instruments to implement environmental policy are studied. However, in this literature the various legal instruments to control environmental pollution are usually not the central focus of the research questions. We will mainly try to focus on literature where the acceptability, feasibility, effectiveness and efficiency of various *legal* instruments to implement environmental policy are discussed both from a theoretical and from an empirical point of view. The vast body of literature on environmental economics in the strict sense will therefore not be addressed in this bibliography on *law* and economics.

This chapter discusses the law and economics with respect to 'environmental regulation'. These words often refer to the so-called 'command-and-control' approach to environmental problems in society. Command-and-control regulatory instruments such as environmental standards and targets, together with other administrative obligations and prohibitions are often referred to as 'legal instruments'. This term is then used in contrast to economic instruments, such as taxes or marketable pollution rights. This terminological division is, however, somewhat misleading. Indeed, also liability rules and traditional command and control mechanisms such as for example emission standards are economic instruments in the sense that they will give an incentive to actors to comply with certain policy goals. In addition: the so-called economic instruments are also legal in the sense that a system of ecological taxation or of marketable pollution rights needs a legal framework as well for example determining who should pay how much of a certain tax on what type of activities and when.

It is not easy to indicate which of these policy instruments can be considered as 'environmental regulation', the topic of this chapter. Economists may consider environmental regulation as all government intervention with regard to the protection of the natural environment. This direct regulation, taxation and transfer payments via the liability system would all be considered classical instruments of government intervention from an economic point of view. Lawyers on the other hand would consider liability rules as being different than direct regulation (see also Shavell, 1984a). For the purposes of this contribution, however, both liability rules and other common law instruments are all classified under the name 'environmental regulation' and thus discussed in this chapter.

It might be interesting in this introduction to refer briefly to some of the text books on environmental economics, some of which also discuss the relevance of various legal instruments. We can, in alphabetical order, for example refer

to Ayres (1978), Baumol and Oates (1979), Endres (1985a, 1985b), Field (1994), Frey (1992), Kahn (1995), Kneese (1977) , Oates (1996), Pearce and Turner (1990), Portney (1990), Revesz (1997), Richardson, Burrows and Ogus (1982), Tietenberg (1992) and Ward and Duffield (1992).

Furthermore, those interested in an overview of recent literature with respect to environmental economics can be referred to the survey by Cropper and Oates (1992). As far as books on environmental law and economics are concerned, we can, for example, refer to Ackerman et al. (1974) and Eide and Van den Bergh (1996).

The remainder of this contribution to the Encyclopaedia is structured as follows. After this introduction it will be sketched how the basic literature on externalities is applied to the pollution problem (Part A); then we will turn to the importance of cost-benefit analysis for environmental standard setting (Part B). In Part C the various instruments to control environmental pollution will be sketched, including environmental liability and compensation mechanisms. Environmental safety regulation will be addressed in Part D and Part E will be devoted to problems of environmental federalism. Special attention will be given to nuclear liability and regulation of the nuclear industry in Part F. Marine oil pollution issues will be discussed in Part F. A few concluding remarks and points for further research will be addressed in Part G.

A. Pollution as an Externality

2. Coase

In many textbooks on law and economics pollution is presented as the classic example of an externality. A factory might engage in socially beneficial activities such as, for example, the production of pharmaceutical products, but this production process may bring about negative side effects, such as the emission of smoke or waste water. Much of the law and economics literature on environmental law is simply dealing with the two fundamental questions, being

- What is the optimal level of emissions (which will be addressed in Part B)?
- How can the law give incentives to comply with this optimal level?

Traditional economists would answer that the right incentives can be given by imposing a tax on the polluting activity. Since this idea builds on the earlier work of Pigou (1951) this is usually referred to as a Pigovian tax. By equalling the marginal tax rate to the marginal costs caused by the harmful activity the factory would get incentives to reduce pollution in an optimal way. However, in his seminal article ‘the Problem of Social Cost’ Coase showed that if

transaction costs are zero an optimal allocation of resources will always take place irrespective of the contents of the governing legal rule (Coase, 1960). Coase stressed the reciprocal nature of harm, meaning in this particular case that the pollution is not just caused by the harmful emissions of the factory but also by the presence of neighbours who are, for example, injured through the smoke emissions. The crucial question therefore is not how the law should give incentives to force the factory to reduce emissions. First of all the question should be asked which of the two actors (factory or victims) should be limited in their activity (and maybe the answer is both, if both can take optimal precautions).

If it is, for example, established that the factory is emitting smoke causing a harm of 200 to each of the three victims living in its neighbourhood, that there is no feasible way in which the victims could prevent this harm from occurring and that all the emissions could be reduced by installing a filter which costs 500, the optimal solution is obviously that the filter should be installed. It follows from the Coase theorem that if the conditions are met, the filter will indeed be installed no matter what the contents of the legal rule are. If the law holds the factory liable to pay compensation to the victims, the installation of the filter (which costs less than the compensation payments) is obviously in the interest of the factory. But the same result will hold if the factory is not liable and victims bear their own damage. Given the zero transaction cost assumption they will get together and negotiate with the factory to convince the owners to install the filter. Also if the victims pay for the filter, the price they pay may be less than the costs they would incur if the emissions place.

Obviously, the efficient outcome may not follow if one of the parties behaved strategically or if the zero transaction cost assumption was not met. In addition, it is clear that the Coase theorem only deals with the efficiency aspect of social problems, not with distributional aspects. Indeed, although the efficient result will hold in both cases (liability or no liability), there is a distributional difference: in the first case the factory pays for the filter; in the second case the victims do. Hence, the contents of the legal rule will matter from the victim's perspective. This may be a reason why, from a policy perspective, the legislator sometimes intervenes to make the polluter liable even in situations where the conditions of the Coase theorem were fulfilled.

This Coase theorem is used by many scholars as a starting point for discussing the role of environmental law and, more generally, the need for legal instruments to control environmental pollution. In this respect we can refer to Baumol and Oates (1979), Frey (1992); Oates (1983) and to Schulze and D'Arge (1974). A literature overview is presented by Mishan (1971a). A drawback of the Coase theorem, especially as far as it relates to environmental problems, is that in real life the situation given in the example of one factory emitting smoke that would affect just three victims, rarely exists. Usually there

are cases of multiple victims where transaction costs will be prohibitive. These drawbacks lead to scepticism concerning the importance of the Coase theorem for environmental problems by, for example, Mishan (1971b) and Kapp (1970). In cases where transaction costs are indeed prohibitive, the Coasian negotiations will not take place and some intervention of the legal system will then remain necessary to reach an internalization of the externality.

3. Nuisance

Nevertheless, there are some doctrines in environmental law closely related to the situation discussed in the Coase theorem. Both relate to the important point made by Coase that harm has a reciprocal nature. From this it follows (1) that it is efficient that both actors take precautionary measures to reduce harm. The law should give incentives for such optimal precautionary measures to both injurer and victims and (2) that if there is an incompatible use of property the efficient solution is obviously not always that the factory should relocate. These issues are addressed in the so-called first use doctrine and in nuisance law. We shall not discuss nuisance law here since it is addressed in Chapter 2100 (Nuisance). It is, however, interesting to stress that this reciprocal nature of harm (stressed by Coase) can also be recognized in nuisance law (Epstein, 1993). The law and economics literature of nuisance law generally holds that both actors should face the social costs of their actions: polluters must pay for incremental harm they cause and victims must not be compensated for excessive harm they could have avoided at a lesser cost (Dewees, Duff and Trebilcock, 1996, p. 267). Landes and Posner hold that therefore courts do not award an injunction to stop pollution unless the damage exceeds the costs of abatement (Landes and Posner, 1987, p. 44). This solution recognizes the reciprocal nature of harm.

4. First-Use Doctrine

The first-use doctrine (also referred to as the coming to nuisance defence) relates to discussions that arise when, for example, a factory was located in a relatively empty area and is afterwards confronted with neighbours who ‘came to the nuisance’ and then claim compensation or even the relocation of the factory. In an *ex ante* perspective these kind of problems should not emerge since citing decisions of firms could efficiently be made looking at the optimal area that is suited for a particular activity. This has been extensively dealt with in the law and economics literature relating to zoning and more particularly in the work of Ellickson (1973). Zoning and land use regulation are explicitly dealt with in this Encyclopaedia in Chapter 2200. From an *ex post* perspective

the law and economics literature, best represented in a paper by Wittman (1980), generally holds the following rules of thumb. If relocation of one of the two conflicting activities is the only way out, one should in principle examine whose costs of relocation are the largest. However, it should also be examined whether the costs of nuisance have already been integrated, for example, in the price paid for the property (next to a railway station). If a much lower price was paid, the externality in fact has already been compensated for and the house-owner cannot claim relocation. Third, the foreseeability of harm is an important criterion as well. The newcomer will have more chances of success if the harmful activities were for example extended in a totally unforeseeable way. Finally, after the decision on who should relocate is made, the question will have to be answered who should pay for the relocation costs. Again foreseeability may be an important criterion in that respect if, for example, many citizens knowingly started building houses close to a factory. Even if relocation costs for the firm would be lowest (and he should therefore relocate) the house owners might have to reimburse the factory for (part of) the relocation costs (see also Epstein, 1979, 1993; Faure, 1994).

5. Cost-Benefit Analysis

5.1 Importance for Environmental Policy

Since we concluded, when discussing the Coase theorem, that in most cases of environmental pollution with multiple victims the zero transaction cost assumption will not be met, some intervention of the legal system will be necessary. Before addressing the variety of legal instruments that can be used to control environmental pollution, the first question to be answered is how the optimal level of pollution should be determined. This question has been addressed from different angles by economists. The starting point is usually the earlier work of Pigou which suggests to impose taxes on a particular activity that should be equal to the marginal social damage it generates. In this Pigovian tradition Baumol and Oates (1971) proposed the use of standards and prices for protection of the environment. Baumol and Oates propose a predetermined set of standards for environmental quality and then advise the imposition of unit taxes to achieve these standards. The appeal of their approach lies in the workability. Baumol and Oates do not need the information that is necessary to determine the appropriate set of Pigovian taxes and subsidies. Although they do not claim that their pricing and standards technique will lead to an optimal allocation of resources, it will reduce the level of environmental damages. In addition they claim that the selection of standards is quite similar to the one already used in public programmes, which should increase the practicality of their pricing and standards approach. This approach has long been the starting point for environmental economic analysis

(see also Schelling, 1983; Tybout, 1972), which approach claims that first a standard of environmental quality will have to be determined (the issue of standard setting will be discussed in further detail below) and then the optimal tax to reach this quality (which is one possible instrument to reach this goal).

However, this approach only provides a partial answer. Indeed, the question still remains how the optimal environmental quality should be determined taking into account a possible conflict with other values. In addition, at the more practical level, the question arises how one should choose between different abatement techniques to comply with the optimal environmental quality. These kind of questions will be answered using cost-benefit analysis, an approach with a substantial history in economics (see, for example, Mishan, 1974a). In environmental policy cost-benefit analysis will be used for example to determine the environmental quality of a certain environmental component, but also to make a trade-off between various abatement techniques. Many authors have shown how traditional cost-benefit analysis can be applied in environmental policy, for example, Ackerman et al. (1974), Oates (1976), Field (1994), Abelson (1979), Cocker and Richards (1992), Tolley, Graves and Blomquist (1981). Nevertheless, there is also criticism on the use of cost benefit analysis from a legal perspective (see, for example, Sagoff, 1981, 1988; Hrezo and Hrezo, 1984; Farber, 1989). Oates (1976, p. 54) pointed out that a cost benefit study involves several essential steps: the first is simply an enumeration of the various forms of benefit costs inherent in the undertaking of for example the clean up of a river. The second step is to assign actual dollar values to the various forms of benefits and costs. The third step involves the selection of a rate of discount for the evaluation of benefits and costs that are expected to accrue in future years. Finally, the present discounted value of the entire expected future stream of benefits and costs will be calculated. In simple words: 'if society is to make the most of its cares resources, it should compare what it receives from pollution control and environmental protection activities with what it gives up by taking resources from other users. It should measure the values of what it gains (the benefits) and what it loses (the costs) in terms of the preferences of those who experience these gains and losses' (Freeman, 1997). The ways of discounting the benefits and costs of environmental regulations are also discussed by Kolb and Scheraga (1990).

Also in public finance since the 1950s public policies have been advocated to control externalities on a marginal cost equalling marginal benefit basis. For this literature on policy analysis see, for example, Friedmann (1984), Stokey and Zeckhauser (1978) and for an overview Rose-Ackerman (1992a). Cost-benefit analysis will obviously also be used when a choice has to be made between various environmental techniques which are all available at different costs and which can all lead to different levels of accident reduction. In an ideal world, incentives would be given to choose the efficient environmental

technique, being the technique for which the marginal costs equal the marginal benefits gained in accident reduction. Requiring a more expensive environmental technique, which could lead to even more reduction of environmental damage, would be inefficient if the marginal costs would be higher than the additional benefits in reduction of environmental damage. With such a balancing process an optimal environmental quality can be determined and optimal environmental techniques can be chosen.

5.2 Limits of Cost-Benefit Analysis

Obviously, this brief sketch of the importance of cost-benefit analysis for environmental policy cannot provide for an indebt discussion of economic theory on this particular point. It seems important to remember that generally economists agree that environmental policy should be based on some weighing of costs and benefits. It is, by the same token, also important to stress that although these principles may be accepted, there is also considerable critique on the use of cost-benefit analysis with respect to environmental problems. One weakness is that a cost-benefit test does not indicate to whom the benefits accrue and who beares the costs (Oates, 1976, p. 56). In other words, it does not take into account distributional matters. More importantly: the question arises how, in environmental matters, benefits of environmental policy can be calculated. One question is whether the benefits will be addressed merely from an anthropocentric perspective by, for example, merely focusing on a reduction of risk to human health or from an ecocentric perspective. Another question is how benefits should be measured if they concern a reduction of a possible threat to an entire ecosystem. The question arises whether the traditional 'willingness to pay' test, which relies on market criteria, suffices to value environmental damage.

5.3 Cost-Benefit Analysis in Environmental Law and Policy

An important part of the remainder of this contribution will be devoted to the question how the law can give incentives to adopt an environmental policy (at government and at individual firm level) that corresponds as much as possible with these principles of weighing marginal costs versus marginal benefits. It might be interesting to mention that increasingly cost-benefit analysis is referred to at the policy level. In the recent work of Sunstein (1993, 1995, 1996b) and Ogus (1995, 1997) it is claimed that policymakers generally, but also with respect to environmental policy, should take cost benefit analysis into account in policy design. Cost-benefit analysis is obviously also used for example to analyse whether the benefits of superfund cleanups justify the costs, a question addressed by Gupta,Van Houtven and Cropper (1995).

Finally, we can point at the fact that environmental law generally seems to rely increasingly on notions such as ALARA (As Low as Reasonably

Achievable), BPM (Best Practicable Means), BPEO (Best Practical Environmental Option) and BATNEEC (Best Available Technique Not Entailing Excessive Costs). Ogus claims that these notions aim for socially optimal levels of pollution where the marginal social costs of pollution abatement are roughly equal to its marginal social benefits (Ogus, 1994b, p. 207). Faure and Ruegg (1994) claim that the BATNEEC notion by its reference to the avoidance of 'excessive costs' refers to the marginal costs/marginal benefit test. Thus, the BATNEEC notion allows for more efficient environmental standard-setting and for an explicit application of the economic model. The BATNEEC notion (or varieties of it) can now also be found in European legal documents, such as the recent directive on integrated pollution prevention and control (see a discussion by Faure and Lefevere, 1996).

Moreover, the use of cost-benefit analysis is often advocated by economists in order to choose those policies which minimise costs for society. Cost-benefit analysis can, for example, play a role prior to a regulatory intervention to assist in choosing the most efficient policy. This area of research, which is in fact a direct application of the law and economics approach, is referred to as the 'economic analysis of environmental regulation'. Some of the work in this area includes the design of models for policy analysis; other work is more practical and looks at the costs associated with alternative policy options. Arnold (1995) provides a good overview of the issues at stake.

6. Environmental Damage Assessment

This brings us to an important second topic related to the pricing of environmental pollution. The valuation of environmental damage is obviously important for the just mentioned cost-benefit analysis, but also when the compensation due in a tort case has to be established. Economists have established a variety of techniques for valuing environmental damage. One method is the so-called hedonic price technique. This is based on the analysis of market data from transactions in private goods and services which are related to the characteristics of the public good under consideration. In other words, in the hedonic price technique the value of changes to the natural environment are analysed by the perceived monetary changes this has caused in markets of influenced goods. It is then, for example, assumed that housing values would reflect the variation in the quality of environmental goods. House prices can be a function of natural surroundings such as the presence of parks and forests. On that basis an evaluation of environmental improvement could be undertaken based on an estimation of the house price function. This approach has, for example, been applied by Hoch and Drake (1974), Harrison and Rubinfeld (1978) and Nelson (1978) and for a critical analysis Maler

(1977). The alternative is to ask individuals to state their willingness to pay for environmental improvement directly, using a survey questionnaire. This is referred to as contingent valuation and is based on a hypothetical allocation procedure for the particular public good. This more direct approach is based on, for example, Davis (1963), Bradford (1970) and Bohm (1971) and for a comparison of both methods of analysis see Pommerehne (1988). There is a lot of discussion of contingent valuation in the US since it is being used under some environmental laws (see for a critical analysis Hausman, 1993). Another option is the use of travel cost studies to estimate environmental benefits. Travel cost studies have been used to treasure the benefits of recreational options (see, for example, Krutilla, 1967).

General attention to methods of valuing environmental damage is also given in the work of Kapp and Smith (1992), Johansson (1990) and Pearce (1976a, b). Recently a lot of attention has also been paid to the interests of future generations and the question how some kind of intergenerational equity can be taking into account in environmental valuation (Krutilla and Fischer, 1985). Howarth and Norgaard (1992) showed that the valuation of environmental services and how society cares for the future are interdependent. They claim that the valuation of non-market goods and social objectives are intertwined.

B. Environmental Standard Setting

7. Target Standards

The further question to be addressed is how the above discussed cost-benefit analysis can be used to set legal standards efficiently. This is the problem of environmental standard-setting. It seems appropriate to state from the outset that one has to distinguish between various different standards, in order to avoid confusion. When economists discuss standards (such as Baumol and Oates in their classic paper on 'The Use of Standards and Prices for Protection of the Environment' 1971) they usually refer to what is called in legal terms a target standard or a quality standard. This standard defines the optimal environmental quality for a certain environmental component and is also referred to as an ambient standard. This can take different forms. The quality standard could very broadly state how for example a particular habitat should be shaped in an optimal ecological way, or it should simply refer to specific chemical parameters to which for example the water in a creek should comply. As we have explained above, economists have traditionally argued that the law should limit itself to set these targets, whereby the instruments to reach these targets should be incentive-based (see in addition, Schultze, 1977). When lawyers refer to standards, they usually refer to the regulatory measures, usually used and imposed by administrative agencies, that prescribe what measures a

factory causing an externality should take to prevent harm. These measures can be imposed in general rules, but can also be found in individual licenses. In the environmental area they will often take the form of emission standards, prescribing the particular quality and quantity of the emissions into the environment. Non-compliance with such standards is usually enforced with administrative and/or criminal sanctions. Since in that particular case the actor is not free to choose the measures he wishes to use, to reach an optimal environmental quality, this approach is by economists often referred to as the 'command and control' approach. In order to avoid this confusion concerning the notion of standards we shall, following the work by Richardson, Ogus and Burrows (1982) distinguish between three types of standards: target standards, emission standards and production standards. The first ones are the target standards, which are often referred to as ambient quality standards. They specify the environmental quality as such, being how much of each pollutant may be present in a particular environmental component. Ogus (1994a, p. 28, 1994b, p. 208) points out that these quality standard may not entirely solve the information problem. If the harm is not closely connected to the activity, the agency costs of determining the causal connection may be very high since the harm may also result from other activities. Target standards are therefore generally in the first place addressed to the standard-setting agency.

