ELSEVIER

Ecological Economics 24 (1998) 259–274

ECOLOGICAL ECONOMICS

Scope and limits of the market mechanism in environmental management

Bo Gustafsson

Swedish Collegium for Advanced Study in Social Sciences, SCASSS, Götavägen 4, S-75236 Uppsala, Sweden

Abstract

This paper tries to evaluate the role of the market mechanism in environmental management and warns against reductionist views on the causes and remedies of environmental damages. According to some of these views, proper pricing of the environment and extensive use of market mechanisms in environmental management would solve environmental problems. But various conditions tell against such simplifications, namely: the complex causality behind environmental damages; the complexity of the functions and values of nature; as well as limitations of the market mechanism in coping with the functions and services of nature. Several of those limitations—the difficulties of defining and enforcing property rights to nature's functions and services; the pervasiveness of externalities conditioned by the public goods characteristics of many environmental functions and values; the difficulties in enticing, processing and using information about environmental goods; and the high transaction costs caused by all these circumstances—often rule out contracts and trading of environmental services. It is less known that the basic cause of market existence and extension, namely specialization and division of labour, have negative environmental effects. With respect to environmental policy, conceptual problems are analyzed. While all kinds of environmental management mechanisms have a regulatory function, only quantity mechanisms, as a subset of incentive mechanisms, are market mechanisms. The choice of relevant environmental policy instrument is conditioned by many considerations. The issue of the superior efficiency properties of market mechanisms in environmental management is not yet settled satisfactorily; extensive empirical tests are still lacking. © 1998 Elsevier Science B.V.

Keywords: Environmental management; Functions of nature; Markets; Regulation; Specialization

> "The real comparison one must make in contemplating a regulatory intervention is that between an admittedly imperfect market and what will inevitably be imperfect regulation. Until it is recognized that this is the dilemma before us, we will be dissatisfied with either approach" (Paul Portney (ed.), Public Policies for Environmental Protection, 1990).

> "Defining the appropriate niche for economic incentive policies in the totality of environmental policy is a timely issue" (Tom Tietenberg, Economics and Environmental Policy, 1994).

0921-8009/98/$19.00 © 1998 Elsevier Science B.V. All rights reserved.
PII S0921-8009(97)00147-X

1. Introduction

There is a widespread feeling that the environmental problems cannot be well understood unless addressed by interdisciplinary approaches. This follows from the fact that environmental problems arise as outcomes of the interaction between nature and society. Unfortunately, we lack theories and models that may describe this interaction as a unified and structured whole.

What we would like to see are theories that are capable of integrating natural and social processes in an essential way. In so far as attempts at integration have been made, they usually amount to something much more modest. In modeling environmental outcomes, environmental economists for example, deal only with their own theoretical domain: human beings maximizing utility under constraints. In the best case, they refer to the environmental scientists for information about environmental constraints and include the latter ones as constraints in their models. But there is no real integration of economic and environmental science approaches.

To be true, there exists an emerging discipline of ecological economics, which is very active and may have a promising future (Costanza, 1991). Ecological economics has increased our insights with respect to the interface of nature and economic activity and has also made some attempts at integrating environmental services into economic analysis (Jansson et al., 1994). But so far, the main contribution of ecology to economics is to make environmental economists aware of the limits and complexity of ecological processes and the risks and uncertainties associated with human interference. Ecological economics has not yet formulated a body of accepted theorems defining this new discipline. Attempts seldom advance beyond the 'box-and-arrows-stage' of theory construction (Folke and Kåberger, 1992). Much work of clarification needs to be done within specialized disciplines in that area before it will be possible to achieve successful integration.

2. The problem

I will try to shed light on this issue by discussing the role of the market mechanism in present-day mainstream environmental economics. Mainstream environmental economics is neoclassical economics and neoclassical economics is essentially the economics of the market mechanism. If neoclassical economics has something important to say—and it has—it is centered on the role of the market mechanism in resource allocation. It took a long time for environmental economics to win recognition among politicians, administrators and environmentalists for the fact that the market mechanism can be used for environmental goals. The tide turned with two important events. One was the victorious return of the ideology and politics of the market and the corresponding exit of planning and regulation on a world scale since the 1980s (Donahue, 1989). The other was the accompanying success of the US tradeable permit approach to air pollution control (Tietenberg, 1994). But as it turned out, the economics of the market mechanism has not only won a rightful place in environmental management, sometimes it is made into a magic wand. As one of many examples one may refer to the title of a recent book in environmental economics: 'Green Markets. The Economics of Sustainable Development' by Theodore Panayotou (Panayotou, 1993). In this the author flatly states: 'Ultimately, excessive environmental damage can be traced to 'bad' economics stemming from misguided government policies and distorted markets that set inappropriate prices for natural resources'.[1]

Assuming that the author, by 'excessive environmental damage', means a damage transgressing critical loads or assimilative capacity, he implies that no environmental problems would

[1] It should, however, be pointed out that the author, in a fleeting moment of sobriety, says something different: 'When the external effects are too widely spread, as is usually the case, the correction of the externality is a public good. In such case, the market does not function effectively and government intervention might be necessary if the externality is worth rectifying'.

arise in a world characterized by enlightened government policies, perfect markets and appropriate prices for natural resources. The implication is that the general application of the market mechanism is a necessary and sufficient condition for sustainable development. There would be no problems of scale of economic activity, all aspects of the natural world would be accessible to the workings of the market mechanism and the laws of nature would be completely subsumed under the laws of perfectly competitive markets.

The statement of Panayotou is by no means an isolated one in environmental economics. We should therefore, as suggested by Tom Tietenberg, try to define 'the appropriate niche' for economic incentive policies in the totality of environmental policies in order to get a correct perspective.

3. Causes of environmental outcomes

In order to get a proper perspective upon the role of the market mechanism in effecting environmental outcomes, let us consider the following possible-world configuration:

$$O_{\mathrm{E}} = \mathrm{F}\{\mathrm{N}, \mathrm{C}; \mathrm{L}, \mathrm{S}^{s}[a(\alpha, \beta, \chi, \delta, \varepsilon)\mathrm{b}, \mathrm{c}, \mathrm{d}]\ \mathrm{T}, \mathrm{P}(r, t, \mathrm{m}, \mathrm{q})\}$$

where (negative) environmental outcomes (O_{E}) are regarded as caused by the specific character of the geo-physical system (N), the cultural system (C), the legal system (L), and the economic system (S^{s}) where s is a scale index, a is the set of possible economic organizations (defined by objective function (α), property rights system (β), incentive system (χ), internal allocation mechanism (δ) and external allocation mechanism (ε)), (b) production, (c) distribution, and (d) consumption, while T denotes the state of technology and P environmental policies (regulation proper, (r) taxes, (t) marketable permits, (m) and (q) enforcement mechanisms). Any given (negative) environmental outcome could be the effect of a variation of any of the indicated variables taken one by one or in various combinations. Ceteris paribus, differences in the geo-physical environment (N) clearly affect environmental outcomes of economic activity. Even if Russia would succeed to introduce as efficient environmental management as US, it would be handicapped due to the more frequent inversions, the colder climate, the maldistribution of natural resources, energy, population, agricultural potential and water flows. Culturally determined values, attitudes and behavior with respect to the environment, (C), evidently vary across nations and history and so do legal systems with regard to structure and efficiency (L)[2]. If we regard an economic system (S) as defined by its organization—in its turn, defined by its objective function, property rights system, incentive system and internal and external allocation system—and the processes of production, distribution and consumption, it is clear that environmental outcomes are affected, not only and maybe not mainly, by the external allocation mechanism (ε) but also by other properties. Most important is the scale of economic activities (s), but also various properties of the specific economic organization (a), as e.g. its objective function (α). It can be shown that, ceteris paribus, an economic organization that maximizes average income of members should emit less waste per unit of input than a capitalist firm and a profit maximizing firm less waste than an output-maximizing firm. At any given allocation of resources, variations in the processes of production, distribution and consumption give rise to various impacts on the environment depending upon technology (T) and organization of the respective processes. It is nowadays often noted that environmental outcomes are more and more determined, not by process but by product technology in production and, therefore, also by the final consumption of goods (d). Environmental outcomes lastly vary because of varying structures of policies (P) as well as of levels of ambition and/or implementation. Otherwise it would be difficult to explain why Germany has a better record of environmental improvement than

[2] One may refer to the quip well-known among lawyers: "In France everything is permitted, even if it is forbidden. In England everything is permitted, if it is not forbidden. In Germany everything is forbidden, if it is not permitted. In Russia everything is forbidden, even if it is permitted".

France and the Netherlands better than Belgium. We should also notice that a set of policies that is appropriate in one setting may not be so in another setting and further, that similar concepts for policies may refer to very different realities. Even if marketable permits per se should be superior to command-and-control regulation, they may not be perfect. Command-and-control regulation also works very differently because of variations in administrative structures and behavior. In a large nation with an anonymous and independently acting regulation authority, the efficiency of regulation may be inferior to what takes place in a small nation with close collaboration between administration and civil organizations, both in policy formation and implementation.

If we, with these complexities in mind, try to account, for e.g. the massive environmental destruction in the former Soviet Union, the reductionist answer would be: it was because of the centralized planning system and the absence of markets. Maybe it was. But what about the initial conditions given by the geo-physical environment? Or the process of rapid early industrialization reminding us of the experiences of the 19th-century Europe? Or the output-maximizing economic organization? Or the Marxist ideology emphasizing boundless development of the forces of production? Or the accepted economic theory allowing for only labor values? Or the badly enforced property rights? Or the absence of mass participation conditioned by the lack of democracy? Evidently, the resource allocation system played its part as well as an irrational and inefficient price system. But these causes were subsets of a much larger set of possible causes.

4. Functions and values of nature

In order to be able to delimit the scope and limits of market mechanisms in environmental management we should consider, first, the functions and values of nature and second, the conditions and properties of the market mechanism and see to what extent they are compatible with each other.

There are several approaches to the proper definition of the functions and values of nature. Environmental economists usually refer to the quadruple 'sink-source-existence-option' combination. The most thorough investigation of this issue to my knowledge has been made by de Groot (1992). The natural environment provides us with four types of functions making existence of the human species possible: (1) regulation functions; (2) carrier functions; (3) production functions; and (4) information functions, and they add up to close to 40 sub-sets of functions (Table 1).