8. Emission Standards

A second type of standard often used in environmental policy is the emission standard. These standards still leave some freedom to the potential polluter, since they usually only determine (in general rules or individual licenses) the amount and quality of the substances that can be emitted into the environment. There is obviously less freedom than with mere quality standards. Quality standards would leave it completely up to the firms how to comply with the target set. When emission standards are used, the quality and quantities of the emissions are regulated. Still, emission standards leave more freedom than the third category, production standards. These standards, which are also referred to as specification standards, regulate at an early stage of the production process by, for example, determining what kind of production technology will have to be used by the firm. The disadvantages of the latter standards are obvious: they may become obsolete very rapidly, delay technological changes and may have significant anti-competitive effects (see Ogus, 1994a, p. 29, 1994b, pp. 209-211; Stone, 1980; Stewart, 1981).

In legal practice one could traditionally mostly find emission standards (the traditional command and control approach). They have been criticized from an environmental point of view, since by merely focusing on individual emissions

of separate firms, an agency would not envisage the effects of the overall pollution on the specific environmental component. This problem could be remedied if the total number of firms is known and there are no expected new entries. This shows that emission standards are therefore momentary static instruments. The overall pollution can no longer be controlled by emission standards as soon as the market situation changes. Moreover, emission standards as such gave little incentives for innovation in abatement technology and further reduction of environmental harm. The innovative effects of various policy instruments are discussed by Downing and White (1986). Policy therefore changed to an increasing use of target standards, but in many countries the target (or ambient quality) standards did not replace the emission standards. In fact, ideally first the optimal environmental quality is determined and afterwards the emission standard of the different firms are fixed in such a manner that the aggregate pollution coming from the various emissions will not exceed the environmental quality standards set. The case for specification standards is generally weak, unless the standard setter has better information than firms concerning the optimal production technology or innovation activity, which is, however, unlikely to occur (Ogus, 1994a, p. 29).

Ideally, one would therefore find target standards defining the environmental quality and, depending upon the implementation instruments chosen (see Section 4) possibly emission standards as well. These emission standards should indeed not necessarily take the form of regulatory standards of the command and control type (for example in licenses), but could also be implemented in emission taxes or take the form of the due care standard in a liability case.

9. Standard-Setting and Cost-Benefit Analysis

The question arises how the cost-benefit analysis discussed above fits into this standard-setting scheme. Cost-benefit analysis will first of all play a role when environmental targets are determined, as has been indicated above. But also at this second stage of defining emission standards, will cost-benefit analysis play a role. In an optimal world where the regulators set emission standards in the public interest, the administrative agency will take into account the marginal costs of more stringent environmental standards and balance these against the marginal benefits from additional reduction of environmental harm. This refined balancing process requires accurate information both on the expected environmental harm and on the marginal costs of the various technical devices that could prevent this harm (and on the corresponding emission standard). Depending on whether either the parties in the market setting or an administrative agency can be assumed to have the best information this will

lead to a choice for fixing emission standards via tort law (in which case they will correspond with a due level of care) or via regulation (in which case they will be incorporated as a condition of the administrative license).

Obviously, a large body of literature had addressed the efficiency of various emission standards, especially comparing the traditional command and control approach with more incentive-based systems to reach an environmental quality. Oates, Portney and McGartland (1989) pointed out that incentive-based policies are not necessarily superior to command and control approaches. This is more particularly the case when command and control approaches are designed with at least one eye on cost savings and when the overdeterrence results in other compensating benefits. This outcome is particularly true if economic analysis plays a considerable role in command and control standard-setting. If cost-benefit analysis is indeed applied in environmental standard-setting many of the inefficiencies may disappear and outcomes can be produced that compare quite well with incentive-based alternatives. Another example is provided in a paper by Stephan (1988), who also argues that (1) emission standards have important distributional effects; (2) they lead to a significant reduction of waste water emissions; and (3) they encourage implementation of less polluting production techniques in the long run.

10. Principles of Environmental Law

To conclude this discussion of the importance of cost-benefit theory for environmental standard-setting it might be interesting to contrast the economic approach with recent evolutions in environmental law. We already pointed out that the recent use of general principles of standard-setting, such as BPM, ALARA and BATNEEC, seems to allow for an increased use of economic methodology in the environmental standard-setting approach. There is, however, another tendency in environmental law that might be somewhat in contrast with this increased attention for cost-benefit analysis. In international documents, such as the RIO declaration, Agenda 21 and the EC Treaty as it has been modified by the Treaty of Maastricht, several general principles of environmental law are incorporated. The status of these principles is still somewhat unclear; they are probably more policy orientations than binding legal texts. Some of these statements, however, seem to depart from the economic principles of environmental law. One clear example is the attention which is given to the so-called polluter pays principle. This is, for example, incorporated in art. 130r al 2 of the EC Treaty. Taken literally it could mean that a firm would in all cases be forced to compensate for environmental harm, irrespective of the behaviour of the victim and irrespective of the costs associated with precautionary measures. Adams (1989) clearly pointed out that

this principle is an empty shell which offers little help at the policy level. Boyd and Ingberman (1996), however, recently examined whether this principle implies that liability should be extended if the polluter can not pay.

The same inefficiency might arise with another principle that currently receives a lot of attention in environmental legal doctrine. This concerns the precautionary principle, which is equally incorporated in art. 130r al 2 of the EC Treaty. Ogus (1995) correctly pointed out that this may force regulators to issue regulation even when the benefits of such a regulation are unknown since there is no information on possible harmful effects, providing another example where these legal principles may collide with economic analysis.

C. Instruments to Control Environmental Pollution

11. Introduction: Various Possible Policy Instruments

11.1 'Economic' versus 'Legal' Instruments

After having discussed how the optimal amount of pollution can be determined from an economic point of view, we shall now turn to the question what kind of legal instruments can be used to reach the goals set. In this part of the contribution a general overview of various possible instruments will be provided and some attention will be given to environmental taxes and tradeable permits. The subsequent parts will specifically address the role of environmental liability (Sections 14, 15 and 16) and environmental regulation (Part D). In the economic literature, based on Pigou's work, a variety of so-called 'economic' instruments have been advocated. It is essential with most of these economic instruments that they do not prescribe directly (as in the command and control approach) what the behaviour of potentially polluting firms should be. Principally the basic idea is that a tax should be attributed to the polluting activity, so that the pollution caused is represented by a certain price. The tax, that is, the price for the pollution, would then be calculated by the firm in the price of its products. The market mechanism would then give incentives for investments in optimal abatement techniques. Firms that refused to invest in abatement techniques would cause higher pollution thus be subjected to a higher tax, and through the market mechanism would price themselves out of the market. This is a simple summary of the basic ideas underlying the literature which is advocating the use of incentive-based instruments in environmental policy. More particularly Schultze (1977) has advocated that the government should reach more of its policy goals by using incentive based instruments. In addition there was the belief that by using the market mechanism the policy goals could be reached more easily than through the classic command-and-control approach (see, for example, Moore, 1989 et al.; Ackerman and Stewart, 1988; Stewart, 1988). However, we already

mentioned above that there is some literature that sheds doubt with respect to this assumption.

Before addressing the variety of instruments that can be used in environmental policy (as has been done for example by Dewees, 1983a, 1983b and Helm and Pearce, 1990), we should first point out that when economists refer to 'economic instruments' they usually mean incentive-based mechanisms, such as taxes or marketable pollution rights in contrast to 'legal instruments' which would be the classic command and control mechanisms.

The basic difference is indeed that the instruments usually referred to as 'economic' are incentive-based, meaning that the policy goals (for example the ambient quality) are set, but that the ways to reach this goals are (more or less) left up to the regulated. It does not seem worthwhile to discuss this terminological question any further. The reader should just bear in mind that economists and lawyers might attribute a different meaning to the wordings 'economic' versus 'legal' instruments. It is, on the other hand, useful to provide a short overview of the variety of instruments that can be used to reach environmental policy goals and which are discussed in the literature and actually in practice as well.

11.2 Common Law Remedies

Starting from the assumption that the Coasian conditions are not met because of prohibitive transaction costs, one could first look at common-law instruments that are relatively broad, easy to administer and applicable at relatively low costs. One should in this respect in the first place obviously point at the importance of property rights in providing protection against environmental pollution. Traditional common law as well as civil law views most conflicts whereby for example a factory emits smoke causing harm to neighbours as an infringement on the property rights of neighbours. This may give rise to a nuisance which can give the victim a right to claim the cessation of the harmful activity via an injunction.

Another related and, in the field of environmental law probably at least as important, common-law instrument is liability law. Liability law can, from the victim's point of view, provide protection against torts committed by the factory. In this case, factory and victim need not necessarily be neighbours and the traditional remedy in case of tort law is compensation. The boundaries between property rights and liability rules have been discussed by Calabresi and Melamed (1972). Although the role of liability rules is rarely discussed in the environmental economics literature when policy instruments are discussed, there is an important body of literature in the economics of accident law, starting with Calabresi (1961, 1968), Posner (1972) and Shavell (1980b) which shows that liability rules can give incentives to the actors in a potential accident setting for efficient behaviour. As we shall discuss below, environmental

liability is now used as one of the important legal instruments to deter environmental pollution. It is still an instrument that leaves a lot of discretion to the actors involved. Depending on whether a strict liability or a negligence rule applies, basically either the firm itself or the court system will determine the due care required in the legal system which can in an environmental case, for example, refer to an optimal abatement technique. Since neither the abatement technique itself, nor the following emission standard, will be determined *ex ante* by a regulator, the liability system is often referred to as a market-oriented approach, for example by Calabresi (1985).

11.3 Incentive-Based Mechanisms

However, in many cases the deterrent effect liability rules can give will not suffice in case of environmental pollution given information problems (see Part D below). This has lead economists to propose a variety of incentive-based (or 'economic') instruments varying from taxes to subsidies and a variety of 'pollution rights models'. In alphabetical order one can refer to the following literature: Ackerman and Stewart (1988), Anderson (1978), Breger (1989), Hahn and Stavins (1991), James, Janssen and Opschoor (1978), Moore et al. (1989), Nichols (1984), Schelling (1983) and Tietenberg (1990). It would go beyond the scope of this contribution to discuss the importance of this literature here. Furthermore we will discuss some of the literature concerning taxes on the one hand and tradeable pollution rights on the other hand below. For now we can simply refer to these economic instruments as measures that do not impose a direct legal constraint on the supplier's behaviour; these measures rather function as incentives, conferring financial advantages or disadvantages on certain activities (Ogus, 1994b, p. 27).

11.4 Regulatory Standards

Another category of possible instruments relates to the standards discussed above in Part B. They can be considered as regulatory in the sense that the actor who fails to meet a certain standard shall be confronted with an administrative or criminal sanction. Another type of regulatory intervention would be prior approval (Ogus, 1994b, pp. 26-27, pp. 214-244). In that case the interventionism again goes further than in the case of mere standards. Standards do allow the activity to take place without *ex ante* control, whereas prior approval requires the firm to have, for example, a license before the activity itself can be undertaken.

11.5 Voluntary Compliance

Finally, one could conclude this list of tools for environmental policy by referring to, for example, voluntary compliance through moral persuasion,

although economists are somewhat sceptical about the efficacy of such an approach (Oates and Baumol, 1975). In addition we should refer to the work by Menell (1991) who points at the inherent limits of legal institutions in controlling environmental risks.

11.6 The Choice of Instruments

Concluding this overview of possible instruments of environmental policy, we should first of all stress that there is an abundant literature concerning the choice of a particular instrument to control a specific externality problem. This literature discusses comparative benefits of various instruments in a given situation. Polinsky (1979) built on the Calabresi/Melamed model which discussed property rights and liability rules by adding the tax-subsidy approach to the comparison between property rights and liability rules. Polinsky argues that when the government has full information about the externality problem, only the tax-subsidy approach can both control the externality efficiently and protect both parties' entitlements. This remains the case also in a positive transaction costs world. Polinsky also addresses the more realistic setting in which the government has limited information. In that case the approaches can be ranked to some extent. He claims that the tax approach will be inferior to the liability rule approach in a wide range of circumstances, but that in terms of entitlement protection there is a clear preference for the property right approach. A comparison of Pigovian taxes and the liability rule approach is also provided by Brown and Holahan (1980). The analysis is further extended by White and Wittman (1981) by addressing both liability rules and zoning to control pollution. A lot of attention has also been given to the trade-off between liability rules and regulation; this literature will be discussed in Part D.

Most of this literature advances criteria for the optimal use of a specific policy instrument. However, the ideal conditions for one specific instrument will almost never all be met at the same time. Hence, in actual policy one will notice that environmental law is usually based on a combination of a variety of instruments such as property rights, liability rules, emission and target standards as well as a variety of taxes. This complies with law and economics literature in which a combined use of instruments has been studied, for example Hansson and Skogh (1987) and Skogh (1982, 1989b). A combined use of taxes, liability rules and insurance has been examined by Gravelle (1987). Also with respect to liability rules and regulation a combined approach has been advocated, which will be discussed below. Generally, differences between a 'pricing' and a 'sanctioning' approach have been examined by Cooter (1984).

12. Tradeable Permits

We shall now pay some attention to two specific economic instruments, being tradeable permits and environmental taxes. These merit some further remarks given the attention they have received in the literature and, to an increasing extent, also in environmental policy. The starting point for most of the literature on tradeable systems is the pioneering work of Dales (1968). Dales proposed that a market of tradeable permits would be organized by the government whereby pollution rights that should be tradeable would be granted for a certain period. The government would act as broker for the trade and would monitor the system. Building on Dales's proposal other authors formulated more specific proposals with respect to the shape of this market for pollution rights. Montgomery (1972) suggested that the pollution right should also indicate which part of the concentration of a specific compound in a particular environmental component could be emitted from a particular source. Further proposals concerning the implementation of such a model have for example been formulated by Ackerman et al. (1974), Rose-Ackerman (1977) Noll (1982) and Tietenberg (1985). Hahn and Hester (1989) pointed at the importance of monitoring and enforcement in the framework of a market for pollution rights.

In addition to these papers sketching the theoretical benefits and the possible legal framework of a market for pollution rights many subsequent contributions have analyzed how some of these ideas have been implemented into environmental policy. Although most of the success stories in that respect come from the US, there is also a (modest) European experience with (some forms of) tradeable pollution rights. For instance in the Netherlands, Peeters (1992) discusses in her dissertation Dutch manure legislation which allows for a trade in the right to produce manure. As far as the US is concerned, the empirical material relating to the experience with transferable permits is overwhelming. Making an arbitrary selection, we can, for example, refer to the work of Oates (1986) who discussed the emissions trading system for air pollutants and reports that trading has made real headway in certain regions. With equal enthusiasm he reports on the success of a system of transferable discharge permits in Wisconsin, noting that even several European countries are closely following the US experience with transferable emissions entitlements (see also Oates and Collinge, 1982; Oates, Crupnik and Van de Verg, 1983; Oates and McGartland, 1985a, 1985b). His enthusiasm is supported by other sources. Hahn and Hester (1989) claim that the trading programmes concerning the Clean Air Act have led to considerable cost savings, albeit it that they had been less than anticipated. However, they also claim that it is hard to demonstrate major environmental improvements as a consequence of these market policies. Indeed, trading may have increased emissions in some cases where the pollution rights that were sold were previously not being fully utilized by the owner (see also Dewees, Duff and

Trebilcock, 1996).

13. Environmental Taxes

Finally, we can briefly refer to the findings in some of the literature on environmental taxes. This is just for sake of completeness; pollution taxes are discussed in more detail in Chapter 2500. We mentioned earlier, discussing economic instruments generally, that the case for pollution taxes has been made since the early work of Pigou. Instead of focusing on the known literature that defends the importance of taxes from an economic point of view, it is more interesting to look at empirical results. As far as theoretical papers advocating environmental policy to be based on a tax system are concerned, we can refer to the papers mentioned above. The classical economic literature on environmental taxes in the Pigovian tradition has recently been taken one step further by Paulus who examined the feasibility of ecological taxation, examining how the whole taxation system could be ecologically reshaped (Paulus, 1995).

As far as empirical material relating to experiences with taxes is concerned, it is remarkable that much more evidence seems to come from Europe than from the US. This was typically the reverse for the marketable pollution permits which were apparently more popular in the American experience than in Europe. Dewees, Duff and Trebilcock (1996, p.326) note that charges are rarely introduced 'in the text book form'. Hahn (1989a), moreover, claims that most emission charges or fees are used as a revenue generating device for public services rather than instruments of environmental policy, as they were prescribed by economists. The reason why taxes are relatively rarely used in the US are also discussed in a report drafted by Oates (1994) for the OECD. Most empirical evidence concerning the effectiveness of environmental taxes and charges come indeed from Europe. Dewees, Duff, Trebilcock (1996, p. 326) argued that in the Netherlands water pollution by 14 industries responsible for 90 percent of total water pollution decreased by 50 percent between 1969 and 1975 and by another 20 percent by 1980, whereby half of this reduction was due to the effluent charge. Similar success stories come from Germany (Braun and Johnson, 1984) that due to water effluent charges there were significant increases in water treatment leading most of the firms to comply with the existing emission standards. Since Germany (as most European countries) still has a combination of effluent charges and emission standards, it is hard to argue that the significant investments in water treatment plans were mainly due to the charges system and not, for example, to the threat of administrative and/or criminal sanctions in case of violation of emission standards. These findings concerning the success of effluent charges in Germany comply with reports by Frey who argues that the environmental taxes lead both to a

considerable reduction of emissions into the aqua system and into the air (Frey, 1992, pp. 149-151). We can finally point at a study by Bongaerts and Kraemer (1987) comparing water pollution charges in France, the Netherlands and the Federal Republic of Germany, coming to the same conclusion that effluent charges provide a strong incentive to invest in water pollution abatement equipment, but that it is impossible to disentangle the separate effects of charges and emission standards. The latter effect is especially strong in Germany where the charges are halved for emitters who meet the effluent standards.

14. Liability Rules

14.1 Negligence versus Strict Liability

One of the instruments of environmental policy which has received relatively little attention in the environmental economics literature is tort law. There is an impressive body of literature on economic analysis of accident law (which will be discussed in Chapter 3000) which has shown that tort rules may have two goals. The first, which is often stressed by lawyers, is the compensation of victims of accidents; the second, usually more stressed by economists, is the deterrent function of tort rules. Indeed, since the pioneering work of Calabresi (1961), Brown (1973), Posner (1972) and Shavell (1980b) economists have stressed the steering function of liability rules. The foresight of being held liable *ex post* will induce parties in the accident setting to take optimal care. These basic ideas, which are further developed in other chapters (3000, 3100) in this volume, can also be applied to environmental damage. By using liability law a potential polluter can be given an incentive not to pollute or to invest in cleaning equipment of which the marginal costs equal the marginal benefits in reduction of additional environmental damage. In other words, the cost-benefit test, described in Section 3, can also be translated into, for example, a due care standard in tort law. Many authors have applied these general notions of the economics of accident law to environmental liability and have shown that also in the environmental context tort rules may have this preventive effect (see Michelman, 1971; Bouckaert, 1991; Endres and Staiger, 1996; Faure, 1996). A nice study on a Swedish environmental liability case has been presented by Skogh and Rehme (1998). Since the details of the economics of tort law are discussed elsewhere we shall now only focus on a few aspects of particular importance for environmental liability from a law and economics angle.

One crucial question (also addressed in Chapter 3100) is whether environmental liability should be based on strict liability or on a negligence regime. The economic literature generally accepts (Shavell, 1980b, 1987b, p. 8) that both a negligence rule and a strict liability rule will provide a potential polluter with incentives to take an efficient care level. However, if the activity

level is also taken into consideration, a negligence rule will not be optimal since the activity level is not incorporated into the due care standard which the courts apply. Hence, it is argued in the literature that in a unilateral accident model (whereby only the behaviour of the injurer influences the accident risk) strict liability will be efficient since it leads both to efficient care and to an optimal activity level. Hence, it has often been argued in the literature that there seems to be an economic rational behind the tendency in case law and environmental statutes in many legal systems to introduce strict liability for environmental damage: since the victim cannot influence the accident risk, strict liability will be first best to give the potential polluter optimal incentives for accident reduction and, hence, for optimal internalization (see, for example, Endres and Staiger; 1996, Faure, 1995a and for nuclear liability Faure, 1995b). However, if risk aversion of the polluter is assumed, strict liability is only efficient if it is insurable (Endres and Schwarze, 1991).

14.2 Damage

A second crucial aspect in environmental liability is the determination of damage. We already mentioned earlier that classic techniques for valuation of damage will be hard to apply when, for example, an entire ecosystem is endangered as a consequence of certain emissions. Nevertheless a more or less accurate estimation of the damage seems important for several reasons. First of all the scope of the environmental harm will have a large influence on the optimal level of care required from the potential polluter. Indeed, there is supposed to be a relationship between the magnitude of the harm and the optimal level of care. Hence, it seems important to have some insight in the amount of the damage to be able to fix the level of care required from a potential polluter in an efficient way. Second, for the same reason it will be important to fix the magnitude of the harm accurately *ex post*, not only to provide a fair compensation to victims (although it may not always be clear who they are in an environmental case), but also because this fixing of the magnitude of the damage will have an influence on future cases as well. We have already indicated that economists have developed various techniques to evaluate environmental damage in the discussion in Section 6.

14.3 Causation

A third issue of particular importance in environmental liability is causation. Again we can refer to the general discussion of causation issues in Chapter 3300 and address just a few aspects of particular importance for environmental liability. In environmental liability the problem will often arise of uncertainty concerning the causal link between an event (for example an emission) and a certain outcome (for example health damage). The question then arises how one should deal with this causal uncertainty if scientific evidence for example

reports that there is a 40 percent probability that a certain cancer was caused by the wrongful act, but a 60 percent probability that the cancer came from another source (the so-called background risk). After early law and economics papers where the importance of the causation issue was stressed (for example Calabresi, 1975; Shavell, 1980a and Landes and Posner, 1983), further studies explicitly addressed the problem of causal uncertainty. Shavell (1985) and Kerkmeester (1993) stressed that in case of causal uncertainty the liability of the injurer should be limited to those cases in which he actually caused the harm. Otherwise liability would be experienced by the injurer as 'crushing' or, in economic terms, over-deterrence would take place. This would result if in our example, the firm would be held to pay 100 percent damage even though there was only a 40 percent probability that his activity contributed to the harm.

Rosenberg (1984), Kaye (1982) and Rizzo and Arnold (1980, 1986) have argued that there should only be liability to the extent that the activity contributes to the accident risk, meaning that on the basis of statistical evidence the liability rule should be constructed in such a way that the polluter will never be held liable for the background risk (which he did not cause), but only for the so-called excess risk (the contribution of his activity to the risk). The question then arises what kind of legal rule can respect these principles. Traditionally there are two possible rules. One possibility is to award 100 percent compensation to the victim once a certain threshold is passed, for example a 50 percent probability of causation. This is called a threshold liability. This rule, which was applied in the US for a long time, is considered to be inefficient and also unjust since it will force a firm to compensate (at least partially) for damage which it can never have caused from a statistical point of view. The alternative is to translate the probability of causation by awarding the victim a proportion of its damage. When the chance, as was the case in our example, is 40 percent that the harm was caused by the tort, the victim will be awarded 40 percent of his loss. The advantage from an efficiency point of view is that the injurer is precisely exposed to the excess risk which he caused. This rule may also be preferable from the victim's perspective, since in this case he would have received nothing under a threshold liability, since the 50 percent threshold was not passed. The threshold liability is indeed an 'all or nothing' approach. Economic analysis generally holds that only the proportional liability rule will give optimal incentives for accident prevention (Landes and Posner, 1984; Robinson, 1985; Makdisi,1989 and Faure, 1993).

Causation issues and more particularly causal uncertainty will play a crucial role in many of the cases involving environmental harm. In many legal systems attempts are made to circumvent causality problems by imposing joint and several liability rules. This is, for instance, the case under the American 1980 Superfund Statute. This may be problematic as far as the incentives for accident prevention are concerned, although joint and several liability may promote

settlements, thereby reducing litigation costs (see Kornhauser and Revesz, 1995a, p. 49). The economics of joint and several liability has also been analysed by Tietenberg (1989).

Also in European cases concerning environmental liability questions of causal uncertainty have arisen, for example concerning the drug DES. With respect to the uncertainty with which the manufacturer sold the specific product to a particular mother, the question arose whether a type of proportional liability rule should be applied to apportion the burden of liability between the manufacturers (a market share liability). The Dutch Supreme Court, however, applied a joint and several liability rule (see Spier and Wansink, 1993). Another example relates to the employer's liability for occupational diseases. In another Dutch Supreme Court case a victim of asbestosis could not prove at what time he had been confronted with the fatal asbestos crystal which had caused his disease. The Supreme Court once more shifted the uncertainty risk concerning causation to the enterprise by holding that it was presumed that the employee had be confronted with the fatal asbestos crystal during the period of his employment for the defendant (Faure and Hartlief, 1996a). Causal uncertainty also plaid a role in the famous British Sellafield case where an English Court had to decide on the causal relationship between childhood leukaemia and the nearby presence of a nuclear power plant at Sellafield (Gardner, 1990). For a discussion of these cases of causal uncertainty, see Faure and Hartlief (1996a).

14.4 Financial Caps

A fourth feature of many environmental liability regimes, especially under international conventions, is a limitation of the compensation. This is usually justified on insurance grounds. Nevertheless, these financial caps have been seriously criticized both in legal and in law and economics literature. Lawyers argue that caps seriously limit the rights of victims to full compensation. From an economic point of view this is a problem as well since there will be no full internalization of the risky activity. Furthermore Landes and Posner (1984) have argued that if the statutory limit is lower than the potential magnitude of the accident, a problem of underdeterrence will arise. Moreover, insurability should not be an argument to introduce financial caps in environmental liability legislation. Liability can be unlimited and a possible duty to insure may be limited to an uninsurable amount (Faure, 1995b).

14.5 Latency and Retroactive Liability

A fifth point concerning environmental liability relates to uncertainty over risk. In environmental liability there is often a long time lapse between the harmful emission and the moment that the damage occurs. This caused an intense debate, especially in the field of soil clean-up liability concerning the question whether liability rules may be applied in a retroactive manner. This relates to

the question whether the damage needs to be foreseeable, discussed in Chapter 3300. As far as environmental liability, more specifically soil clean-up liability is concerned, the law and economics literature generally holds that a retroactive application of new standards either through case law or through regulation could never affect incentives for future behaviour of the specific operator and is therefore usually to be considered inefficient. This statement may, however, be different since the foresight that there may be liability ex post even for risks which are not known at the time (the so-called development risk) may give incentives to obtain information about that risk (Shavell, 1992; Visscher and Kerkmeester, 1996).

15. Insurance of Environmental Damage

Obviously, within a discussion of compensation for environmental damage one should also discuss insurance aspects. This discussion is short since insurance is looked at at a more general level from a law and economics perspective in another chapter in this encyclopaedia. Hence, we shall merely summarize the most important research results related to the application of insurance theory to environmental damage. Insurability issues have generally been discussed, among others, by Faure (1995a), Karten (1997) and Zeckhauser (1996).

15.1 Moral Hazard

First one can note that the general principles underlying any insurance cover must obviously be respected with environmental liability insurance as well. Therefore the devices suggested by, for example, Shavell (1979) must be taken into account. One of these devices consists of still exposing the insured partially to risk which will often be done through for example deductibles or by imposing an upper limit on coverage (the upper limit is therefore not only necessary given the limited capacity of the individual insurer, but also to control moral hazard). In addition the insurer, should monitor the behaviour of his insured as much as possible, adapt the premium accordingly and require specific preventive measures through the policy conditions. Such an optimal control of moral hazard obviously requires information by the insurer (Endres and Schwarze, 1991). This may require a specialization of insurers engaging in insuring the environmental liability risk in order to be able to exclude bad risks or reward good risks and require relevant preventive measures. On the role of insurance to promote sustainability see Stahel (1997). Insurability issues with respect to hazardous waste have been analysed in the contributions to Kunreuther and Gowda (1990).

15.2 Adverse Selection

In the absence of an accurate distinction between good and bad risks, risk pools may become too broad, giving the good risks an incentive to leave the pool thereby creating the famous risk of adverse selection (Akerlof, 1970). This risk of adverse selection led - according to Priest (1987), but criticized by Viscusi (1991) - to an insurance crisis in the US

15.3 Capacity

In addition to moral hazard and adverse selection there is a third condition for insurability which might play an important role when insuring the environmental risk, being simply the capacity of the individual insurer. Since there is often little *ex ante* information on the predictability of the risk, a relatively low probability that the event will happen and a relatively high magnitude of the damage once the risk occurs, the insurer will have to react by, on the one hand, charging a risk premium to account for the unpredictability of the risk (often in the absence of reliable statistics) and, on the other hand, by providing for an adequate reserve to be able to provide cover for the environmental damage once it occurs. Since the magnitude of the damage will often exceed the possibilities of an individual insurer he will use various traditional insurance techniques (co-insurance, re-insurance) to cope with this capacity problem. One other solution in case of environmental liability insurance is pooling of capacity by insurers. In many countries insurers have shared risks in mutual pools on a non-competitive basis to be able to provide coverage also for risks with a relatively high potential magnitude. This is also typically the case for the nuclear risk. One should, however, distinguish the pooling of risks by insurers in so-called insurance pools from the pooling of risks by operators through risk-sharing agreements which we shall discuss below (Section 16).

Hence, in environmental liability insurance the insurer might want to use specific techniques to be able to provide coverage even for relatively large losses.

15.4 Latency

Another problem we have already referred to (Section 14.5) is latency. When legal standards change over time and new standards are applied to 'old' situations (which will sometimes be the case with liability for soil clean-up) insurance problems may arise. If the risk must be considered to be totally unforeseeable the insurer could not charge a premium *ex ante* for the specific risk, nor could he require specific preventive mechanisms or set aside reservations for potential losses. On the other hand, insurers principally always deal with uncertainty, so that the risk that the law may change must not under all circumstances be considered as unforeseeable. A specific risk premium could be charged in addition to the actuarily fair premium to cope with this

uncertainty problem (Kunreuther, Hogarth and Meszaros, 1993).

Since latency problems will often arise in case of environmental liability the insurer may want to protect himself against the risk of being held liable today (maybe even on the basis of a retroactive application of new standards) for risks that originated for example 15 or 20 years ago. One possibility often advocated in the literature now and applied in many insurance policies is to change the period of insurance cover. Instead of providing coverage for the period when the harmful event occurred or when the loss originated, insurers now often change to a system whereby the claim must have been filed during the period of insurance cover (a so-called claims-made system). By using this insurance technique the insurer can exclude the risk of being confronted with claims years after the period of insurance cover. Hence, this 'claims-made policy' allows for an exclusion of the so-called 'long-tail risk' which is typical in case of environmental liability with latency problems (Katzman, 1988; Hankey, 1994; Spier and Haazen, 1996).

15.5 Causal Uncertainty

Another problem that may specifically arise in case of environmental liability insurance is causal uncertainty (also discussed in Section 14.3) if for example a joint and several liability rule is used, this would mean that the insurer would have to cover risks that were not even caused by his insured. This may cause uninsurability, as has been shown by Abraham relating to insurance for superfund clean-ups in the U.S (Abraham, 1988).

15.6 Insurance Principles

There are, moreover, some other specific features of environmental liability insurance, which are discussed in the literature, which make it difficult to apply traditional insurance principles to environmental liability. One of these aspects, often stressed, is that liability insurance traditionally provides for coverage of accidents, meaning a sudden event whereas, as we just indicated - in environmental liability there is often a long time lapse between the emission and the occurrence of the harm. Moreover, many of the pollution cases are not sudden events, but evolve gradually. This causes many technical problems, for example relating to the question when the damage actually occurred. These and other questions relating to the application of insurance principles on environmental liability are extensively discussed in law and economics literature (see for example Bocken, 1992, 1993; Bocken and Ryckbost, 1991; Cousy, 1995).

15.7 Compulsory Insurance

Finally, we should also point to the fact that the question can arise whether liability insurance for environmental damage should be made compulsory. We can be brief concerning this issue here since the law and economics of

compulsory insurance is extensively discussed in Chapter 2400 (see also Faure and Van den Bergh, 1989a; Jost, 1996; Skogh, 1989b). In this respect we should only point out that some legal systems, for example Germany, have imposed a duty to insure on certain operators for environmental harm. The efficiency of such a duty and other aspects are analysed by Endres and Schwarze (1991) and Wagner (1991, 1992, 1996), specifically relating to the German Environmental Liability Act.

16. Other Compensation Mechanisms

Increasingly a lot of attention is paid to other mechanisms that could be used to cover for environmental damage. Some believe that the insurance problems mentioned above are that important that insurance can in the end only play a small role in covering the environmental risk. Especially as far as financing clean up of polluted sites is concerned, many have argued that alternative financial schemes must be investigated other than traditional liability and insurance.

Skogh (1982; 1989a) and Hansson and Skogh (1987) have argued that when the two policy goals of optimal prevention and optimal compensation have to be fulfilled, the policymaker can choose between either liability rules with private insurance on the one hand, or safety regulation and public compensation mechanisms on the other. This literature develops criteria for when public compensation mechanisms, such as compensation funds, could show comparative benefits. Faure and Hartlief (1996) have argued that no matter how a compensation mechanism is organized, the incentives for prevention of damage should always remain untouched. Hence, the costs of harmful behaviour should as far as possible be attributed to the one who caused the harm and a system of risk differentiation should be included in the financing system as well. Therefore, a public compensation mechanism should still provide incentives for prevention by forcing only those who actually contributed to the damage to contribute to the fund, for example.

Obviously, an alternative compensation mechanism for environmental damage could take various forms. One possibility one could think of would be a mutual risk-sharing of operators. In case of very technical risks operators might have better information on the risk than an insurance company or an administrative agency, for example. Hence, the accident risk could be reduced via an optimal mutual monitoring of the operators. There is a large experience with these risk-sharing agreements in the field of compensation for oil pollution. This is provided by the so-called Protection and Indemnity Clubs (P&I Clubs), which are based on a mutual risk sharing between tanker owners (see, for example, Coghlin, 1984). Faure and Skogh (1992) have argued that also a risk-sharing agreement between nuclear power plant operators could lead

to a better monitoring and provide higher amounts of compensation for victims than with traditional insurance. There is some evidence that risk-sharing agreements will indeed be used in the revision of the Paris and Vienna Conventions on Nuclear Liability (Faure, 1995b).

Compensation funds are in some cases also advanced to cover for insolvency of insurance companies. These so-called guarantee funds usually intervene when for some reason traditional insurance fails. In those cases a guarantee fund is usually applied in combination with traditional insurance; the fund then intervenes only for example when for some reason there is no insurance cover (for the basic argument see Finsinger, 1996). The third type of fund is a public compensation mechanism that really takes the place of traditional insurance because the particular risk may be uninsurable. In the environmental context one can think of situations for which no individual injurer can be made liable, for example the degradation of a particular habitat caused by acid rain. Inevitably the question arises how the fund can be financed, taking into account the causes of the particular pollution problem. If it is clear that for example sulphur dioxide emissions caused the particular problem from an economic point of view, one could argue that a tax should be introduced on the polluting activity which can be used to finance the compensation fund. This was basically the idea behind one of the major environmental funds known today, namely the American superfund introduced by CERCLA. The law and economics of the superfund experience has been analysed in a recent book edited by Revesz and Stewart (1995). This book provides a valuable insight into the economics of the superfund system, addressing issues such as the applicable liability regime, the role of insurance industry, clean-up standards and more particularly the transaction costs involved in the current superfund regime.

Other no-fault compensatory alternatives for environmental injuries are discussed by Dewees, Duff and Trebilcock (1996, pp. 328-331). They equally discuss both compensation for oil pollution and nuclear liability, although they rightly stress that the American Price Anderson Act (on nuclear liability) was largely motivated by a desire to allow the development of a nuclear power industry. They show little enthusiasm for an environmental disease compensation fund, arguing that many of the problems of the liability system, for example causal uncertainty, would not be removed by the instalment of a fund. Indeed, the administrative agency handling the fund would have to determine whether an individual disease is caused by the specific pollutant, which might render the administration of such a fund difficult and expensive. In Europe there are some experiments introducing environmental compensation funds on a rather small scale (for an overview see Bocken, 1987, 1988, 1990, 1991).

D. Theory of Regulation and Other Aspects

17. Public Interest Criteria for Regulation

17.1 Criteria for Regulation

After having discussed the economic function of environmental liability we now come to the question under what type of circumstances liability rules or other common law instruments will not suffice to deter environmental pollution, so that a regulatory intervention is necessary. The basic economic arguments in favour of (safety) regulation have been formulated by Wittman (1977), Shavell (1984a,1984b, 1987a) and by Kolstad, Ulen and Johnson (1990). Several criteria have been developed to indicate when liability rules alone will not provide a sufficient incentive for a firm to take efficient care. In case of the environmental risk most of these criteria point in the direction of *ex ante* regulation: information can be obtained more easily by the regulator, there is an insolvency risk and a serious risk of underdeterrence since no liability suit will be brought if, for example, the damage is widespread. This literature indicates that there is a strong case for controlling environmental harm through regulation, whereby we can refer to the literature mentioned above which discusses the question whether this *ex ante* regulation should take the form of taxes or the command and control approach via emission standards in licenses. In legal practice regulation plays an important role in controlling environmental harm. Similar economic criteria for regulation are advanced in Ogus's recent book on regulation (1994b, pp. 29-46).

17.2 Enforcement

Many studies have addressed the effectiveness of specific environmental regulations. A lot of attention has in this respect been paid to the enforcement of environmental regulation. Shavell already stressed that one of the weaknesses of regulation in comparison with tort law is that whereas in tort law a victim will usually have an incentive to sue if he is injured, the damage is sufficiently large and the injuries can be identified, the effectiveness of environmental regulation will to a large extent be dependent on the possibilities of enforcement. Enforcement issues have been addressed for example by Hawkins (1984), McKean (1980), Richardson, Ogus and Burrows (1982), Russell, Harrington and Vaughan (1986) and Russell (1990). The question what kind of penalties have to be used to deter inefficient emissions has been addressed by Segerson and Tietenberg (1992). They more specifically address the question how an optimal penalty structure can be achieved in case of corporate environmental crime, addressing the question under what kind of circumstances there should be individual or criminal penalties or a combination of both. The effectiveness of criminal liability for environmental offenses has also been addressed in the many publications in this field of Cohen (1987,

1992a, 1992b). He argues that the magnitude of criminal sanctions should be based on harm, thereby criticizing the current American sentencing guidelines which hold that the fine should be based on the illegal gain. Furthermore, Cohen argues, as many other authors do, that criminal sanctions are only one part of the total picture, since civil sanctions and private settlements must be taken into account as well. Deterrence of environmental harm has been investigated as well by Epple and Visscher (1984), developing a model to measure the effectiveness of enforcement efforts. Recently Gren and Kaitala (1997) examined the possible gains for the enforcing agency from disseminating information as its skill on detecting and convicting violators.