Underlying those functions are a series of complex environmental characteristics, processes, as well as components, like bedrock characteristics and geological processes, atmospheric properties and climatological processes, geomorphological processes and properties, soil processes and properties, hydrological processes and properties, vegetation and habitat characteristics, species-properties and population dynamics, life-community properties and food chain interactions as well as integrated ecosystem characteristics. The various environmental functions now provide us with certain services and/or values of specific types. de Groot suggests that these values may be grouped into three sets: ecological values, social values and economic values. Market values may be regarded as a sub-set of economic values. If we define value in the wicksteedian sense of 'terms on which alternatives are offered, some values can be quantified while others cannot (Wicksteed, 1933). According to de Groot, ecological values usually can be described only in qualitative terms; social values may be quantified by setting standards for minimum requirements for the availability of a given function, e.g. air-quality or maximum limits for example, waste absorption; economic values may be expressed not only in physical quantities but also in monetary units. But while all market values are economic values, all economic values are not market values. For an economic value to qualify as a market value it should have originated in a spontaneous allocation process, where the free choice and information of the consumers, the extensive competition among the producers and the absence of pervasive externalities, public goods as well as increasing returns to scale give

rise to a unique set of equilibrium relative values. de Groot defines ecological values as conservation values and existence values, social values as health and option values and economic values as consumptive use values, productive use values and the values attributed to employment. Conservation values refer, for example, to the value of the maintenance of algae and cyano-bacteria, which are responsible for about 40% of the global photosynthesis (Molander, 1995). (Photosynthesis is the process in which carbon-dioxide plus water plus light energy in the presence of enzyme systems associated with chlorophyll, results in glucose plus oxygen. During photosynthesis, part of the sunlight energy is stored as potential or 'bound' energy.) While it may make sense to assign quantitative or—more doubtful—monetary values to the conservation of elephants, blue whales or Kemp's ridley sea turtles, any attempt to assign such values to the estimated 0.2–1.0 million species of algae would, indeed, be a daunting exercise. Existence values are also intangible (ethical or aesthetical) values attributed to nature, conditioned not only by the regulation and conservation functions but also by the carrier and production functions of nature. This applies also to health and option values as social values. Option values of environmental functions refer to the importance people assign to a safe future and potential benefits of natural processes or of species not yet discovered. The value people attach to recreational services represent a minor aspect of these values. de Groot's definitions of economic values seem somewhat arbitrary. A more satisfying approach would be to define them in terms of regulated values (like taxes and charges), imputed values (like shadow prices) and market values. Regulated values are values assigned in a political-administrative process, primarily reflecting the preferences of the regulators on the basis of their perceptions of the preferences of experts, political parties and voters; shadow prices represent more or less imperfect attempts to interpret and translate opportunity costs and consumers' preferences; while market prices ideally mirror those costs and preferences 'best'.

If we now combine the types of functions of the natural environment and the types of values that can be attributed to these functions, we arrive at the following reduced matrix (Table 2).

Table 1
Functions of natural environment

Regulation functions
1. Protection against harmful cosmic influences
2. Regulation of the local and global energy balance
3. Regulation of the chemical composition of the atmosphere
4. Regulation of the chemical composition of the oceans
5. Regulation of the local and global climate (include the hydrological cycle)
6. Regulation of runoff and flood-prevention (watershed protection)
7. Water catchment and groundwater-recharge
8. Prevention of soil erosion and sediment control
9. Formation of topsoil and maintenance of soil-fertility
10. Fixation of solar energy
11. Storage and recycling of organic matter
12. Storage and recycling of nutrients
13. Storage and recycling of human waste
14. Regulation of biological control mechanisms
15. Maintenance of migration and nursery habitats
16. Maintenance of biological (and genetic) diversity

Carrier functions
providing space and a suitable substrate for
1. Human habitation and (indigenous) settlements
2. Cultivation (crop growing, animal husbandry, aquaculture)
3. Energy conversion
4. Recreation and tourism
5. Nature protection

Production functions
1. Oxygen
2. Water (for drinking, irrigation, industry, etc.)
3. Food and nutritious drinks
4. Genetic resources
5. Medical resources
6. Raw materials for clothing and household fabrics
7. Raw materials for building, construction and industrial use
8. Biochemicals (other than fuel and medicines)
9. Fuel and energy
10. Fodder and fertilizer
11. Ornamental resources

Information functions
1. Aesthetic information
2. Spiritual and religious information
3. Historic information (heritage value)
4. Cultural and artistic inspiration

Source: de Groot (1992).

Table 2
Functions and values of the natural environment

Values / Functions	Ecological		Social		Economic		
	Conser-vation	Exis-stence	Health	Option	Regula-ted	Impu-ted	Market
Regulation (16)	●	●	●	●			
Carrier (5)		●	●	●	●	●	●
Production (11)		●	●	●	●	●	●
Information (5)	●	●	●	●			

Adapted from de Groot, 1992, p. 130.