17.3 Effectiveness

Finally we can point at literature that generally examined the effectiveness of safety regulation in controlling environmental harm. Dewees (1992a, 1992b) demonstrated that in North America the quality of the environment has improved substantially as a result of regulatory efforts, not so much in response to legal action in tort. This empirical evidence of the success of regulation, compared to tort law, has also been stressed in the recent book by Dewees, Duff and Trebilcock (1996). They hold that the large regulatory effort to improve the environment has been met with considerable success when measured by the reduction of emissions, but that it is more difficult to argue that the environmental regulations of the 1970s in the US equally had a considerable influence on the ambient environmental quality. Moreover, they also stress that while environmental regulation is a determining factor in pollutant emissions and ambient concentrations, other non-regulatory factors such as economic growth and even the weather also influence environmental quality (Dewees, Duff and Trebilcock, 1996, pp. 307-323).

18. Private Interest Theory of Regulation

18.1 Lobby for Barriers to Entry or Lenient Standards

Until now we have assumed that government regulation is always made 'in the public interest', meaning that the government would always make environmental regulation to cure the externality in an optimal way. Reality is, however, often very different. Sometimes regulation is passed if it would not be necessary according to the criteria for regulation of Shavell, discussed above; in other cases there is a proper argument for regulation, but the contents of the regulation is inefficient. This phenomenon, being that regulation is sometimes promulgated not in the public interest, has been examined by scholars of the public choice school. Public choice is analysed in Chapter 0610 of this encyclopaedia, where the basic literature in this respect is discussed. For this

contribution it is interesting to discuss some of the literature that applies public choice and other interest group theories to environmental law.

The starting point of the public choice analysis is that regulation is considered as the product of supply and demand on a political market. On the demand side we find the various interest groups who demand favourable regulation and on the supply side, the wealth-maximizing politicians who wish to favour interest groups which provide them with political support. The product is environmental legislation protecting an interest group in exchange for political support. Thus a wealth transfer (a so-called rent) can be transferred to the interest group protected. This rent-seeking behaviour will be especially successful, according to the literature, if the transaction costs of bringing together individuals to defend a common interest are relatively small for the group and if the information costs incurred by the public at large to find out the rent-seeking are relatively high. These conditions for rent-seeking may often be met in case of environmental regulation. The fact that a transfer to an interest group has taken place will often be disguised by arguing that environmental protection or victim protection is provided by the particular piece of legislation. Transaction costs are often low if only a few firms come together to defend a common interest.

There is a lot of literature providing theoretical support for the rent-seeking argument in case of environmental regulation and empirical evidence as well. The starting point for environmental regulation is often the political will to provide some action for environmental protection. Keenan and Rubin (1988) would argue that this demand for regulation, which is not represented by a well-defined and active particular interest group, may be initiated by a so-called shadow interest group. This is a group that would have members and would come into being if an accident occurred. Potential victims of environmental pollution can thus be seen as members of this latent group. If a shadow interest group ceases to be a shadow group and becomes active, it will have all the characteristics of a normal interest group. Knowing that shadow interest groups have the potential to become an effective lobby, rational politicians will, under certain circumstances, respond to these groups in the same way that they will respond to normal interest groups, even though the shadow groups have not yet been organised.

If under these circumstances legislative intervention seems unavoidable, the theory of regulation suggests that the interest groups involved will accept a general principle of regulation, but may strive to change its scope (Peltzman, 1976). The industrial interest groups to whom the environmental regulation will be applied may realize that regulation may enhance producer wealth while it simultaneously corrects, or at least reduces, an externality problem. This outcome has been stressed by Maloney and McCormick (1982) with respect to environmental quality regulation. They argue that the industry, realizing that environmental regulation is unavoidable, will cooperate in the development of

the regulation and try to change the contents to its advantage. A classic example is the introduction of so-called 'grandfather clauses' which stipulate that the regulation will not be applicable to firms or products which are already in existence. Hence, the regulation can create a new barrier for market entry and so protect the existing industrial practices and products (see also Dewees, 1983a). In other cases, for example as far as standard-setting is concerned, industry may lobby for lenient environmental standards to increase their own profits.

As indicated above, the efforts of industry may go in various directions: sometimes regulation will be used by using grandfather clauses to limit market entry (Maloney and McCormick, 1982); in other cases there will be lobbying for more lenient environmental standards. With respect to the first type of lobbying we can refer also to the function of licenses, which are considered a central instrument in environmental policy. Moore (1961) pointed at the anti-competitive effects of licensing (see also on the use of standards to seek competitive advantages Hahn, 1990b; Huber, 1983; Ogus, 1994a).

Evidence of rent-seeking behaviour in environmental regulation in the US was recently reported by Adler (1996) and similar stories can be found in Europe as well (Faure and Van den Bergh, 1990).

The lobby for lenient standards may take place with the legislator. But since legislators usually give standard-setting power to administrative agencies, this type of lobbying, for example to get lenient emission standards for an individual firm, will usually take place with the administrative agency. The behaviour of bureaucracies in response to this capturing by industry is analysed in different papers, for example by Downing (1981). Rent-seeking will obviously not only take place as far as the standard-setting process is concerned, but can also play a role in case of zoning (Ault and Ekelund, 1988; Fischel 1980, 1985), which is addressed in more detail in Chapter 2200.

18.2 Influence of Private Interest on Instrument Choice

The influence of private interest in environmental law has been addressed specifically in the literature with respect to the issue of instrument choice. In Part C we indicated the variety of instruments that can be used to control environmental pollution, indicating that the literature suggests under what kind of circumstances a particular type of policy instrument would be optimal. In practice these 'economic prescriptions' (Hahn, 1989a) are not always followed. One reason why emission taxes are seldom used, for example in the US, and policy still relies to a large extent on the command and control approach is that firms prefer emission standards to taxes, because standards serve as barriers to entry to new firms, thus raising the profits of existing firms. Charges on, the other hand do not preclude entry by new firms and represent an additional cost to the existing firms on the market (Buchanan and Tullock, 1975 and see the comments by Coelho, 1976 and Yohe, 1976). This basic point made by

Buchanan and Tullock has been extended by other scholars examining the implication of rent seeking for pollution taxation (Lee, 1985; Brooks and Heijdra, 1987). The influence of lobbying on instrument choice has also been analysed in the many papers by Hahn (Hahn, 1989a; Hahn and Noll, 1983; Körber, 1995) and by De Grauwe (1995). Hahn points out that the policy instruments are almost never used in the way that is suggested by economic theory. Emission charges are, for example, used as a revenue-raising device with few direct effects on polluters and many marketable permit approaches are not really designed to create markets. Through grandfathering the rights of existing firms are often protected. In addition, even in cases where the economic prescriptions (marketable pollution rights) were followed, there is some evidence that emissions trading was used as a loophole by which industry could forestall compliance (Hahn and Hester, 1989). Hahn also argues that the varying interest group attitudes in, for example, the US and Europe may account for the fact that European countries tend to rely more on the use of fees, whereas marketable permits have been introduced at a relatively important scale in the US (Hahn, 1989a, p. 111). Hence, the selection of an appropriate mix of policy instruments will to a large extent be determined by the way political choices are actually made in different countries.

18.3 The Choice for the Level of Government

The influence of interest groups will not only play a role as far as the contents of regulation is concerned, but also when the level of government where action will be taken is determined. Noam has argued that interest groups will obviously choose the level of government where their influence can be largest. In the context of the European Union Faure and Lefevere argued that this may explain why some industries will lobby in favour of environmental regulation at the European level. For new areas (where no national legislation exists) industrial lobby groups may encounter less countervailing power than at the local level where the environmental problems occur and NGOs may oppose lenient standards. Once standards are set at the central level in Brussels, Member States will have to comply. On the other hand, the industry of Member States which already have relatively stringent environmental standards may have an incentive to lobby at the central level to make these stringent environmental standards compulsory unionwide to force (southern European) competitors to comply with these stringent standards as well and thus to create barriers to entry (Faure and Lefevere, 1995). This may explain why a lot of environmental regulations will emerge from Brussels also in cases where economic theory would predict that the problem may better be dealt with at the decentralized level (see Part F).

18.4 Liability Law and Rent-Seeking

Finally, one should not forget that rent-seeking can also take place in environmental liability law. Industry may lobby in favour of a financial cap on

liability thus transferring a rent from potential victims. Caps can be found for example in conventions on marine oil pollution and nuclear liability. The ideal conditions for efficient rent-seeking will often be met: transaction costs for the nuclear industry, for example, are low and the information costs for the public are high since the caps are often combined with other legal instruments which are supposedly aiming at 'victim protection' such as strict liability and compulsory insurance (see Faure and Van den Bergh, 1990).

18.5 Importance

The interest group theory is important both for theoretical research and at the policy level. Theoretically it is important to stress that these theories have demonstrated that the traditional argument that regulation is necessary if the market fails to internalize externalities may not necessarily be true if the regulation provides results that are inefficient as a result of rent-seeking compared with the market solution that would have emerged. Second, most authors stress that it would be too one-sided to argue that environmental laws only serve the private interest. Even if there will always be strong incentives for rent-seeking, many environmental statutes are still enacted in a struggle to protect the public interest (Adler, 1996). Third, in some cases the interests of industry and environmentalist coincide; hence, lobbying will not always result in industry opposing environmental regulation. Fourth, theoretically, a combination of public interest and private interest approach is highly useful to provide an understanding of how environmental regulations work. If the environmental policy instruments actually used do not correspond with the predictions of (public interest) economic theory, it might be helpful to look at the possible influence of private interest groups which might explain the existence of inefficient environmental regulation. Fifth, the fact that environmental regulation too is susceptible to rent-seeking which might for example lead to too lenient standards, may be an argument for combining regulatory standards with other policy instruments such as liability rules, which may be less susceptible to the influence of private interest.

19. Liability and Regulation Combined

19.1 Necessity of the Combination

In Section 17 we stated that according to Shavell's criteria there is a strong argument to control the environmental risk through *ex ante* regulation (or taxes). However, in individual cases there can still be damage to the environment. Then again liability under tort comes into the picture and the question has been addressed in the literature how regulation influences the liability system and vice versa. These complementarities between tort law and regulation have more particularly been addressed by Rose-Ackerman (1992a,

1992b, 1996), Faure and Ruegg (1994) and Kolstad, Ulen and Johnson (1990). Rose-Ackerman also compared US and European experiences in using regulation versus tort law in environmental policy (1995a, 1995b). The first point which is often stressed, is that the fact that there are many arguments in favour of *ex ante* regulation of the environment does not mean that the tort system should not be used any longer for its deterring and compensating functions. One reason to still rely on the tort system is that the effectiveness of (environmental) regulation is dependent upon enforcement, which may be weak. In addition the influence of lobby groups on regulation, just discussed, can to some extent be overcome by combining safety regulation and liability rules. Moreover, safety regulation, for example emission standards in licenses, can be outdated fast, which equally merits a combination with tort rules.

19.2 Violation of Regulation and Liability

The question then arises whether a violation of a regulatory standard should automatically be considered a fault under tort law and thus lead to liability. Shavell argues that this should not necessarily be the case, so as to avoid some parties who pose lower risks taking wasteful precautions (Shavell, 1984a, pp. 365-366). However, in many legal systems, a breach of a regulatory duty is often considered a fault. This can be understood since the regulation will pass on information to both the parties and to the judge on the efficient standard of care. Thus the statutory standards can be applied to define negligence (Rose-Ackerman, 1992a).

19.3 Compliance with Regulation and Liability

A second question is whether following the conditions of regulation, often laid down in a license, excludes liability. This point of view is usually rejected in most legal systems (Faure and Ruegg, 1984, pp. 55-56). The economic rationale behind this rule is that if compliance with a regulatory standard were to release the operator from liability, there would be no incentive to invest more in care than the regulation asks for, even if additional care could still reduce the expected accident costs beneficially (Shavell, 1984a, p. 365). A second reason is that exposure to liability even in case of compliance with regulatory standards may be an adequate remedy when too lenient standards are set as a result of lobbying. Finally tort law can also be seen as a 'stop gap' for situations not dealt with by statute (Rose-Ackerman, 1992a, p.123). A problem with this point of view is, however, that it may destroy the uniformity a standard is supposed to bring when judges are allowed in all cases to 'second guess' agency decisions (see Rose-Ackerman, 1992a, p.124).

The issue whether *ex post* liability and *ex ante* safety regulation are substitutes or complements has also been addressed by Kolstad, Ulen and

Johnson (1990). They show that where there is uncertainty, there are inefficiencies associated with the exclusive use of negligence liability and that *ex ante* regulation can correct these inefficiencies. In that case they argue a joint use of *ex ante* and *ex post* regulation will enhance efficiency.

19.4 Liability and incentive-based instruments

Finally it should be mentioned that in the literature some attention has been given to the problem of combining tort recovery and effluent fees or tradeable rights. Rose-Ackerman has argued that incentive schemes require a fundamental rethinking of the relationship between tort law and statutory law. She has argued that incentive-based regulatory statutes should preempt tort actions: if fee schedules have been set to reflect the social costs, tort actions would be redundant or even counterproductive (see, for example, Rose-Ackerman, 1992a, p.128).

E. Environmental Federalism

20. Criteria for (De)centralization

So far we have discussed the goals of environmental policy assuming a harmonized legal system which would be applicable to all kind of different situations. It is, however, obvious that environmental problems may vary highly between communities. This brings about the highly controversial question at what level of government environmental problems should be regulated. This issue receives increasing attention in the literature, both in Europe and in the US. The central question always is whether environmental regulation should be promulgated at central (European or federal) level or at a more decentralized level. A more balanced question is what kind of environmental regulations (or standards) should be set at the central and at the decentralized level. This issue has generally been addressed in the economics of federalism.

The starting point of the analysis usually is the theory of Tiebout (1956) about the optimal provision of local public goods. Tiebout argues that when people with the same preferences cluster together in communities, competition between local authorities will, under certain restrictive conditions, lead to allocative efficiency. Well-informed citizens will move to the community that provides services that are best adapted to their personal preferences. Hence, there would be competition between legal orders and citizens would move (the so-called voting with the feet) to the community that provides legislation that corresponds best with their preferences. This basic idea has been further developed with application to fiscal decisions and environmental choices by Oates and Schwab (1988). Recently Van den Bergh (1994a, 1994b) has built

on the Tiebout model to provide criteria for centralization/decentralization within the European Union. Van den Bergh argues that from an economic point of view decentralization should be the starting point, since competition between legislators will promote efficiency. However, there are certain conditions under which Tiebout competition will not work and which can, therefore, constitute arguments in favour of centralization. One argument is the transboundary character of externalities: this may be an economics of scale argument to shift powers to a higher legal order that has competence to deal with the externality over a larger territory. A second argument is the risk that a 'race for the bottom' between countries would emerge to attract foreign investments. This race for the bottom would cause prisoners' dilemmas whereby countries would fail to enact or enforce efficient legislation.

21. Environmental Issues

These insights can also be applied at environmental problems, as was the case, for example, in the just mentioned paper by Oates and Schwab (1988). Both general arguments in favour of centralization could play a role with environmental problems. It can be argued that these are certainly often transboundary. The prisoner's dilemma argument could be valid as well if there were empirical evidence that differences in marketing conditions may lead to dislocation of firms to the location with the lowest standards (the so-called race for the bottom argument). Whether this argument is valid depends on empirical findings which we shall discuss below. Van den Bergh's arguments comply with the findings in another paper by Oates and Schwab (1988) who equally argue that as long as the effects of pollutants are confined within the borders of the relevant jurisdictions, local authorities will make socially optimal decisions on levels of environmental quality. Hence they provide an argument for decentralized environmental policy and argue that competition among jurisdictions for economic activity need not be 'destructive'. A similar argument against the race to the bottom rationale for central environmental regulation is made by Revesz (1992). He argues that this race to the bottom argument encounters no support in existing models of interjurisdictional competition. In addition, Revesz stresses that central-standard-setting would not be an effective response to this race to the bottom problem since local communities concerned would have other means to attract industry if they wish (relax regulatory controls in other areas).

22. Subsidiarity and the 'Race for the Bottom' Rationale

If we now turn to the actual division of competences, for example in Europe, we should first mention that the question whether action should be taken on community or national level is now guided by the so-called subsidiarity principle. On the basis of article 3B(2) of the EC Treaty, the community shall take action 'only if and insofar as the objectives of the proposed action can not be sufficiently achieved by the Member States and can, therefore, by reason or the scale of effects of the proposed action, be better achieved by the community'. If we apply the economic criteria in favour of centralization to the areas in which the European Community legislated, one can certainly argue that many of the problems regulated through directives, for example, deal with transboundary problems. In many other cases the race to the bottom argument is disguised by mentioning that the creation of equal conditions of competition is necessary for the functioning of the common market. However, the empirical evidence to uphold this rationale is rather weak. Repetto argues that pollution control costs are only a minor fraction of the total sales of manufacturing industries (Repetto, 1985). Moreover, recently Jaffe et al. (1995) have argued that empirical evidence shows that the effects of environmental regulations are 'either small, statistically insignificant or not robust to tests of model specification'. They argue that the stringency of environmental regulations might have some effect on new firms in their decision to locate for the first time, but that this will not induce existing firms to relocate. They equally argue that other criteria such as tax level, public services and the unionisation of labour force have a much more significant impact of the location decision than environmental regulation. Recently this empirical evidence has been somewhat contradicted by Xing and Kolstad (1995), who argue that the laxity of environmental regulations in a host country is a significant determinant of foreign direct investment from the US chemical industry. The more lax the regulations, the more likely the country is to attract foreign investment, so Xing and Kolstad argue. Although this somewhat weakens the evidence presented by Jaffe et al. as far as the location of new firms outside the US is concerned, it does not contradict their finding that existing firms will not relocate because of the stringency of environmental regulations. This material, therefore, substantially weakens the prisoner's dilemma argument both for European Community and for US federal legislation in the field of environmental law. Even if differences between local communities would exist as far as the stringency of environmental law is concerned, this will generally not lead companies to relocate to 'pollution havens'. Nevertheless, many European Directives deal with, for example, drinking water or bathing water, problems which are typically not transboundary and for which the European competence is therefore hard to fit in the economic framework (see Faure, Lefevere and Van den Bergh, 1996a; Faure and Lefevere, 1996).

As far as the federalisation of environmental law in the US is concerned, we can point at an early work of Peltzman and Tideman (1972) and at a historical overview provided by Elliott, Ackerman and Millian (1985) and at the work of Revesz who in addition to his already mentioned 1992 paper in which he criticizes the race to the bottom rationale for federal environmental regulation, recently also criticizes the various approaches that federal environmental laws have taken in controlling interstate externalities (Revesz, 1996).

23. Environmental Standard Setting

At the European level there is, however, another reason for environmental action at central level. This has to do with guaranteeing all European citizens a similar environmental quality. This is sometimes referred to as the protection of the 'European environmental and cultural heritage and human health'. In a Tiebout framework of competition between legal orders, local communities would be free to choose the environmental quality that corresponds with their preferences. This is precisely the reason why in the US context one can increasingly hear pleas in favour of standard-setting by the states instead of by the federal environmental protection agency (see Schoenbrod, 1996), whereas in Europe one wishes to guarantee citizens a minimal environmental quality. But even if one accepts that a basic environmental quality should be guaranteed (contrary to the economic reasoning) to all of the citizens, irrespective of their individual preferences, this should not be realized through a harmonization of emission standards, as was done at the European level so far. This basic environmental quality can be guaranteed by harmonizing quality (target) standards. These quality standards define how much of each pollutant can be present in a certain environmental component. But the theory of optimal specificity of legal rules (Ehrlich and Posner, 1974; Ogus, 1994a) has taught that the costs to reach a certain level of environmental protection may well vary with location-specific circumstances (Kolstad, 1987; Faure and Lefevere, 1995). Hence, the same environmental quality can be reached in Europe through differentiated emission standards aiming at an equal environmental quality Europe-wide (Faure and Lefevere, 1996).

F. Specific Environmental Problems

24. The Nuclear Risk

24.1 Safety Regulation

There are two types of environmental risks that deserve a short separate

treatment since there is some literature dealing specifically with nuclear risks and oil pollution. Obviously, most of the problems addressed so far appear with these two risks as well, so we shall simply report on some on the literature addressing specific issues concerning these risks.

As far as the nuclear risk is concerned, Nichols and Wildavsky (1987), Feinstein (1989) and Paté-Cornell (1987) stress the specific character of the nuclear risk, being the low probability of an accident and the difficulties of probabilistic risk assessment in quantifying risk at nuclear power plants. Feinstein examines the safety records of US nuclear power plants and found a sharp increase in detection of violations following the Three Mile Island accident.

24.2 Liability and Insurance

Special attention has equally been given to nuclear liability and the insurance of the nuclear risk. Taking into account the economic test for strict liability, nuclear accidents pose a strong case in favour of strict liability, since these accidents are typically unilateral (Faure, 1995b). Most international conventions on nuclear liability also adopted a strict liability rule. However, in many legal systems the compensation due to victims is also statutorily limited to relatively low amounts. Here we can refer to the discussion of financial caps above: these are largely inefficient, lead to underdeterrence and undercompensation of victims (Trebilcock and Winter, 1997).

As far as nuclear insurance is concerned, it should be mentioned that in most legal systems, insurance is provided by national nuclear pools, which have brought resources together on a non-competitive basis and provide relatively low amounts for third-party insurance. This liability-insurance scheme for the nuclear risk can to a large extent be explained as the result of lobbying by the nuclear industry (Faure and Van den Bergh, 1990). The conventions on nuclear liability which were drafted in the 1960s had as their main goal to guarantee that nuclear power could further develop and that the nuclear industry would be protected against high claims. Hence, strict liability was combined with relatively low caps, also to make the nuclear risk insurable. An alternative compensation mechanism would be the pooling of risks by operators, based on a risk-sharing agreement whereby a mutual monitoring between plant operators would guarantee prevention and higher amounts of compensation could be made available (Faure and Skogh, 1992).

24.3 Causal Uncertainty

Finally, it should also be mentioned that in case of the nuclear risk many problems of causal uncertainty will arise. Usually a probability of causation formula is used to investigate the likelihood that a certain disease (for example cancer) was caused by a certain exposure to radiation (Bond, 1981; Ketchum, 1985). However, in practice it is often very difficult to establish this probability of causation: data on these probabilities in individual cases are certainly not conclusive (Estep, 1960; Meddler and Moselly, 1985; Van Mieghem, 1988).

25. Marine Oil Pollution

Marine oil pollution is also an issue which received attention in the literature, even before environmental problems were analysed at a general level. Economists have always been interested in the question how accidental or voluntary marine oil pollution by tankers could be prevented optimally either by investments in the safety of the tankers (in case of accidental pollution) or by increasing detection (in case of voluntary discharge) (see, for example, Burrows, Rowley and Owen, 1974). The problem of detection of oil spills has been modelled by Epple and Visscher (1984). They show how vessel size, the price of oil, the enforcement of pollution control regulations and the risk associated with variants in spill size affect the oil transporters' decisions concerning expenditures on measures for spill prevention. They provide empirical data to support their theoretical analysis. Cohen (1987) has followed up on their work by providing an optimal enforcement strategy to prevent oil spills. We can also point at a paper by Dunford (1992), addressing the natural resource damages from oil spills, addressing the question under what kind of conditions there can be liability under the US Oil Pollution Act for natural resource damages. The recovery for economic loss following the Exxon Valdez oil spill has been examined by Goldberg (1994).

One important weakness in the enforcement of marine oil pollution is the fact that the so-called Protection and Indemnity clubs provide full insurance for the fines which are imposed (Lomas, 1989). However, Faure and Heine (1991) have argued that it is not the insurance itself which poses the problem, but the low probability of detection, which causes a low expected fine.

Furthermore, we can point at the fact that the liability regime for oil pollution is governed by international conventions that have a similar legal structure as the conventions on nuclear liability: strict liability with financial caps. Insurance is provided through the Protection and Indemnity clubs, mutual insurance companies of the ship owning companies, which is typically different than in the nuclear liability sphere (see Bongaerts and De Bièvre, 1987). These oil pools are as such not inefficient and costly government regulations would

not be able to improve efficiency to a large degree (see Libecab and Wiggins, 1984; Ault and Ekelund, 1988, p. 75). Another major difference with the nuclear liability regime is that in case of maritime oil pollution compensation is provided not only through these P&I clubs, which act as insurance companies, but also through an oil pollution fund, financed by taxes on crude oil. In this case there is hence a combined financing by the oil-producing industry and the ship owners (see on liability for marine oil pollution the contributions in De la Rue, 1993).

G. Concluding Remarks - Points for Further Research

This overview of the literature on environmental law and economics was unfortunately nothing more than a selection. So much has been published in this area that it would be impossible to discuss every paper published. The reader should be aware of the fact that some topics have not been discussed at all. This is, for instance, the case for the important area of international environmental law. A lot of economic research, especially in the area of international environmental economics, has focussed on issues such as the greenhouse effects, CO_2 emissions, and so on. However, more research can be done in this area, for example concerning the use of the various instruments to control transboundary pollution. In particular the effectiveness of international environmental agreements merit further research from both a law and economics and a public choice perspective.

The brief overview of literature provided in this contribution has shown that many aspects of the environmental problem have now been analysed from a law and economics perspective. It is, however, remarkable that most of the environmental economics research has for a long time particularly focussed on tradeable permits and environmental taxes, paying less attention to other instruments such as, for example, liability rules and insurance, whereas liability played a crucial role in the traditional law and economics literature on externalities. One point for further research is the possibility of an integration of the various instruments to control environmental pollution. It merits careful analysis under what kind of specific circumstances various standards, taxes or liability rules are best suited to control environmental pollution and under what kind of circumstances a combined use of these instruments might be optimal. Furthermore, increasingly public choice analysis should be taken into account in the analysis of environmental regulation. Many of the inefficiencies discovered in environmental regulation might be due to the influence of interest groups. In addition, attention should be paid to the institutional conditions under which interest groups might be less successful and environmental regulation can be expected to be more in the public interest. Finally, we did not pay attention at all to other than legal instruments which may play an

important role in controlling the environmental risk. In this respect we think especially of, for example, eco-audits, environmental management systems and voluntary agreements. The efficiency and effectiveness of these instruments equally merit a careful analysis from a law and economics perspective.

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2400
MANDATORY INSURANCE: TRANSACTION COSTS ANALYSIS OF INSURANCE

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Abstract

The pooling-of-risks theory of insurance has proven to be most useful and is widely applied in law and economics. Nevertheless, the theory has important limitations. This article reviews the established approach to insurance and liability. However, the focus is on law and economics aspects of property and liability insurance, which the standard risk-aversion theory fails to explain. An institutional theory of financial intermediation clarifies the services supplied by the insurance firm. Besides risk-aversion, transaction costs in trade explain a demand for insurance. Mandatory requirements and insurance as a private alternative to public justice are other reasons for an insurance demand.
JEL classification: G22, K13, L14
Keywords: Mandatory, Insurance, Transaction Cost Theory, Guarantee

1. Transaction Costs Analysis of Insurance

The basic pooling-of-risks theory of insurance assumes: (i) expected utility-maximizing, risk-averse individuals with positive but decreasing utility of wealth; (ii) risk given by nature with known loss distribution; and (iii) no transaction costs. Under these conditions insurance is mutually beneficial for a risk-adverse individual and a risk-neutral (fully diversified) insurer. This theory was first formulated by Arrow (1965) and Pratt (1964). Recommended reading on the foundation of insurance economics is Dionne and Harrington (1992). The theory of insurance has proven to be most useful and is widely applied. In law and economics it is applied in most fields where risk is analyzed, see for example, Chapters 4200, 4600, 4700, 5600, 5700 and 7700.

Nevertheless, the theory has important limitations. First of all, it does not explain why there *is* an insurance industry. Following the assumptions of the basic model, insurance contracts can be traded as lotteries, or as an option on the financial market - that is, insurance will be available *without* an insurance industry. Moreover, besides risk aversion, there are other reasons for a trade of risks to insurers that remain unexplained by the theory.

In this article we will review briefly the established approach to insurance and liability. Our main focus, however, will be on the law and economics aspect of property and liability insurance, which the standard-risk-aversion -pooling-of-risks theory fails to explain.

A crucial difference between the standard insurance model and the transaction costs, or institutional, approach applied here and in other fields of law and economics is the treatment of information, see Chapters 0520, 0530 and 0740. The standard insurance theory assumes that the probability distribution is (subjectively) known by both insurer and insured (or by the insured at moral hazard and adverse selection). The transaction costs theory presumes bounded rationality (Chapter 0710) and analyses comparative advantages in producing and distributing information - that is, the insurance firm exists and makes a profit because it possesses an informational advantage not accessible to others, policyholders included. The advantage explains the existence of specialized insurers, contractual forms and the supply of private (and public) legal services. The institutional theory has been applied to various industries, but seldom to the insurance business.

First, we present an institutional theory of financial intermediation that clarifies the services supplied by insurance firms. Then, we study the demand for insurance. Risk aversion is first examined. The second major reason for insurance demand - transaction costs in trade - is subsequently analyzed. Mandatory insurance and insurance as a private alternative to public justice are examined in separate sections. Concluding remarks end the article.

A. Intermediation and the Supply of Insurance

2. Credit Risks

Insurance firms are specialized in areas pertaining to fire, storm, health and life. The structure of the industry appears to be virtually the same throughout the capitalistic world - that is, it appears to be independent of national customs or regulations. If this is so, how can the specialization of the industry be explained? An answer may be found in the institutional economics of financial intermediation. The theory was first applied to banks by Benson and Smith (1976) and Leland and Pyle (1977), who raised another fundamental question: why do lenders and borrowers transact via costly intermediaries such as banks, instead of trading directly with each other?

Their answer is based on a presumption that hidden and unspecified, information exists - that is, that the borrower, as well as others, may be privy to some information about the borrower's ability and willingness to pay back that is not freely available to the lender. The lender, in turn, demands this

information in order to avoid credit risk. A firm may specialize in supplying such credit risk information. Such firms may either act as consultants or as intermediaries. As intermediary, the firm borrows and re-lends. The credit risk is, thus, assumed by the firm.

The reason for the firm to accept to become the residual claimant is due to the fact that traded information may easily become public. On the other hand, information collected and experienced is, at least partly, private or 'transaction specific' and, hence, not marketable (see Williamson, 1979). Thus, a consulting firm selling information may not be able to appropriate enough of the value of the information to cover the costs of information acquisition. It may choose to keep the information secret and instead of selling it, search for profit through the choice of borrowers. The profit of the intermediary depends directly on the private and hidden information available only to the residual claimant. The firm, therefore, has an incentive to utilize economies of scale and scope and to invest in information that is profitable because of its hidden character. The value of specific information explains why we observe banks specialized in households, agriculture, shipping, and so on. This theory of the firm rests on the seminal work of Coase (1937), Alchian and Demsetz (1972), Fama (1990) and others (see Chapter 5610).

3. Property and Liability Insurance

The same approach has been be applied to insurance by Skogh (1991). The insurer is a risk-carrier, as is the bank. The profit depends directly on information about the risk, the terms of the contract, the claims and the portfolio of assets and liabilities. To glean most of the value from information, it is helpful (i) to accept being the residual claimant; (ii) to keep information secret; and (iii) to monitor the policyholder.

The insurance industry specializes in writing contracts on insurable risks such as potential losses due to fires, storms, traffic accidents and third-party liability. A general characteristic of insurable exposures is that a large number of specific risky events may arise, but the probability that a specific event will occur is very low. Low probabilities may provide a specialized insurance firm with a comparative advantage in writing contracts and in dealing with accidents that have occurred. The insurer obtains information on damages, the impact of safety devices, deductibles and co-insurance and the costs of various claim settlement procedures. In a competitive market, insurers offer different policies at premiums that vary with actuarially expected costs and a loading due to administrative costs. An important property of the insurance contract is that it gives the insurer latitude to adjust or withhold claims in accordance with contractual provisions. A number of empirical studies show that the minimum

efficient scale in handling the insurable risks is relatively large (see, for example, Allen, 1974; Cummins, 1977; Skogh, 1982).

Accident risks involving water, storm, traffic and fire have much in common and claims-adjustment procedures for such risks are similar. The common features in both acquisition and claim adjustments are important sources of economies of scope. For the buyer, it is often advantageous to transact a whole bundle of contingencies to the insurer through the purchase of a single property and liability policy. Hence, it is not surprising that these risks are covered by the same insurer. Banks, on the other hand, specialize in credit risks or 'business risks' that are related to the activities of the borrower. Such risks are usually not covered by property and liability insurance.

In sum, the institutional approach presents a rationale for the insurance industry: the insurance firm is there because it has specific information about the risks in question. The success of the insurance firm depends on the organizational and informational advantages accrued and, of course, on the fact that the insurer is trustworthy (see Hägg, 1994). Therefore, the insurer must have a sufficiently large and diversified portfolio of assets and liabilities to be able to cover potential claims. The size of the immediate pool, however, is not decisive as re-insurance and financial markets are available.

B. Demand of Insurance

4. Risk Aversion

There are several reasons for individuals and other economic agents to trade risks to trustworthy, specialized insurers. The most thoroughly analyzed reason for insurance demand is risk aversion. Risk-averse individuals faced with potential losses are willing, first of all, to pay for the coverage of large losses. If expected accident costs as well as administrative costs are included in the premium, the policyholder prefers a deductible (see Arrow, 1974). If the premium is equal to the expected actuarial cost of compensation, the risk-averse policyholder prefers full insurance coverage.

Note that liability is transferred to the insurer through the insurance contract. The policyholder's incentive to take care is thereby reduced, which may increase the accident risk. In other words, accident insurance may cause a moral hazard. The insurer, however, is specialized in handling the risk in question. If the insurer is: (i) informed about the preventive measures available to the potential injurer; and (ii) able to monitor the behavior of the injurer (through the premium and the conditions of the policy, as well as through the claims settlement), the moral hazard problem may be mitigated. In addition, if the moral hazard remains, there is the option of a deductible; partial insurance

increases the level of care and is preferred as a second best when the insurer cannot control the policyholder.

In the law and economics model of liability rules it is usually assumed that the liable party is risk-neutral. In case of risk aversion it is assumed that the risk can be insured. At insurance, the efficiency of the liability rule depends on the insurer's ability to mitigate moral hazard. Two extremes are analyzed: first, the case where the insurer is perfectly informed; and, second, the case where the insurer is unable to control the moral hazard. For an introduction to the economics of tort liability and insurance, see Shavell (1987), Becker and Ehrlich (1972) and Hansson and Skogh (1987). Moral hazard in various branches is examined in Landes (1982), Bruce (1984), Danzon (1984), Chamberlin (1985), Frech (1988), Deere (1989), Rottenberg (1990), Cummins and Weiss (1991), Danzon (1990), Devlin (1990), Viscusi (1993), Sloan, Reilly and Schenzler (1995).

Adverse selection is another difficulty thoroughly analyzed in the insurance literature. This problem may arise when the policyholder has some hidden information that is not in the possession of the insurer. Assume, for illustrative purposes, that there are two types of policyholders according to the insurer's point of view: 'good' risks and 'bad' risks. The insurer cannot distinguish between them and the policyholders do not reveal their nature - both maintain that they are good risks. In that case the market may break down. The logic is as follows: initially, the insurer charges the same premium for the two. The premium is based on the average actuarially expected costs. Insurance will then be a good affair for the bad risk and a relatively poor affair for the good risk. Consequently, many bad risks and few good risks will purchase insurance and the insurer will incur a loss on average. It will, then, be necessary to increase the premium the next round, thus discouraging good risks, attracting bad risks and precipitating a new loss. The cycle will repeat itself. In the end there may be no market left (see Rothschild and Stiglitz, 1976; Gravelle, 1991).

Consequently, the insurance industry must solve the adverse selection problem in order to survive (see, for example, Borenstein, 1989). Apparently, they have been successful in many fields of insurance. Again, the reason may be that the insurer is relatively well-informed because of specialization. Details such as risk of fire in wooden houses versus stone houses, risk reduction through the use of sprinklers, death rates in traffic accidents involving various types of cars, and so on, are known by insurers. Of course, some information will always be concealed by the policyholders, but that does not seem to be decisive in well-established branches of insurance.

Many risks are not insurable. One reason for this is that the risk may be new and inexperienced by the insurance industry and the premiums not calculable. In such cases, risk-sharing in mutual pools may serve as an alternative (compare Skogh, 1997). Moral hazard and adverse selection may also cause uninsurability. Furthermore, the potential loss may be very large or uncertain.

Uninsurability may prevail at large environmental and catastrophic risks. For the study of the uninsurability problem and catastrophic risks (see Kunreuther, 1987, 1996 and Katzman, 1988).

Another important problem related to liability and insurance is that courts may increase compensation when the liable party is insured. This 'deep pocket' phenomenon, together with high defense costs in courts, caused a serious 'insurance crisis' in the late 1980s, especially in the US (see Priest, 1985, 1988, 1996; O'Driscoll, 1987; Trebilcock, 1987; Wade, 1987; Lacey, 1988; Winter, 1991; Viscusi, 1991; Strasser and Rodosevich, 1993 and Lamb, 1995; see also Chapters 5140 and 2300).

5. Transaction Costs

Insurance at Risk Neutrality

Risk aversion certainly explains a significant part, but not all of insurance demand. In the literature on risk management it is often argued that large profit-maximizing firms should self-insure losses in order to avoid the loading costs of insurance. Smith and Warner (1979), Mayers and Smith (1981, 1982, 1987) and Main (1982, 1983) note that individuals in frictionless capital markets would adjust their portfolios so that there would be no demand for a resource-consuming insurance industry. They also state that with well-functioning capital markets, insurers would have no obvious comparative advantage over corporate firms in diversifying risks. However, property and liability of relatively low value are often insured. Individuals also tend to 'over-insure'. Given the loading charges, one would expect less insurance and larger deductibles than observed (see Friedman, 1974; Pashigian, Schkade and Menefee, 1966 and Stuart, 1983). Mandatory insurance is another phenomenon not explained by risk-averse policyholders. This is difficult to understand as pure risk-pooling is also the purchase of insurance policies to cover the replacement of buildings when replacement costs exceed expected flows of future returns (see Doherty, 1985, p. 277).

Insurance purchases by widely-held corporate (risk-neutral) firms may be motivated by: low-cost claims administration services provided by insurers, assistance by insurers in assessing the value of safety and maintenance projects, improvements in the incentives to undertake investments in safety and maintenance projects and a reduction in the firm's expected tax liability (see Mayers and Smith, 1987). The services offered by insurers can be explained in part by the information advantages of the insurer. The explanation is incomplete, however. Why does this industry act as risk-taker and not as consultant? A partial answer may be found above: transaction-specific information makes it profitable to the insurer to carry the risk. The insurer has

a comparative advantage in carrying the risk, given that the insurer is able to monitor the policyholder and is solvent enough to carry potential losses.

Guarantees

Note that the property and liability insurance market is a market where liability is traded to an insurer. One situation where such a trade may appear profitable is when traders do not trust each other and require some form of security. Here, insurance functions as a guarantee.

Assume again, for illustrative purposes, that two traders, A and B, are to contract on a risky project. They expect the project to become mutually beneficial, but are concerned about liabilities at a potential loss. Both parties are risk-neutral. A, being the 'least-cost avoider', is willing to accept the liability, but the assets that can be collected from A are limited. Hence, there is a limit of liability and a problem of moral hazard. The cost to collect may also be high. Moreover, A and B are strangers who do not expect to trade with each other again. Therefore, A would have limited incentive to take care and to compensate B *ex post.* The parties may, therefore, end up with a project of low value, or with no contract at all.