A black dot in the matrix indicates the existence of a major relation between functions and values of the natural environment. From the point of view of the functions of the natural environment, carrier and production functions are associated with all the three main types of values of the environment, while the regulation and information functions are immediately associated with ecological and social values but not with economic values. From the point of view of values of the natural environment, social values are associated with all four types of natural functions, while ecological values are mainly associated with the regulation and information functions, respectively, and economic values are centered around the carrier and production functions.

5. Scope and limits of the market mechanism

In order to be able to situate 'the niche' of the market mechanism in environmental management, we need a characterization of the market mechanism. Although textbooks in economics repeatedly talk about and analyze the market mechanism, one seldom sees attempts to formulate the necessary and sufficient conditions for the existence of the market mechanism.[3]

The market is a mechanism that allocates and re-allocates resources between traders. The viability of the market mechanism is explained by the fact that it represents a 'spontaneous order' (a term introduced by Hayek), that is, it allocates resources on the basis of free choice, reflecting—at a given distribution of income—the needs of the market agents (except for very important utilities like health, security, education and equality) and it promotes innovation and ingenuity. It consists of four elements: traders, traded goods, terms of trade and acts of trade. These elements must possess specific properties that together define the market mechanism and distinguish it from other mechanisms of resource allocation (command, voting and bargaining in isolated exchange). For markets to exist, the following eight conditions must be fulfilled. (The extent of their fulfilment defines the degree of perfection/imperfection of the market mechanism):

1. Self-interested traders maximizing utility (profits), which distinguishes market exchange from gift-giving and altruism.
2. Institutions, i.e. formal and informal rules, primarily well-defined decentralized property rights (private property rights are a sub-set of decentralized property rights) and adequate enforcement mechanisms, whereby internationalization of costs and rewards is safeguarded.

[3] Not even in The New Palgrave Dictionary of Economics do we find an entry for 'market' or 'market mechanism', although various aspects of this mechanism are exhaustively treated. This is often the case with concepts strongly affected by ideological connotations. They are simply taken for granted.

3. Excludibility in supply and rivalry in demand, which technically defines private in contradistinction to public goods and prevents externalities.
4. Comparative advantage in the conditions of production (division of labor) of traded goods and different relative valuations of the traders with respect to these goods.
5. Free entry and exit to exchange between traders.
6. The number of traders must be 'large' to ensure competition and to make traders 'price takers'.
7. 'Sufficient' and symmetrically distributed information between traders about goods, terms of trade and opportunities to trade.
8. Transaction costs must not be 'too high'.

From this list we may perceive, first, that the conditions of existence of the market mechanism are related to properties of traded goods, traders and their environment; second, that there are interrelations between them. The two central conditions are the nature of traded goods and the character of the institutions. If traded goods are not private but public, trading will result in externalities and externalities will affect transaction costs. If property rights are ill-defined, trading will likewise give rise to externalities and high transaction costs. Generally speaking, environmental goods fail to fulfill or fulfill badly four of the eight conditions (or even five, if we include also profit maximization) for (efficient) market exchange, since: (1) institutions, primarily well-defined property rights, are often lacking or are difficult to establish and enforcement of those property rights, as well as internationalization of costs and rewards, also meet with difficulties; (2) environmental goods are often public goods, likewise giving rise to externalitites in exchange; (3) information about environmental goods is generally deficient or very costly to acquire; and (4) transaction costs are high because of (1), (2) and (3).

This state of things is basically caused by the properties of the environmental functions and by differences in the modes of operation of ecological and economic mechanisms, respectively. As emphasized by Holling (1994), environmental functions are, first, inter-related and systemic and maintain themselves by diversity. Let us regard just one of infinitely many examples: ''Ledec and Goodland have shown how the production of Brazil nuts depends on a variety of poorly-known forest plants and animals. Male euglossine bees, which pollinate the flowers of the Brazil nut tree, gather certain organic compounds from epiphytic orchids to attract females for mating. The hard shell covering the nut is opened naturally only by the forest-dwelling agouti (a large rodent), thereby enabling the tree to disperse. Thus, maintaining Brazil nut production appears to require conserving enough natural forest to protect bee nesting habitat, other bee food plants, certain orchids and the trees upon which they grow, the insects or humming birds that pollinate the orchids (and all their necessities in turn) and agouties'' (McNeely, 1988). They are, second, fundamentally non-linear in causation and demonstrate multi-stable states and discontinuous behavior in time and space. There are, third, limits to their capability for resilience and when these limits are transgressed, due to the accumulation of human impacts, sudden changes occur in the environmental variables. Lastly their span of connections are often cross-scale in space and time and are becoming more so due to the transformation of the earth by human beings. It is these properties that give rise to the public goods aspects of environmental functions, to the difficulties in delimiting property rights and to the problem of pervasive externalities. Confronted with the market mechanism, nature kicks back because of the conflict between two qualitatively different sets of laws and behaviors, as well as of different 'goals'. The 'goal' of nature is to preserve the stability of the system in the cybernetic sense, while the 'goal' of economic activity is the continuous transformation of nature and transgressing of natural limits. No mechanism exists which can guarantee that the behavior of nature and the behavior of the economy are adjusted to each other except by pure chance. The reasons are, on the one hand, the complex interrelations of ecological mechanisms and on the other hand, the optimizing behavior of economic man and the impossibility of acquiring and utilizing all the necessary information about these ecological