A way out of the dilemma may be for A to offer a pledge or collateral or, if such security is not available, a guarantee. Collateral may not only increase the collectable amount but also the probability that a given amount can be collected. A guarantee transfers risk to an external risk-carrier, the guarantor. The guarantee is valuable to the extent it ensures payment. It functions as a collateral, given that the guarantor is credible and has sufficient funds to cover the loss. Moreover, to accept the risk at a relatively low price, the guarantor must be in possession of some comparative advantage as risk-carrier. One advantage may be that the guarantor is able to collect more from A than B can, perhaps because the guarantor has had a longer-lasting relationship with A than B has had. The guarantor may also be able to control the behavior of A because of some specific information about A. The guarantor may be a bank, a relative, or a business partner who knows A rather well.

In sum, a guarantee increases the value of the initial trade if the guarantor has: (i) assets enough to cover potential claims; and (ii) a comparative advantage in monitoring the liable party. Note that the argument for a guarantee is similar to the argument for vicarious liability in tort law (see Sykes, 1984; Shavell, 1986; Chapter 3400); that is, a 'judgment-proof' problem arises when a party that has become legally liable is unable to fully pay the claim. Someone else - for instance, an employer - may then be held vicariously liable. This situation may be efficiency-increasing because the employer is able to observe the employee continuously and has the power to reward or dismiss the employee. Parents are often liable for damages caused by their children for the same reason. Similarly, professional associations and branch organizations

with the power to control membership may be willing to guarantee the services of their members.

An insurance contract in which A or B pays a premium and the insurer compensates losses at certain specified contingencies is equivalent to a guarantee. In a 'perfect' world in which the insurer knows the marginal impact of the control, the insurer can steer A's behavior toward optimal care by stipulating conditions in the policy and by varying premiums.

As noted above, the insurer specializes in specific risks such as fire, heath, and so on and covers normally only such risks. Insurance is, therefore, a complement to other guarantees. Assume, for instance, that a shipper is willing to accept liability for property damages during transportation, but that the buyer of the service, a manufacturer, questions the credibility of the shipper and requires some form of security. For the sake of simplicity, suppose there are two options: a bank that issues a guarantee and a transport insurance. Which would be preferred? The (solvent) insurer with long experience of transport damages has a comparative advantage in the coverage of transport risks. Similarly, the bank with substantial reserves and experience in the evaluation of credit risks possess a comparative advantage in insuring risks of bankruptcy. Consequently, the manufacturer may require both a guarantee from the bank in case of bankruptcy of the shipper and transportation insurance.

The literature on the insurer as guarantor and monitor is most limited (see Smith and Warner, 1979; Kunzman, 1985; Katzman, 1987; Holderness, 1990; Endres and Schwarze, 1991; Skogh, 1991).

Contracting

Another important reason for transferring liability to an insurer is that it reduces contracting costs (see Skogh, 1989b); that is, contracting parties realize that a complete contingent claim contract regulating all possible outcomes is unfeasible because of the costs of identifying all events, negotiating, pricing, documenting that contracted liabilities have occurred and enforcing the contract. Contingencies that are too costly to regulate contractually may, therefore, be insured.

Assume that the above manufacturer and shipper enter into a contract for the transport of the manufacturer's machinery. Their contract specifies the price and date of delivery, as well as some other basic details. However, the contract does not cover contingencies such as fire, storm and explosion risks, because the traders possess too little knowledge of these risks to be able to price liability and precautions and because the liable party may not be financially able to fulfill the agreement if a serious accident occurs. Instead, they add a clause stating that the cargo must be insured during transportation. Accordingly, a whole package of contingencies is transferred to an insurer.

An insurance policy contains a list of restrictions and limitations that specify the liabilities of the insurer and the involved parties. For instance, a

shipping policy may state explicitly that the insurer is liable except when the shipped goods are improperly packed, which would make the packing firm liable, or when the shipper is negligent, which would make the shipper liable. Hence, the services of the insurance industry include writing, pricing and enforcing liabilities as defined in the insurance policy.

Suppose a risk management expert specializing in low-probability events were to offer advice to the parties about how to draw up a contract and assistance with safety projects and claim adjustments. Because of the low probability of each specific event, the credibility of information is low. Consequently, information about the value of the risk-manager's advice is unreliable. This implies that there is a principal-agent problem whereby risk managers may shirk their duty. Of course, the principal-agent problem might be reduced by transferring the risk to the risk manager, who would then also receive an *ex ante* payment covering expected claims and administrative costs. Such a contract that renders the risk manager the residual claimant is in essence an insurance contract.

Qualitative evidence supports the view that transaction costs are a central motive for insurance. Contractual clauses frequently require guarantees and/or insurance. Shipping contracts and standard loan contracts normally include a clause requiring that property and liability are insured. The same is true of rental and lease contracts. Covenants, which require that the issuing corporation purchase insurance, are commonly attached to bonds. Insurance clauses have a long tradition in the construction industry (see Bunni, 1986). Franchisers often require explicitly that franchisees are insured. These requirements appear to be independent of whether the insured party is risk-averse or not - insurance is universally required to reduce costs related to contracts, trust and control.

C. Mandatory Insurance - Insurance and Public Justice

6. Mandatory Insurance

Insurance is often a mandatory requirement for permission to run a business, transport goods, drive a car, employ personnel, and so on. The reason for the obligation to insure may differ depending on whether the involved parties are contractors or not. In the case of the contractor, the obligation to insure may be part of a standard contract or a result of collective bargaining. Examples are 'free on board' or 'costs, insurance and freight' clauses in transportation contracts. Such contractual agreements or trade customs may, of course, be codified by law.

Insurance may also be required as a guarantee on behalf of potential victims. The victim, the victim's first-party insurance, or the public may need

to cover losses if the injurer does not pay. Moreover, if the injurer's liability is limited, inefficient (too little) care results. Mandatory insurance, therefore, contributes to efficiency to the extent that the insurer compensates the victim and monitors the behavior of the injurer. That explains why traffic, health and environmental insurance, for instance, are often mandatory requirements.

An insurance may not only simplify contracts between two trading parties. The insurance may also simplify contracts or relations with other parties. Assume, for illustrative purposes, that the owner of an apartment complex, A, borrows from a bank, B, with the property as collateral. To guarantee the value of the collateral, the bank requires property insurance. This policy will serve to simplify the landlord's contracts with tenants C, D, E, and so on. Without the policy, it would be costly to agree on liability at fire, water damage and so on; and if the parties neither contract on the risks nor insure, the potential for conflicts *ex post* of accidents is augmented. Such conflicts may be burdensome, not only to the landlord and tenants, but also to the public authorities. A mandatory property and liability insurance requirement for apartment complex owners may, therefore, eliminate a number of complicated bargainings.

The contracting cost motive for insurance also provides an explanation for the observed purchases of (mandatory) insurance that cover the replacement of factories when replacement costs exceed the expected flows of future returns (see Doherty, 1985). In a world with no contracting and enforcement costs, the owner(s) would sign complete contingent claim contracts with bondholders, workers, customers and suppliers. Because of moving costs and firm-specific capital, these contracts would include payments to workers (damages) in the event of factory closure. Confronted with a replacement decision, the firm would then have to compare the expected return from replacement with the damages paid if no replacement were made. If damages were sufficiently high, replacement would be optimal even if the investment cost exceeded the expected flow of future returns. In reality, of course, comprehensive contracts are costly. An alternative contracting technique that can lead to the same outcome as under a comprehensive contract is for the firm to purchase replacement insurance. The insurance policy reduces contracting costs and enforcement problems that would arise through potential conflicts between shareholders who have no incentive to reinvest in a new factory and other claimholders.

Public insurance is also mandatory. One argument for public insurance is the adverse selection problem mentioned above - that is, if bad as well as good risks are forced to pay a premium (tax), all can be insured, which may be preferable as compared to a situation where no one is insured. A second reason for the state to insure the population through mandatory premiums (taxes) is the need of a large pool. Thirdly, the state may cover highly uncertain events that the insurance industry does not insure (see Skogh, 1998; Chapter 6100).

7. Insurance and Public Justice

Risks in trade must not necessarily be regulated by contract or by insurance. They may in some cases be simply ignored. On the other hand, if such an unregulated risk does occur, the liability must be settled *ex post*, for example, by a public court or by arbitration. Hence, *ex post* litigation is an alternative to insurance. Dispute settlement is costly, however and sometimes not feasible. Property or liability insurance may thus be preferred to public justice.

Insurance may also be an substitute for, or complement to, repeated dealings - that is, if there are no long-term relationships that foster loyalty and provide solutions to conflict, the parties may demand insurance.

Aviation insurance may serve as an interesting, albeit scientifically unexplored, example. The aviation industry began its international operations after the First World War. At that time there were few trade customs or conventions regulating the liability of carriers and passengers in the air. Crashes and emergency landings were frequent. Today, an advanced system of safety regulations and liability prevails. Reliance on public litigation, however, still appears inferior to private solutions, especially in the case of accidents where the victims are from many different nations. Settlements are normally made out of court. The solution of the liability matter has been to insure all parties including aircraft, pilots, customers, cargo and airports. A remaining problem is that third parties who are on the ground are not covered by insurance. Nilsson (1982) suggests, therefore, that this group should also be covered by insurance. Most liability is hereby transferred to the insurance industry. *Ex post* of an accident, the insurers interpret the policies and settle the sharing of accident costs among the insurers. A reason why these private liability systems work may be that the insurers are involved in repeated dealings.

Another example of the development of liability by traders and their insurers is the liability of accountants in Sweden (see Skogh, 1989a). The professional liability is covered by mandatory insurance. The insurance policies, negotiated by the accountants' associations (that act as agents for their members) and the insurers, specify the liability of the profession. The liability is mainly interpreted at claims settlements by boards established by the industry, where the insurers and the agents bargain on the liability standards of the profession. Some disputes are settled in public courts, but the courts usually defer to 'good practice', which - to a large extent - is developed in the bargaining interplay between the insurers and the associations of accountants.

8. Concluding Remarks

The risk-aversion-pooling-of-risks theory is applied to most areas of law and economics. Yet, large segments of the insurance business are related to property law and liability law in a way that cannot be explained by risk aversion and pooling. Besides risk aversion, insurance is demanded because of problems of enforcement and the costs of contracting. These sources of demand are complementary rather than competitive; insurance both eliminates risk by pooling and reduces transaction costs. The combined risk-aversion and transaction costs demand explain why a major part of all insurable liability is covered by insurance. Because most publicly settled liability is transacted to insurers, it is of importance to analyze the functioning of the insurance industry to understand the effects of liability laws. The availability of insurance and the monitoring of the industry is especially important at new and/or very large losses, such as nuclear accidents, chemical accidents, products liability, hazardous waste, and so on. Only a fraction of the damage may be covered by the assets of the liable party, guarantors and insurers. Therefore, liability may be strongly limited and inefficient in practice, although it is strict and unlimited formally (Chapter 2300). Thus, it is important that research be conducted on the insurance industry, its contracts and performance.

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POLLUTION TAX

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Abstract

This chapter aims to give a short but comprehensive overview of key literature on pollution taxes. It focuses on the introduction of the concept by Pigou in the 1920s and Coase's alternative 'property right' analysis of the pollution problem. Critiques of both approaches are subsequently discussed. The author then turns to some current views on the topic using tools such as game theory and public choice analysis. Finally a look is taken at different types of pollution taxes used today.
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1. Introduction

Environmental policy was designed to combat the increasing costs of human behavior to our natural environment. Environmental pollution is seen as the main cost to the environment. Pollution can be defined as the 'harm or damage done to animals/plants and their ecosystems' (Turner, Pearce and Bateman, 1994, p. 4). Governments have the option of protecting the environment by means of a 'direct regulatory' approach or a more 'economic' or market-oriented approach.

The 'command-and-control' approach uses standards in an attempt to alter behavior; the economic approach is based on the use of 'incentives', otherwise known as market-based instruments (MBI). The latter implies that a polluter should respond to economic signals once a market in 'pollution' is created. Possibly one of the most widely used methods of economic incentives to change behavior is taxation. The idea of environmental taxation can thus be translated as an attempt to alter polluting human behavior by imposing taxes that can be avoided, or diminished, by more environmentally friendly behavior.

The concept of pollution taxes was put forward almost 80 years ago but is still not universally accepted as an effective means to pollution abatement, in the camps of both lawyers and economists.

Some feel the solution to the problem of environmental degradation lies in economics, others feel law is the best instrument, a third group feels the problem will require a combined effort of law and economics.

This chapter will track the history of the pollution tax concept starting by discussing the Pigovian tradition, then concentrating on the subsequent issues and discussion involved.

2. Externalities - The Root of the Problem

The idea of pollution taxes finds its raison d'être in the existence of externalities. Pollution, as defined above as damage done to the natural environment, is seen as a classic example of externalities. Alfred Marshall (1936, p. 277) first wrote of what is now known as positive externalities as 'the external economies of production on a large scale' in 1910 in his work *Principles of Economics.*

Externalities are defined by Samuelson and Nordhaus (1995, p. 32) as follows: 'Externalities or "spillover effects" occur when firms or people impose costs or benefits on others outside the marketplace'; or as Begg, Fisher and Dornbush (1994, p. 52) put it in their basic *Economics* volume: 'An externality exists when the production or consumption of a good directly affects businesses or consumers not involved in buying and selling it and when those spillover effects are not fully reflected in market prices.'

Environmental externalities are generally negative and the consequence of the absence of markets (no exchange through supply and demand) and market prices (no payment required) for part of the natural environment. This presents an information gap for the economic agents who have no concept of the cost of their actions on the environment and thus the society. Pigou (1962) accepted this problem fully and even devoted a whole chapter to the 'hindrances to equality of return due to imperfect information'. His definition of externalities also included the concept of unintentional damage ('*incidentally* rendering services or disservices') conforming to the general idea that market imperfections such as a lack of information are responsible. As Pigou considered externalities to be market failures, he suggested tackling the problem with state intervention in the shape of taxes and subsidies. However, in the 1960s Coase argued that the problem of externalities could best be approached as a problem of poorly defined, or absent, property rights, and should be dealt with accordingly.

Solutions to the problem of externalities tend to be aimed at the compensation for, or the avoidance of, negative externalities, sometimes referred to as *external diseconomies.*

3. Pigou

3.1 Pigou's Original Writings

The British economist Arthur C. Pigou first developed the basis for the concept of a pollution tax or Pigovian tax, in *The Economics of Welfare* (1920). In this, Pigou (1962, p. 224) explains that in case the marginal *social* net product (including externalities) is different from the marginal *private* net product (net products are the results in the output of marginal resource increases), a tax or bounty (subsidy), depending on the sign of the difference, can be implemented to minimize the difference. There is only one tax or bounty for each externality that can lead to the optimum effect, that is, the equalization of the marginal private and social net product.

One could question whether Pigou originally meant this concept to be used as a means for environmental preservation. Pigou quite clearly answers this question himself by including the natural environment in his definition of possible social net products. In fact, he explains the principle of marginal *social* net product with the example of 'uncompensated damage done to surrounding woods by sparks from railway engines' (Pigou, 1962, p. 134).

However, this interpretation of Pigou's writing runs into problems, or rather contradictions, when reading on. The inclusion of the environment in the concept of social net product becomes unclear when one considers that Pigou explains the *value* of the marginal social net product on the following page as the 'sum of money which the marginal social net product is *worth in the market'* (Pigou, 1962, p. 135; own italics). As has already been discussed, the root for many environmental problems is exactly the absence of a pricing mechanism for the natural environment in today's markets.

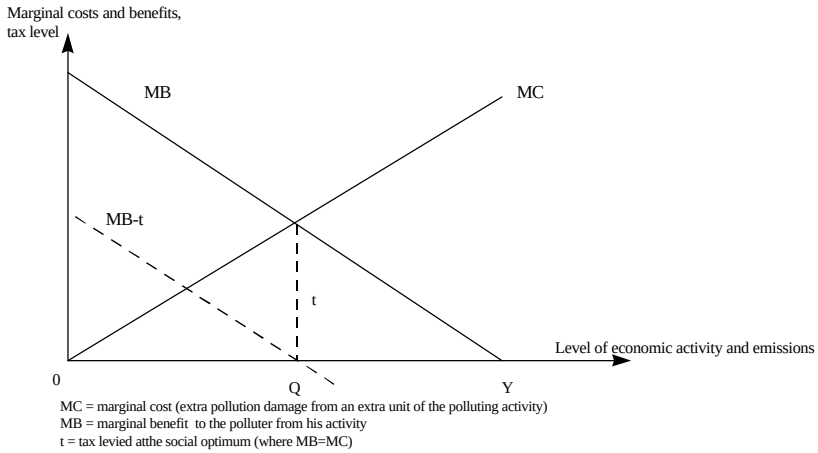
3.2 Current Interpretations of Pigou's Concept

The term pollution taxes, otherwise known as pollution charges, externality taxes or Pigovian taxes, by definition refers to a tax:

- used to correct the misallocation of resources when social costs are different from private costs; and
- based on the estimated damage.

This is graphically shown in Figure 1.

Figure 1 Optimal Pollution Tax



Assume the economic actor responsible for pollution in Figure 1 is a firm. The marginal benefits (MB) of the firm's activity decrease as the activity continues. However, as the firm is not confronted with the pollution in market prices, it is from a profit-maximizing perspective worthwhile to expand the activity so long as the marginal benefits are larger than zero (private optimum Y).

As the activity is responsible for pollution (expressed here in terms of marginal costs), the social optimum, which takes external costs into account, corresponds to a lower level of activity (Q). Marginal benefits are then equal to marginal costs. In order to confront the firm with this social optimum, and internalize the externalities, a tax can be introduced. A tax set at exactly the damage level (MC) at the social optimum, will in fact decrease the MB at each level of economic activity. The firm will now use the MB-*t* curve, instead of the MB curve, to decide on its optimal level of economic activity. As MB-*t* becomes equal to zero at level of activity Q, the firm will now see Q as its private optimum. The tax has thus succeeded in its purpose. The private optimum is now equal to the social optimum due to the implementation of an economic incentive.

Although this tax works perfect in theory, the practical implementation is very difficult due to a lack of complete information on damage levels (MC). Economists from the Austrian School have argued that the evaluation of costs is extremely difficult due to their subjective nature. Buchanan (Cordato, 1992, p. 6) defines costs as subjective because they 'only exist in the mind of

decision-maker or chooser' and are 'individual evaluations of enjoyment or utility anticipated'. He therefore concludes that costs can only be judged by the decision-maker since no one else can observe the 'subjective mental experience' surrounding cost evaluation.

Due to these practical problems, other taxes are now referred to as pollution taxes although they are not Pigovian taxes in the strict sense of the word. The term 'pollution charges' tends to be used for, and confused with, what are correctly called emission and product charges. Emission charges can be defined as 'fees collected by government, levied on each unit of pollutant emitted' (Tietenberg, 1996, p. 335). Product charges, on the other hand, are levied on each unit of a product harmful to the environment, for example, charges on fuels, detergents, and so on. Neither are defined to necessarily ensure that production is at the optimal level, that is, where marginal net private benefit equals marginal external cost, or where marginal abatement costs are equal to marginal benefits of reduced pollution, nor are they based on the estimated damage. They may not be pollution charges as originally defined by Pigou, but are considered to be legitimate interpretations of the Pigovian concept (see Section 5.3 and further), as they are taxes implemented to combat environmental pollution.

4. Coase

An introduction to the idea of (Pigovian) pollution taxes and consequent discussions in an Encyclopedia of Law and Economics must include Coase's main criticisms, and alternative solutions. As this is, however, also discussed at length in Chapters 0730 and 2300, the discussion here remains basic.