mechanisms. If the market emits a signal to farmers to grow broccoli, they write contracts with buyers, specifying quantities, prices, qualities, terms of delivery, etc. and the farmers buy seeds, allocate land, plant, harvest and sell more or less according to plans. But, if the market emits a signal to fishermen to catch cod, they would have to rely on the spot-market because of uncertainty due to fluctuations of the fish stock and the biological structure of the fish population. They may be lucky and catch big, old fish of high economic value. But optimizing harvest rate may affect age of capture negatively and bring mainly herring (a favorite food of cods) in the future or the catches would deplete vulnerable sub-species of cod or bring species or sizes of fish that are low-priced and less desirable. If the fishermen would try to imitate farmers and hatch fish, e.g. salmon, in order to reduce the variability of the target, the productivity of the hatcheries would decline over time. The standard response of an economist-advisor to these problems would be to recommend the fishermen to manage a portfolio of fish assets instead of one single one. But this advice would again, encounter high costs of information and transactions and, if successful, enlarge the original problems at the end.

Nature thrives on diversity because diversity facilitates resilience. The market mechanism thrives on and promotes specialization and increased scale because both bring lower costs, increased sales and increased profits. The large-scale reduction of the number of species due to specialization, that has been going on since the invention of agriculture and at an accelerated rate since the general introduction of the market mechanism in human societies during the last two centuries, has brought enormous increases in agricultural productivity and human well-being. But at the same time, this depletion of biodiversity is spoiling 'a uniquely formulated insurance policy against shocks to the life system itself… because existing life forms encapsulate a history of successful adaptation within a changing physical environment' (Swanson, 1994). The lack of information concerning the value of biodiversity and also of other properties of ecosystems implies that the market mechanism usually underestimates the value of stocks as well as of flows of natural services. Values can be disclosed often only after the loss of the environmental function (de Groot, 1992). But even if the information problem would be solved, if property rights would be established, if public goods would be transformed to private goods and if externalities would be internalized, the costs for effecting all this—especially for eliciting the necessary information—would be so forbiddingly large, that they in many cases, would exceed any possible benefits. Imputation of values and assignment of implicit prices may solve certain environmental problems and in certain areas extend the domain of the market mechanism. But from the theory of the second best, we know that such partial corrections may bring outcomes that harm more than they help. (If only one of several divergencies from optimal conditions is altered, a correction of one of them may aggravate remaining divergencies.) We do not even know if they bring about functioning markets, since the ensuing costs ultimately have to be borne by consumers with preferences (and incomes) that make them willing to bear the costs. Further, the market valuation induced by environmental concerns would create a regulation of prices and quantities that at best would entail a very specific type of market mechanism, that only superficially would resemble genuine markets representing spontaneous order, because of the extensive political and administrative decision making, monitoring and enforcement it would bring in its trail.

We have already mentioned that the proliferation of the market mechanism is behind the large scale extinction of species because of productivity benefits reaped from increased specialization. Specialization is the single most important factor behind market widening, since specialization is an effect of increased division of labour and, as already Adam Smith noted, extended markets presuppose increased division of labour. The power of increased division of labour and increased specialization is explained by the productivity increase that motivate them. But from an environmental point of view, the consequences look different. Division of labour usually leads to the establishment of new property rights and this may not be efficient for managing environmental

mechanisms of public goods nature. Increased division of labour and increased specialization also widen the gap between local consumption and global production. This makes it difficult for traders and consumers in the market to signal their preferences to producers, while producers lack incentives to adapt production to environmental concerns. Swedish consumers of Swedish pork have a fair chance of exerting an influence on Swedish pig farmers not to use too many chemicals. Swedish consumers of Dutch pork may have some possibility to react on what Dutch pork farmers do or not do. But Swedish consumers of Australian lamb meat cannot be expected to receive and act upon information about what Australian lamb farmers do. And if something unexpected happens in one small part of the chain, the consequences can be large. To minimize the risk, regulation is necessary. A well-known real-world example is Botswana beef production: 'Botswana exports more than half of its beef output overseas. Two-thirds of it goes to the EEC, which has a high demand for lean (grass-fed) beef.... Wildbeest have dwindled in numbers through loss of habitat until they now total only 10% of their once vast number. A similar process of wildlife depletion, with the consequent degradation of range lands by overgrazing of domestic cattle, can be seen in several other African countries where the spread of ranching is subsidized by foreign aid' (McNeely, 1988).

Another consequence of increased specialization in production and marketing is that the number of goods and services in the consumers' budget increases. Therefore, the share of each good in total expenditure decreases. Hence consumers' incentives to bother about decisions to purchase or not, also carry less weight. This aspect takes on special importance when goods are composed of several elements, some of which are hardly noticed by the consumers. It was reported recently in Swedish press that beech forests are threatened because of the demand for ice cream. According to ice cream producers, beech wood is essential for marketing ice cream bars because beech wood has a neutral taste. Ice cream consumers (especially children) do not usually reflect upon the stick when consuming ice cream and probably do not care because the wooden stick is a joint consumer good of little if any importance for the decision to buy ice cream.

6. Managing and adjusting to the environment

If the general orientation of the preceding account can be accepted, we should not expect too much from the use of the market mechanism in environmental management, in spite of its, in many cases still, untapped power. The reasons are that efficient resource allocation is only one of many objectives in successful environmental management; that the environmental functions are too many, too varying in character and too complex to be coped with one single mechanism; that the applicability of the market mechanism with respect to environmental functions meets with too many constraints; and that the social, cultural and historical environments wherein it should be implemented are too varied to permit general applicability.

A too narrow focusing on one policy instrument blinds to the possible power and efficiency of other approaches. When evaluating policy instruments, economists also are too often inclined to compare planned instead of implemented outcomes, usually because the interest is focused on models of rational decision-making. Further, the assumptions of the models pay usually only limited attention to the institutional environment where the models are supposed to work or the institutional environment implicitly assumed is supposed to have universal validity (Dale, 1968).[4] In economic theory administrative regulation, e.g. is often treated as a relatively fixed constraint on behavior. But, of course, it is a variable. An efficient legal enactment prescribes goals, lays down rules, devises implementation, allocates resources and controls the result. But the legislation

[4] J.H. Dale gives an interesting example from the economics of water pollution. In the US, water pollutions are usually passed on downstream and thus, river pollution is preferably analyzed in terms of externalities. In Canada people usually live on a lake system and tend to pollute themselves, requiring economic analysis in terms of social decision-making.

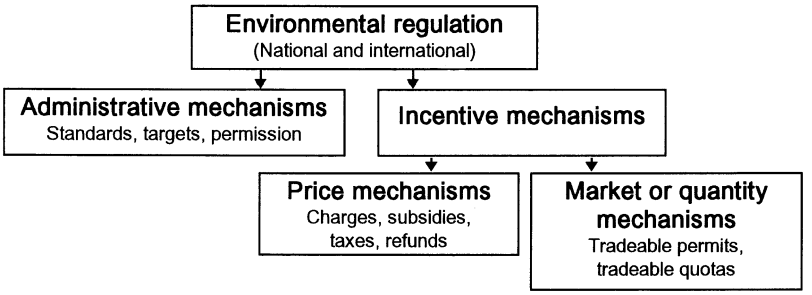

Fig. 1. Environmental policy instrument.

may prescribe a fuzzy goal, devote main interest to the rules, skip the implementation, avoid the problem of resources and may not be too interested in the result. In a critical evaluation of Swedish environmental management, such behavior has been compared to a car designer, who constructs the car without thinking through what the car should be used for, whose main interest is focused on the power of the engine, skips the question of power transmission, avoids the problem of resources and is not too interested whether the car rolls or not. With regard to the implementation, it is one thing to be regulated by pollution inspectors in the United States, who risk lawsuits from indignant environmentalists if they deviate from the letter of the law (but which also implies expensive litigation between regulator and polluter). It is another thing to behave like the classical British pollute inspector (at least before the 1990 Environmental Protection Act signaled a change): 'A friendly advisor, who treats those whom he visits as gentlemen desirous of doing right', an attitude which probably has put a break on control costs, but probably also on clean-up operations (Cairncross, 1995).

In many texts on environmental policy, terminology is sometimes confusing. 'Regulation' sometimes signifies 'administrative mechanisms' which really are a sub-set of regulations and 'market mechanisms' sometimes signifies not only market mechanisms proper, but also incentive mechanisms as a whole. 'Environmental policy' may refer to environmental policy proper, but also to intergovernmental agreements, voluntary schemes as well as policy efforts of non-governmental organizations. (In reality environmental outcomes are affected also by laws and governmental institutions responsible for physical national planning, conservation, etc.) Here we will delimit the concept of environmental policy to those governmental activities that have been explicitly designed for environmental management. I suggest the following taxonomy (Fig. 1):

In this view, environmental policy always implies regulation in the sense of explicit policy decisions. There are two subsets of regulation: administrative mechanisms ('command-and-control') and incentive mechanisms. Administrative mechanisms rely on public regulation, rules, enforcement and control executed by officials with or without the consent and cooperation of economic agents. Incentive mechanisms, in addition, to some extent rely on or engage the economic agents' self-interest, information and resources. The incentive mechanisms can be of two kinds: price mechanisms and quantity mechanisms, also called market mechanisms. Only the subset quantity mechanisms hence can be regarded as market mechanisms. But this market mechanism is a market mechanism that is created and changed by policy decisions and enforced and monitored by administrative structures. It has family resemblance with proper market mechanisms in so far as there are traders, contracts, prices, incentive mechanisms and cost minimization behavior involved. But in contradistinction to proper market mechanisms, the markets of environmental regulation are not entities of a 'spontaneous order'. If government had not created and enforced them, they would not have existed. From the point of

view of the traders, they represent a costly constraint enforced by government. Since there are no inbuilt mechanisms for quality control of the traded good (the buyer of a permit does not care whether the seller reduces the emissions in proportion to the permit and the seller evidently has incentives to exaggerate it), these markets imply strategic behavior and presuppose a substantial amount of metering and monitoring by the environmental administration.