In the 1960s the concept of externality taxation was criticized by Ronald Coase who introduced an alternative approach, using a property rights theory. This theory may lead in some cases to the, at first sight contradictory, conclusion that once property rights have been correctly defined, it may be optimal to tax not the polluter but the victim of pollution. This is due to the fact that Coase addressed the *reciprocal* nature of the externality problem. For a negative externality to exist there must be at least two parties, one whose action (production or consumption) results in the externality (injurer) and one who is affected by the externality (victim). Due to the action, the injurer perceives a benefit (otherwise he would not do it) and the victim perceives a cost. Both parties attach values to their perceived costs and benefits. It seems obvious here that the injurer inflicts harm to the victim but at the same time it is also true to say that the injurer would suffer (lose benefits) if the victim were to prohibit or restrict the injurer's actions. Coase (1960, p. 2) therefore stated in his famous article 'The Problem of Social Cost' that the problem was 'to avoid the more serious harm'. In order to resolve the problem of externalities, the potential bargaining positions of both the victim and the injurer should, therefore, be analyzed, and could, in theory, lead to the restriction of the victim. Pigou,

however, placed the burden of liability solely on the polluter (that is, the polluting factory in his example).

Coase's ideas in 'The Problem of Social Cost' (1960) were later interpreted as 'the Coase Theorem' which was seen as propagating the use of property rights for internalizing externalities. The Coase Theorem can be interpreted as follows:

regardless of who holds the initial property rights, the bargaining process between polluter and those affected will bring about the most efficient solution, *assuming* transaction costs are zero.

However, Coase (1980) dissociated himself from this common interpretation of his ideas in the preface to his book, *The Firm, the Market and the Law.* He argued that in reality the presence of considerable transaction costs would often not enable bargaining to reach the optimum solution. The Normative Coase Theorem: 'Structure the law to remove the impediments to private agreements' (Cooter and Ulen, 1988, p. 101) can be seen to follow from this.

It is interesting to note, as Bromley (1991, pp. 62-64) does, that if property rights are clearly defined and there are no transaction costs (defined as ICE: Information, Contracting and Enforcement costs) there could be no (Pareto relevant - when the activity can be changed so that the victim can be made better of without the imposing party being made worse off) externalities. All possible gains from trade would have been bargained away. Consider the possible gains from trade (the beneficial effects of a certain action which normally only gives benefits to one party) to represent the externalities and the transaction costs to represent the bargaining process. A bargaining process will take place as long as there are possible gains from trade and no transaction costs. Bromley (1991, pp. 62-64) therefore feels the Coase theorem to be void as in his interpretation it only holds true in cases where there are no externalities in the first place. This interpretation is sensitive to the use of certain time horizons though. Bromley's statement can in any case only hold true in the long term. Short-lived externalities will always exist during the bargaining process.

In 'The Problem of Social Cost', Coase reproached Pigou because he felt environmental externalities were not the consequence of market failures but rather of a failure of regulation (see also Andersen, 1992). Coase referred to Pigou's example of the electricity sparks damaging the woods (see above) to justify this critique since under British law there was no right to compensation for damage from 'authorized' railways (Coase, 1960). He therefore felt that the interventionist approach taken by Pigou was not justified.

Coase (1960) also felt that Pigou's original text and the common interpretation lacked detail. He pointed out that Pigou never clarified how the tax receipts should be used. There is a clear difference between a simple tax on the polluter and regulation requiring the polluter to compensate the victim. Nonetheless, he continued, economists often see these two different solutions as being identical.

Spulber (1989, pp. 343-345) showed that private bargaining under complete information, absence of consumer income effects and independent of the assignment of property rights, induces an efficient emission level of pollution. However, other authors such as Hamilton, Sheshinsky and Slutsky (1989, pp. 453-471) have argued that a decentralized efficient solution to production externalities with free entry does not exist. In fact, standard monopoly inefficiency may result. Only if complete property rights exist (that is, the ability to control the right to pollute and the right to entry) and if the property rights holders bargain with all relevant consumers and producers, can bargaining provide an efficient output level. As this is highly unlikely they suggested an alternative solution using the property rights approach and Pigovian taxes when appropriate (see Section 5.5).

5. The 'Pollution Tax' Discussion Continued

5.1 Transferable Property Rights - Dales

Dales (1968) is best known for suggesting an actual market in property rights as the solution to pollution problems. This concept has its practical application in, for example, tradable emission permits.

Although Dales did not dismiss the idea of Pigovian taxes as such, he believed it impossible to obtain the information required to set taxes at the optimal level without wasting too many resources. This in turn would make the whole exercise inefficient. Dales (1968, p. 40) stated that 'it is the lack of information that is the crux of the matter'. He dismissed the use of cost-benefit analysis as the necessary information on costs and benefits could only be obtained when assuming a very simplistic, and therefore artificial world.

However, Dales also acknowledged the deficiencies of a transferable property right system and suggested that regulations, subsidies and excise taxation would be appropriate in case of multiple source pollution, as this could not be adequately handled with transferable property rights. Dales did therefore not completely dismiss Pigou's 'taxes and bounties'.

As transferable property rights cannot be classified as pollution taxes, they will not be discussed any further in this entry.

5.2 Pigovian Taxes and Monopolies - Buchanan's Critique

As Buchanan (Cordato, 1992, p. 6) defines costs and benefits as very subjective (see Section 3.2), he sincerely questions the idea of setting Pigovian taxes for the obvious reasons.

He further argues that Pigovian taxes (and subsidies) might increase misallocation in cases of monopoly. This cannot be seen as a critique of the early writings of Pigou, though, since Pigou (1962) specified quite clearly that

there are *optimal* taxes and bounty 'under conditions of simple competition'. Buchanan's criticism can therefore only be seen as dismissing the interpretation of Pigovian taxes as the ultimate solution in all circumstances and market forms. Baumol (1972) pointed out that as simple competition is close to reality in most cases anyway, Buchanan's critique is of no great importance. The existence of certain (natural) monopolies can, however, not be denied.

5.3 Baumol's 'Environmental Charges and Standards' Approach

Baumol (1972) accepted the basic idea of Pigovian taxes. He argued that Pigovian taxes on the 'generator of the externality' are most effective and that 'the conclusions of the Pigovian tradition are in fact impeccable'! He nonetheless recognized the difficulties of practical implementation as the main shortcoming of Pigovian taxes.

Instead of setting a tax rather arbitrarily in the hope of achieving a certain reduction of pollution, Baumol (1972) suggested to first set certain standards of pollution (emission, air and water quality, and so on) and then, through a process of trial and error, derive which levels of taxes have proved to give certain outputs. He thus suggested achieving 'selected standards of acceptability by experience'. He later referred to this as the 'environmental charges and standards approach' (see below). This approach aims to solve the implementation problem of Pigovian taxes.

5.4 Baumol and Oates - the Acceptability Standard further Developed - Emission Charges

Baumol and Oates further developed the environmental charges and standards approach in *The Theory of Environmental Policy* (1975).

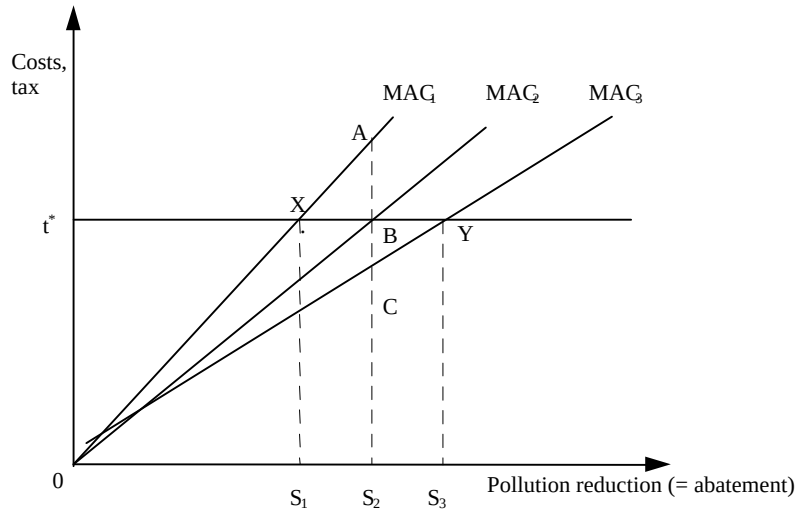
Taxes would be set to achieve a certain acceptable standard rather than being based on the 'unknown value of marginal damages'. Baumol and Oates (1975) further argued that such an approach would not result in Pareto optimality but that the 'use of unit taxes (or subsidies) to achieve specified quality standards ... is the least-cost method for the achievement of these targets'. 'An allocation is Pareto efficient for a given set of consumer tastes, resources and technology, if it is impossible to move to another allocation which would make some people better off and nobody worse off' (Begg, Fisher and Dornbusch, 1994).

As they were aware of the drawbacks of the use of acceptability standards, Baumol and Oates (1975) proposed to utilize these standards only in cases where 'there is reason to believe that the existing situation imposes a high level of social cost and that these costs can be significantly reduced by feasible decreases in the levels of certain externality-generating activities'.

The benefits of this approach are very well illustrated in Pearce and Turner (1990, p. 95) which gives the following example (illustrated in Figure 2).

Assume three companies' marginal abatement cost curves (MAC1, MAC2 and MAC3) which illustrate the extra cost of one extra effort of pollution abatement. It is possible to compare the total abatement costs (TAC) of a standard and a tax which both produce the same optimal pollution reduction level.

Figure 2: Charges and Acceptability Standards



Assume the desired pollution level has been set at S_2. This standard can be achieved in two ways:

a. Each firm has to abate pollution by S_2. Firm 1 will produce at A, firm 2 at B and firm 3 at C. Overall standard of abatement of $3S_2$. Total abatement costs: $TAC_1 = 0AS_2 + 0BS_2 + 0CS_2$
b. Tax t* is set. Firm 1 will produce at X, firm 2 at B and firm 3 at Y. Simply comparing the cost to the individual firms of the abatement costs and the tax can derive this. Again an overall standard of abatement of $3S_2$ is achieved; this time at $TAC_2 = 0XS_1 + 0BS_2 + 0YS_3$

It is clear that TAC_1 is greater than TAC_2 (the difference is $S_1XAS_2 - S_2CYS_3$ and S_1XAS_2 is greater than S_2CYS_3).

The tax policy referred to here is commonly known as emission charges. They are a way of achieving the desired pollution reduction at minimum cost of control. The idea behind this is that individual (profit-maximizing) firms will reduce pollution as long as this is cheaper than paying the government emission

charges. In economic terms this implies that a firm will reduce pollution, that is, manage pollution levels, as long as the marginal cost of this management is smaller than the emission charge levied on the firm's pollution.

The strength of emission charges therefore lies in the fact that the government can introduce incentive policies that will result in minimum costs of control without knowing the exact level of pollution damage. Bear in mind, however, that it is essential that the government apply the same emission charges to all firms.

The problem, of course, is once again at which level to set the emission charge. The costs of the firms to reduce pollution are unknown to the government. It is therefore impossible for the government to know which level of emission charges will result in the desired reduction of pollution as this depends on the firm's own technology and operation. The emission charges will therefore tend to be set on a trial-and-error basis, adjusting the charges periodically until a charge is set which results in the required pollution reduction.

As the firm's pollution management costs are dependent on the technologies used, a firm will invest in research and development to find more cost-effective technologies. However, as Tietenberg (1996, p. 336) explains, the firms will have an incentive to hide their new technologies from the government as the government will tend to tighten the standards as they learn of new, less polluting, technologies.

The main problem with this trial-and-error emission charge is that firms will have difficulties planning their investments. A new (tighter) emission charge may make their previously potentially profitable investments a recipe for disaster, so preparing a long-term investment plan will become more difficult as the firms are faced with more uncertainties.

5.5 Are the Pigovian Tradition and the Coase Theorem Contradictory?

At first sight, and considering the above discussions on the topic, the two theories on social cost - the Pigovian tradition and the property rights approach - seem totally different from each other and in fact quite opposite. However, some authors propose that these approaches can sometimes complement each other or that one policy can even be a special case of the other.

Bishop (1988, p. 194) in fact argued that: 'Pigovian analysis is a special case of the more general property rights approach'. He sees a Pigovian tax as a 'property rights solution' which 'concentrates on the income characteristic of property'. He explains this with an example of an air pollution tax. In this case the polluter is no longer the sole owner of the income derived from the air pollution (that is, the production which has this pollution as its externality) but has to share this property right with the government. The government then requests their share of the return on air in form of a tax. Concluding, Bishop

remarks that 'Pigovian taxes can be viewed as involving the assignment of property rights via the constitution'.

Hamilton, Sheshinsky and Slutsky (1989, pp. 453-471) further examined Coase's externalities approach (as seen above in Section 5) and developed further ideas on the application possibilities. They started from the idea that the Pigovian and property rights approach complement each other. The Pigovian approach could be used when bargaining is too costly or infeasible. However, their main finding was that decentralized bargaining cannot be efficient in cases of production externalities with free entry for new actors, unless this is done as economy-wide negotiations. In cases of limited property rights (for example due to a liability rule which induces people to step in and claim compensation), their solution is to introduce some government intervention in the sense of a tax system - this even in cases where bargaining is possible! An efficient outcome will only be achieved through a non-linear tax scheme; the combination of a tax on company output if and only if this is in excess of the efficient level of production, and a franchise fee to tax away profits. The latter should discourage new entries. Note that such a tax should not raise revenues in equilibrium, as the franchise fee would be given as a lump sum to consumers. The authors conclude that 'it is better to limit property rights and discourage bargaining than to try and make them as complete as possible and encourage bargaining'. The authors also conclude that, as ever, the efficiency of this system depends on the ability for the government to estimate the optimal taxes.

When comparing the alternatives, some authors found that both Pigou and Coase's alternatives had their costs and benefits and that in the real world, neither were perfect. Starret and Zeckhauser (1974, p. 66) compared artificial markets (that is, the property rights approach) and taxing schemes, and came to the conclusion that neither provide easy answers in a complex real world situation. However, whereas they concluded that 'an equilibrium may not even exist with artificial-markets setups', the problem with taxation solutions was rather a problem of multiple equilibria, that is, apparent different optimal pollution taxes, and the problem of detecting the one efficient tax.

6. Current Views on Pigovian (and Related) Taxes

6.1 Are Pollution Taxes in Accordance with the Polluter Pays Principle?

In 1972 the OECD adopted the Polluter Pays Principle (PPP) aiming to use this principle as an instrument for internalizing environmental costs. It therefore links in well with the initial ideas of Pigou.

The PPP is now a commonly used term. One has to be careful, though, when interpreting the meaning. As Bugge (1996) argued the polluter pays principle can be read as having four main meanings:

1. the PPP as an economic principle; *a principle of efficiency;*
2. the PPP as a legal principle; a *principle of just distribution of costs*;
3. the PPP as a *principle of international harmonization of national environmental policy*; and
4. the PPP as *principle of allocation of costs between states.*

Pollution charges as discussed here primarily relate to the principle of economic efficiency; reducing pollution insofar as this can be achieved by internalizing social cost of pollution. However, the pollution charges could also be seen in the context of the PPP as a legal principle as its aims to efficiently redistribute costs of externalities and abatement efforts.

One could assume, as in the interpretation of Coase's writing, that compensating the victims of pollution or taxing those affected (for example, when it is felt that they were the parties who could have prevented the damage from occurring most efficiently) would have the same result as taxing the polluters. Baumol (1972), however, claimed that optimal resource allocation could only be achieved by 'a Pigovian tax (subsidy) upon the generator of the externality'. This idea corresponds fully with the PPP principle and at the same time dismisses the common interpretation of the Coase theorem. However, Baumol (1972) only intended his critique on Coase's ideas in cases of large numbers and does not consider the 'small number' case where negotiation is easily possible.

6.2 Environmental Taxes - a Revenue-Generating Instrument?

Every type of pollution taxation raises revenue for the enforcing government. Although one could argue that for some taxes, such as product taxes, the ultimate goal is to minimize the use of the polluting product, the revenue-generating aspect remains appealing to governments. In fact this aspect can cause problems when considering the real reasons for implementing and continuing pollution charges.

This problem can easily be compared to that of, for example, cigarette (excise) taxation. Governments declare that raising excise taxes on cigarettes is necessary because the government wishes to discourage its citizens from smoking as this is damaging to their health. This is what can be referred to as the paternalistic objective. However, the excise tax revenues are also a welcome income for the Treasury. How can a government therefore satisfy two goals, discourage smoking and raise revenue, with one instrument, namely excise taxation? Indeed, were the health objectives to be successful, less cigarettes would be smoked and the revenue would fall; alternatively, to raise sufficient revenues enough cigarettes are to be sold. A balancing of goals is possible - decreased smoking at a certain revenue level - though will not optimize (maximize) either goal. This problem refers back to the issue raised by Tinbergen (1952, p. 39) in his *On the Theory of Economic Policy*; that one can only fulfil one goal efficiently when using just one policy instrument.

The same problem will occur when governments start relying on the revenues of the implemented 'green' taxes. While the goal is to reduce environmental pollution, generation of revenues becomes an 'induced' secondary (or primary in the worst-case scenario) goal the longer the tax is levied. In fact opposite assumptions concerning elasticities are required. A 'justified' environmental tax requires high elasticity of the taxed behavior. For example, an energy tax aims to reduce the use of a certain energy source. In other words, the tax will raise energy prices which should consequently reduce the demand (because people have started using less energy or are using alternative, less polluting, energy sources) and thus the tax revenues will fall. The demand therefore has to be elastic. However, if governments wish to use the pollution tax as a revenue-generating instrument, the tax base has to remain sufficiently large. This implies that in order to raise revenues on a continuing base without having to keep increasing the tax rate, demand should be fairly inelastic.

This whole issue can be avoided by earmarking revenues for specific projects, such as clean-up projects, funding awareness campaigns and so on. However, earmarking is generally avoided as a budgeting procedure as it does not allow for unexpected changes in revenues and required finances, nor does it allow for flexibility in public finances.

An alternative is the use of the revenues of green taxes to compensate for the reduction in Treasury revenues of other taxes. This is commonly referred to as the 'double dividend' aspect of pollution taxes. The double dividend idea implies that new environmental taxes can not only reduce environmental damage but can also reduce the need for other revenue-generating distortionary taxes such as levies on income. As all the new tax revenues are thus returned to taxpayers, the double dividend idea is linked to the 'revenue recycling' idea. Appealing as this idea might be to governments, questions are being raised as to the validity of this proposition. This primarily concerns the idea that as environmental taxes correct distortions (externalities) they cannot be distortionary themselves. However, if, for example, these taxes are indirect taxes (such as a carbon tax would be), they will influence the real after-tax wage and can therefore not be considered non-distortionary (O'Riordan, 1997, pp. 106-120). In fact Bovenberg and Van der Ploeg (1994) consider, contrary to what proponents of environmental taxation feel, that employment will decline even if the double dividend idea of compensating the taxes with a lower tax on wages were implemented.

Four main alternative uses for the pollution tax revenues can then be distinguished (OECD, 1991, p. 11):

1. Earmarking funds for polluters who reach the desired pollution abatement standard as long as the charges can not ensure a reduction to this level. The funds should be distributed so as to ensure the bridging of the gap between

the actual and the required level of pollution. This technique is sometimes used in the water sector.
2. Funds can also be earmarked to finance specific environmental projects and services, for example clean-up operations.
3. The revenues can also be poured into the general budget. This implies that specific revenues will not be used for specific uses (non-earmarking).

A fourth alternative is to pour the revenues into the general budget but only if combined with a reduction in other taxes (see above). For example, many governments have played with the idea of combining the implementation of an energy tax with a reduction of the tax on labor.

6.3 Do 'Green' Taxes Give Rise to the Same Adverse Effects as Other Taxes Do?

There is vast and extensive literature on the advantages and disadvantages of taxation. Taxes are often regarded to be inefficient as a policy tool because of the distortion created in the economic decision-making process. However, in the case of pollution taxes, the shift in consumer and producer behavior is exactly the desired output. One therefore tends to speak of tax 'incentives'. For example, an energy tax is used to incorporate the environmental cost of energy in consumer's energy choices.

Nonetheless, pollution charges can have a negative impact on certain aspects of the economy, comparable with those seen with other types of taxes and regulation.

6.3.1 Adverse Competitive Consequences of Non-Global Pollution Charges If only one country's government imposes environmental taxes one could wonder what would happen to the competitiveness of the industries affected in that country. Consider a country's chemical plants are subject to environmental charges, which they pass on to their consumers by raising their prices. These goods might be faced with a falling demand, since on the international market there are now cheaper comparable products available. Another consequence could well be that multinationals decide to relocate their plants to other countries without these environmental charges. The relocation of the most polluting industries can be seen as a clear sign that this country now has a comparative disadvantage. Bovenberg and Van der Ploeg (1994) feel that greener preferences in public finances (that is, environmental taxation) will ordinarily result in capital flight. This can be compared to the consequences of non-global social security contributions and differing social regulations concerning wages. The relocation of labor-intensive industries to developing countries has drawn widespread attention and concern.

However, Porter (1990) sees stringent standards among other environmental impacts as contributing to creating and upgrading competitive advantages, as

it forms an incentive for companies to improve, for example, quality and the use of new technologies. When Porter uses the word 'standards' in this context, this can be interpreted as more stringent environmental regulation of any form.

Wolken and Koopmans (1992) used Porters' theory on the importance of rapid national adjustments to society's new (environmental) requirements, to show that the sooner a country introduces *national* policies to protect the environment, the more competitive that countries' industries will be when *international* environmental regulation will be implemented. Stringent national environmental regulation can thus be seen as only a temporary comparative disadvantage. They therefore even referred to, for example, the 'reinforced national advantage' of Sweden because of its 'environmental sensitivity'.

A clear line was taken at the round table on 'The Role and Enforcement of competition policy in regulated sectors' (21 October 1994, OECD) by the Dutch delegation. They presented a paper which declared that the effectiveness of market-oriented instruments, such as pollution charges, in environmental regulation could be reduced if the competition policy is not strict enough. Indeed, firms will feel less need to improve their environmental performance if they can form cartels or even monopolies, as they can just pass the taxes on to the consumers who would not be able to shift to substitute products. The tax would therefore be paid by the consumers and would form a revenue source for the government, but form no incentive for the firms to clean up their act.

At the same time, though, the optimal output for monopoly firms should in theory fall, which is partly the aim of the pollution charges in the first place. Monopolies' optima lie at a lower production and output level than is the case in perfect competition. The prices they charge are higher.

Concluding, Turner, Pearce and Bateman (1994, p. 178) feel that many environmental taxes can only be implemented on a significant scale for global problems (ozone layer, greenhouse effect, and so on) if they are the result of concerted action by many countries. However, this form of international agreement introduces the threat of a 'free-rider effect', since every country has an incentive not to sign the agreement whilst profiting from the global environmental improvement resulting from other countries' commitment.

In short, international agreements may be required to implement an environmental regulation, which is deemed too risky on competitive grounds by national governments. Those countries taking the risk, though, may in the long run, be rewarded with a competitive advantage instead of a competitive disadvantage.

6.4 Pollution Charges and Uncertainty

Increased importance is being given in the literature to the effect of '*uncertainty*' on pollution taxes. Uncertainty can be defined in situations where

probabilities cannot be assigned to possible consequences. It impacts on both macroeconomic and microeconomic variables. Uncertainty is especially important with effect to discounting of environmental effects, uncertainty of future preferences and developments, and also uncertainty concerning the damage function (relationship between polluting activity and emissions and pollution). It is therefore unlikely that a government faced with uncertainty will implement policies that achieve optimal outcomes.

Melese and Michel (1991, pp. 140-153) point to the fact that the threat of future tax changes can influence the (present) behavior of economic agents in a negative, lasting and important manner. They refer to the writings of Adam Smith (1776) who called uncertainty in taxation a 'great evil' in his *Wealth of Nations* and built a model examining the consequences to firms' behavior of 'perceived future changes in the probability of tax reform and the expected profitability under the new tax structure'. The results of the analysis were that the firms alter their behavior in an attempt to shift the burden. Taking into account, in turn, the uncertainty surrounding these behavioral changes, the task of setting the optimal taxation level becomes ever more difficult as the production function changes.

6.5 Pollution Taxes and Strategic Behavior - the Use of Game Theory with Relation to Pollution Taxes

The above issue of the link between uncertainty and the responsive behavioral changes is in close relation to the study of strategic behavior and pollution charges. Economists use *game theory* to analyze strategic behavior. This is the behavior of at least two economic agents whose payoffs are interdependent and who take the expected behavior of the others into account when deciding on their actions.

Samuelson and Nordhaus (1995, p. 193) speak of 'the pollution game'. This game shows that in an unregulated market each firm prefers to maximize profits, that is, pollute, rather than install pollution abatement equipment when they are not sure (due to non-communication, non-cooperation) whether their competitors will be installing costly abatement equipment. This is even the case when firms suspect installing abatement equipment might provide them with advantages in the long run (see Porter's theory in Section 6.3.1 above). This leads to a (Nash-) equilibrium where both parties are responsible for high pollution as a result of non-cooperative behavior. This is referred to as the 'deadly pollution game'.

As mentioned before (see Section 4), under the Coase theorem this problem would be dealt with by a private bargaining system. This would in fact make the regulator obsolete (assuming there are well-defined property rights and zero transaction costs). The alternative was the Pigovian tax levied on the polluter.

However, there have since been several studies in the field of game theory that tackle the issue differently.

Leung (1992), for example, suggested a pollution tax scheme which would tax both the injurer and the victim. Assume a situation where the polluter and victim have full information about each other's taste and technology, but the regulator is faced with a lack of information. The question is then how to reach an (economically) efficient pollution level. This scheme should help the uninformed regulator in case of a sequential game and would lead to a first-best output. The polluter is taxed to redistribute revenues amongst polluter and victim, whilst the victim is taxed to avoid exaggeration of the damage claims by the latter.

Other authors discuss different possibilities under simultaneous or sequential games. This would, however, lead us too far in this chapter - the discussion becomes rather complicated and mathematical - which merely aims to give a general overview of the literature and discussions.

6.6 Increased Importance of Valuation Techniques

Valuation techniques become important because pollution taxes, as theoretically described by Pigou, are impossible to devise in reality. Lack of information makes it impossible to set a tax on the optimal level (see above). The optimum level is where (see above) the marginal cost of abatement equals the marginal reduction in pollution. Whereas it is (sometimes) possible to estimate a company's marginal abatement costs, it is fair to say that the marginal benefit of reduced pollution is much more difficult to calculate. These difficulties arise in part from the subjectivity of costs and benefits (see Section 3.2). Many valuation techniques have been devised but none are ideal.

As the optimum Pigovian tax is fairly impossible to set, it is of extreme importance to set as efficient a tax as possible. Economists have developed a wide array of techniques for valuing the environment, mostly derived from so-called cost-benefit analysis. A short overview of cost-benefit analysis can be found in Chapter 2300, Environmental Regulation: General.

The most used valuation techniques are the contingent valuation technique, an expressed preference method which makes use of surveys to reveal people's willingness to pay (WTP), and the revealed preference methods such as hedonic pricing method (using prices in related markets, for example real-estate) and the travel cost method.

These techniques are essential for valuing the damage done to the natural environment, itself a prerequisite for the optimal Pigovian tax, which should be based on the 'estimated damage'. However, these estimates will inevitably be plagued with a certain degree of uncertainty, a problem, discussed in short in Section 6.4 above.

6.7 Pollution Charges from a Public Choice Point of View

Pollution charges are a policy instrument, and when implemented by democratic governments can be analyzed from a public choice (see Chapter 0610) point of view. Who has an interest in seeing pollution charges being implemented, which parties feel pollution charges are inappropriate, and what specifications are requested by alternative economic agents? These are all questions which can help understand why or why not pollution charges are being implemented, and why they are used for specific target groups and products and not for others.

Whereas economists of different backgrounds agree on the (efficiency) superiority of pollution charges in comparison with command-and-control policies, many governments have so far preferred the latter. As in all public choice theories it is possible to relate this to the interests of those affected by the environmental externalities and those potentially affected by the pollution charges.

Buchanan and Tullock (1975, pp. 139-147) feel direct regulation is (was) often preferred because 'penalty taxes' were not acceptable to those primarily affected. As long as individuals cannot expect returns from the tax revenues in the form of 'cash subsidies, public good benefits or reductions in other taxes', they will prefer direct regulation to taxes as their loss in 'consumer surplus' under this alternative is smaller. Democratic governments will therefore implement regulations as their decisions on the implementation of policy instruments are influenced by the 'preferences of those subject to them'.

In retrospect it has become apparent that governments have tried to 'sell' the pollution taxes by pointing out what can be done with the earmarked revenues; provide public benefits such as clean-up operations or support to environmental causes, or a reduction in other taxes such as income taxes. Buchanan and Tullock's reasoning may therefore no longer be valid.

Wilson (1980) developed his 'regulation' theory in which he no longer followed the classic public choice idea of 'capture' by regulated interest, but simply looked at the costs and benefits of regulation (as perceived by affected parties) in a classic law and economics way. Andersen (1994) used Wilson's regulation theory to analyze how costs and benefits of regulations affect the choice of policy instruments.

Environmental regulation can, then, according to Andersen using Wilson's theory, be classified as being part of the 'entrepreneurial regulation' classification (a classification designed by Wilson, 1980, pp. 367-370) which implies that costs are concentrated and benefits are spread. Whereas under the classical assumptions that regulations will only be passed in the interest of the regulated, Wilson explains that the 'new social regulations' are supported by the 'entrepreneurs', who lobby to have these regulations put on the political agenda. Whether these entrepreneurs are successful in outweighing the influence of affected parties largely depends on their support from 'non-affected third

parties, such as media, influential writers, and so on'. The problem is that the lobby is mainly concerned that some action is taken, against, for example, air pollution. They are less interested in which policy instrument is being used as they have inadequate information to assess which policy is to be preferred. Those who will be affected by the policy, however, such as private firms, for example, have more interest in making sure certain policy instruments are used or not. They have specific cost information, which cannot be estimated by the lobby. The latter cannot, therefore, provide reasons to policymakers why a specific instrument should or should not be implemented. The target groups mostly perceive economic instruments, such as pollution taxes, to impose much greater costs on them than command-and-control policy through standards and voluntary agreements. The lobbiest will tend to accept any policy instruments as long as the 'polluters' have to comply with a general criterion.

7. Pollution Taxes in Practice

7.1 Economic Incentives

One of the practical problems with estimating the efficient level of environmental damage, required to set a Pigovian tax, was tackled by Kohn (1986, pp. 625-630) when he suggested the introduction of a *non-linear per unit tax* to reach a long-run social optimum. This was to surpass the problem of non-linear abatement cost curves. Carlton and Loury (1980, pp. 559-566) used a model to show that a Pigovian (per unit) tax will not produce the socially optimal output as it will uniformly raise a firm's average cost curve. This would result in the firm minimizing its costs at the same output level as before the tax was implemented. Their solution is to supplement the Pigovian tax with a lump-sum tax subsidy scheme for participating firms. This should also give an incentive for efficient entry into the industry.

The realization that many of the economic instruments proclaimed by the economists of the first hour did not take into account the practical implementation difficulties which would jeopardize the efficiency of the instruments, is reflected in the many alternative, more practical, solutions that have since been developed (OECD, 1994).

7.1.1 Emission Charges (Effluent Charges) Emission charges are implemented by governments to be paid on emissions into the environment and are based on the quantity and/or quality of the pollution discharged.

When the charges are levied to fund the public treatment of effluents they are called 'user charges'. The charge may then be uniform or dependent on use.

The OECD (1994) distinguishes three types of emission charges classified by the charge base:

a. actual source emissions (the emission are actually metered);
b. a proxy of source emissions (the estimated emissions are based on pre specified characteristics serving as proxies, for example, water consumption serving as a proxy for wastewater emissions);
c. a flat rate (each source, being a company or a household pays a fixed amount unrelated to the actual pollution caused by this source).

It is obvious that these are, in descending order, less and less true to the original idea of Pigou where the tax would be based on the marginal damage.

One of the main problems with emission charges is one of implementation. Emissions below the officially permitted levels are exempt from taxation. This prohibits the dynamic benefits of a tax system (as opposed to a command and control system) to create results. At this cut-off point (the maximum allowed level of pollution) the firms will also stop comparing marginal benefits against marginal cost of pollution, so unless the government has been able to set the standard at the exact efficient level of pollution (where marginal costs equal marginal damages), this approach will prove to provide inefficient results. Moreover, as many firms will have differing marginal abatement costs, it is impossible for the government to set a uniform level of production that would be efficient for every firm.

7.1.2 Product Charges (Taxes) Product charges or taxes are levied on each unit of a product, which is harmful to the environment. Whether a product is to be taxed depends on:

- whether any of the different stages of its product life is deemed to be polluting. A life-cycle analysis can detect whether the product is polluting in any aspect of its manufacturing or consumption phase or after disposal (from *cradle to grave*);
- the damaging effect of a product component or the product itself. The tax itself will have this as its base. For example, a charge on the lead content of gasoline or a gasoline charges.

Product charges can thus generate government revenues. The danger here is that the revenue-raising aspect may become the prime goal. This can be prevented though as, in practice, product charges can be implemented under the form of tax differentiation. The more 'environmentally friendly' product becomes cheaper due to the tax differentiation. This was used with success, for example, in several European countries as an incentive to boost the sales of unleaded petrol. Whereas product charges may have a revenue-raising goal, tax differentiation operates in a budget neutral manner. In fact it may even lead to a drop in tax revenues, depending on the exact implementation.

Although so-called '*input or resource taxes*' are sometimes seen as a separate environmental tax category, they can be classified under product taxes if the 'product' (or characteristic of a product) taxed is a natural input/resource.

7.1.3 Administrative Charges Administrative charges are fees that should be paid to cover the expenses made by the controlling authorities for control and authorization and related administration. A tax dependent on the domestic consumption of water, or charges implemented for the removal and disposal of waste fall under this category.

However, as these charges are not directly related to pollution levels, and are thus far removed form Pigovian taxes, they will not be discussed any further in this chapter.

7.1.4 Transferable Property Rights Whereas the idea of transferable property rights may well stem from that of pollution charges (see Section 5.1), the outcome - emissions trading - can no longer be seen as a pollution tax and therefore also falls outside the scope of this chapter. Transferable property rights are discussed at further length in Chapter 2300.

Practical experience with the permit trading system can primarily be found in the USA, where they exist, for example, under the Clean Air Acts (1970 and 1991).

7.2 Are Pollution Taxes as Studied and Implemented Today Efficient?
Throughout this contribution, the development of pollution taxes and its many related problems have been discussed. The question now remains whether the current translation of Pigou's ideas on tackling the pollution problems, that is, the emissions and product charges discussed above, provides an efficient instrument.

Evaluating the efficiency of an instrument is not a simple task. Most instruments will have their own advantages and disadvantages compared to other, alternative, instruments. The efficiency can be evaluated in terms of costs to governments, households and firms, but the costs to environment remain difficult to assess in purely financial terms.

Some clear advantages of pollution taxes can be pointed out (though not expressed in easily comparable units such as money):

- pollution taxes leave the choice of pollution-abating policy to the individual firms. Some firms may use clean-up technologies, others may prefer to control their output of emissions or their input of raw materials. This allows a *least-cost abatement* as the firms themselves are best-placed to estimate the different costs of abatement possibilities and firms are confronted with differing individual clean-up costs;

- where non-point sources of pollution cannot be controlled by standards or permits, it is often possible to tax proxies such as consumer products;
- taxes are a dynamic instrument (as opposed to a fixed license) and as such give a constant incentive (if implemented correctly, see Section 7.1.1 above) to reduce emissions;
- firms subject to pollution taxes which are not, or cannot be, passed on to customers are provided with an incentive to develop cleaner technologies which will reduce the price of pollution - this is therefore also beneficial to the long-run resource conservation;
- firms who pass their costs on to customers will in the long run be confronted with a falling demand for their products provided there are cheaper, less-polluting, substitutes available. As consumers favor the more environmentally friendly, and less wasteful products, the use (and abuse) of natural resources will be minimized as all firms will aim to alter their products and production processes to meet the altering demand; and
- taxes provide revenues for the controlling government, which may choose to use this to further protect and clean up the natural environment.

From the last remark it becomes once again apparent that the efficiency of pollution taxes is linked very closely to the price elasticity of the polluting product or services and the availability of less-polluting alternative products or services (see Section 6.2. above). Raising taxes on price-inelastic products (that is, the demand is fairly independent of the price changes) may raise a lot of tax revenues, but is of little incentive to changing behavior. Taxes on price-elastic products, on the other hand, may not in the long run raise much revenue but can be responsible for a shift in consumer buying behavior (provided there are cheaper more environmentally friendly substitutes available).

The above efficiency arguments in favor of pollution taxes has to be seen, however, in the light of the many practical implementation problems with finding the right (efficient) tax level. Many alternatives to the optimal Pigovian tax have therefore been suggested. This has been discussed at length throughout this paper. The main drawbacks of practical implementation are summarized again next.

8. Conclusions and Recommendations for Further Research

The theoretical concept of pollution taxes as first introduced by Arthur C. Pigou has drawn widespread attention. It is neither possible nor desirable to summarize more than half a century's literature on a subject as vast as this in a short encyclopedic entry. The distributional effects and labor market distortions due to pollution taxes have, for example, not been discussed, and

neither has intergenerational distribution due to the implementation of pollution taxes. The bibliography does, however, include sources on these and other topics that have not been discussed in this entry. This entry has primarily focussed on the original writings of Pigou and Coase, seen within the context of law and economics analysis. Public choice aspects of the issue have therefore also been mentioned.

It is not only (environmental) economists who have been drawn to the area of pollution taxes, policymakers looking for efficient environmental regulation (see Chapter 2300) have also shown great interest in this subject area.

In theory pollution taxes have many advantages when compared to command-and-control policies. They allow least-cost abatement, are generally more dynamic and provide incentives for producers ànd consumers alike. The main draw-backs lie with the practical implementation:

- Pigovian taxes are close to impossible to implement effectively as the efficient level of taxation is dependent on estimated damage costs.
- Even if the main goal of a tax is environmental improvement, the effect will often depend on the availability of alternatives and the price sensitivity of consumer demand. If demand is inelastic, that is, the tax does not change consumer behavior but consumers simply pay a higher price for the good, the tax will have little effect on the environment, and government may in the end use pollution taxes as merely a revenue-generating instrument.
- Governments are often hesitant to implement environmental charges as they fear this may damage the competitive position of domestic industries *vis-à-vis* international competitors. This holds true for any type of nationally implemented environmental regulation.

The most important challenge for research on pollution taxes lies in the field of implementation. How can theoretical systems be transposed to the real world and provide tangible results?

New research into the theory of pollution taxes is also required. What may once have been seen as nothing but a mere theoretical exercise, may one day effectively be implemented. For example, the theoretical idea of tradeable pollution rights first introduced by Dales and now effectively implemented in the USA under the Clean Air Act.

As it has become clear that the manner of implementation by policymakers is as important to the success of a pollution tax as the original theoretical concept, an analysis of pollution tax schemes using a law and economics perspective, including a public choice approach, is recommended.

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