The choice of relevant environmental policy instrument depends upon several considerations: (1) the nature of the environmental problem; (2) the goals, their ordering and constraints, as well as; (3) the acceptance of goals and ambitions; (4) the possibilities of implementing policies; (5) efficiency considerations; and (6) distributional concerns to name a few (Bohm and Russel, 1985; Gruenspecht and Lave, 1989). Even if, ceteris paribus, policy A is more efficient than policy B, possibilities of acceptance, implementation or equity may favor policy B. Since environmental problems and their solutions are multi-dimensional, we should also expect that several policy instruments are used parallel. Sometimes it is found that a given environmental goal may be achieved with more or less identical efficiency with alternative policy instruments. By way of illustration, Thijssen and Laan (1992) made an econometric study of the effects of reducing ammonia in the Dutch intensive livestock sector by the year 2000, by reducing the numbers of pigs and poultry and alternatively by taxing the inputs. The differences in efficiency of the 'regulation' scenario and the tax scenario were negligible. The former policy instrument was preferable from a distributional point of view, since the tax scenario caused a large income transfer from the small to the large farms because of differences in sensitivity to changes in input prices.

Confining our discussion to (1) and (2) above and referring to Tables 1 and 2, it stands to reason that most environmental functions and values are inaccessible to the application of market mechanisms and maybe also price mechanisms, even if specific manifestations of functions and values, to some extent, may be accessible to the use of imputed prices and sometimes should be (for a systematic overview, de Groot, 1992). The over-enthusiasm for the use of market mechanisms in environmental management is explained largely by their successful application in US air pollution control. But even in this 'niche' of environmental policy, their success is mainly limited to stationary-source local air pollution (Section 7). The fact that they have not been applied to regional and global air pollution, mobile-source air pollution, water pollution or toxic substances is not only and not mainly conditioned by inertia, but by considerations of relevance and/or applicability (this seems to be a fair conclusion from a reading of Tietenberg, 1992). In these as well as in other areas of environmental management, political-administrative, as well as price mechanisms, could be used, are used and should be used.

7. Administrative and incentive mechanisms

Let us briefly recapitulate the pros and cons for administrative and incentive (price and markets) mechanisms, respectively, in environmental management, trying to avoid the traps of comparing theoretical constructs with applied constructs, well-designed mechanisms with badly designed mechanisms or planned outcomes with implemented outcomes. Even if those traps are avoided, there is still room for uncertainty and doubts caused by possibly flawed models, dirty data and biased estimation.

From an efficiency (cost-minimizing) point of view, administrative mechanisms are expected to be inferior to incentive mechanisms. The reason is that administrative mechanisms, first, have limited flexibility (partly because of equity considerations and partly because the costs of flexibility would mainly fall on the principal, since agents do not have incentives to share them); second, that they have difficulties in inciting, processing and using sufficient information; thirdly, that the stick-and-carrot incentives are (and should be) weak, which has consequences for the efficiency of implementation. But administrative mechanisms have to be used when incentive mechanisms do not work at all, should be used when they work better than incentive mechanisms and could be used whenever

the superiority of either mechanism cannot be established. We have in mind, not only the standard cases of market failure (see above), but also others: (1) When uncertainty prevails and precautionary action is a merit good ('If you do not know where you are going you had better halt until you know'). (2) When the interests of future generations beyond grand-grand children are involved. (3) When swift action is necessary and rational. (4) When ecological limits evidently have been reached or transgressed. (5) When production technology or cost conditions are essentially similar between firms or there are few firms or one dominating firm. (The scepticism towards the utilization of market mechanisms in European environmental management is not primarily explained by bureaucratic inertia, but by the fact that markets are small and usually dominated by one or two firms.)

Compared to the efforts invested in proving the inefficiency of administrative mechanisms, less (pragmatic) ingenuity seems to have been displayed in devising efficient ones. One option is to combine administrative and incentive mechanisms as in the Baumol-Oates 'standard and charges approach' (Baumol and Oates, 1988). In a Swedish governmental report this approach is designed as follows, with respect to emissions of pollutions. The emission of a certain minimum quantity is free of charge up to a threshold value. Emissions above that threshold are charged. For emissions above the ceiling heavy penalties are paid (Kriström and Wibe, 1992).

Evidently, administrative mechanisms have been used with success in some areas of environmental regulation in developed countries. During the 1980s, particulate emissions in the US were down by 22%, sulfur dioxide emissions by 17%, carbon dioxide emissions by 25%, nitrogen dioxide emissions by 8%, volatile organic compounds by 17% and lead by 93% (Tietenberg, 1992). On the other hand, no appreciable overall change seems to have occurred with respect to water pollution control. The big differences in result, with respect to control of pollutants, is explained by Commoner with differences in policy approach. According to Commoner, the success stories (prevention of emission of lead, DDT, PCB, mercury in fresh waters, radioactive fallout and local phosphate emissions) were made possible by controlling inputs, while the less successful prevention of standard air pollutants was based on controlling outputs (Commoner, 1989).

For environmental economists, the successful environmental policy per se is not so interesting, since anything can be done if there are no cost constraints. They ask whether the policy was cost efficient or not. When they find that it was not, compared to what would have been possible by using incentive mechanisms, their conclusion is that such mechanisms should be used. This inference may be accepted, although with three qualifications. First, not only the relative but also the absolute measure of inefficiency is interesting. It may be terrifying to note that administrative mechanisms, on average, are four times as costly as cost-efficient methods, although with large variations, between 1 and 22 (Tietenberg, 1992). But it should also be noted that the absolute costs of environmental regulation are so low that the overall impacts on efficiency are negligible, maybe 0.0–0.3% of yearly productivity growth (for a recent overview of existing studies for USA and Europe, see Wibe, 1991). Second, the requirement that the mechanisms should be comparable in essential respects is not always met (Cropper and Oates, 1992). If we list a series of administrative and incentive mechanisms, respectively, on a continuous scale from lowest to highest cost efficiency, a sample of a few of those mechanisms that so far have been tested may give a very unreliable picture of the relative merits of administrative and incentive mechanisms in general. Third, it is widely admitted that administrative mechanisms, because they are more inflexible than incentive mechanisms and because standards typically are maximum standards, result in 'overcontrol' compared to incentive mechanisms. From a purely cost-efficient point of view, the resulting increase of environmental quality in less harmed areas is inefficient (Tietenberg, 1992). But it is not at all certain that the cost-efficient solution agrees with the ecological optimum. Further, people highly value the preservation of greened sanctuaries in a polluted world precisely because they are sanctuaries, irrespective of whether pollutions are evenly distributed or not.

Turning to incentive mechanisms, they are often superior to administrative mechanisms with respect to cost-efficiency because of their utilization of the price mechanism and the self-interest of the agents for information and incentives. If charges are correctly set and markets for permits are competitive, both price mechanisms and market mechanisms should achieve cost-efficiency so that, in the price mechanism, marginal costs for emissions are equal to the charge, while in the market mechanism, marginal costs for pollution control are equal to the permit price. The market mechanism, in addition, possesses one property that the price mechanism possesses only if charges are correctly set: it allows the regulating authority to decide the permissible level of pollution, while leaving the agents (the firms) free to allocate the distribution of it between themselves. While in the price mechanism, the principal sets prices and lets agents decide quantities, in the market mechanism the principal sets quantities and lets agents set (hopefully take) prices. From the point of view of cost-efficient environmental management, the market mechanism therefore is an ideal policy instrument, since it permits the authorities to have the polluters themselves control, on efficiency grounds, what the authorities first and foremost want to control—the quantity of emissions. Because of standard market failure problems (public goods, property rights, externalities, transaction costs, metering) especially market mechanisms (tradeable permits) have been confined mainly to certain types of air pollutions (stationary point-sources with uniformly mixed pollutants).

Although both mechanisms are cost efficient, they each possess weak points. The weakest point of the price mechanism is the difficulty for authorities to set the charge or tax at a level, which will realize the quantity goal. Usually charges have been set too low. A way out may be combined mechanisms, as indicated above, or possibly, iterative charge fixing which, however, may be costly and may create uncertainty about the rules. Alternatively, firms would be requested to report their emissions and pay an initial charge based on this report. If firms are monitored, they would receive a rebate when actual and reported emissions coincide (Swierzbinski, 1994).

Incentive mechanisms, however, also have drawbacks. First, as emphasised by Ehrenfeld, economic criteria of environmental values are 'shifting, fluid and utterly opportunistic in their practical application' (quoted in McNeely, 1988). Prices are always prices for specific goods in specific situations based on the values of specific producers and consumers in specific time and space. But values of nature are composite, interconnected and should ultimately be based on criteria for survival and sustainability. If an elephant herd in Amboseli National Park is found to be worth $610 000 per year in terms of visitor attraction, this valuation is of very limited interest from an environmental point of view. Second, by relying mainly on incentive mechanisms in environmental policy, one may create long-term disincentives to protecting nature because the use of incentive mechanisms may foster the illusion that we may solve the long-run environmental problems simply by paying our way. The more cemented this illusion becomes, the higher the payments requested and accepted, while the long-run problems may be postponed but not solved.

8. Evaluations of market mechanisms

The issue of the superior efficiency properties of the market mechanism in environmental regulation does not yet seem to be finally settled. The results of an early evaluation were inconclusive, since either little trading and few cost savings were observed or a well-functioning market (although with little effect on environmental quality) was attributed to ease of monitoring and political consensus (Hahn, 1989). Also, the early results from the emission trading policies under the auspices of EPA were inconclusive, even if great cost reductions were estimated. But external offset trades were modest in volume, due to uncertainty about property rights, difficulties in finding trading partners and in judging future permit prices, as well as restrictions leading to high transaction costs (Hahn and Hester, 1989). In an overview of cost differences in administrative and market mechanisms in air pollution control quoted above, Tietenberg found least-cost solutions

vastly superior to administrative methods. It should, however, be pointed out that the comparison was between actual 'command-and-control' costs, on the one hand and hypothetical least-cost solutions on the other hand, for achieving specific air quality objectives. It would have been more illuminating if the comparison either had been between actual costs of both mechanisms (which lack of data for market mechanisms evidently prevented) or still better, between cost/effect change ratios for respective mechanism, since it is costs in relationship to estimated effect change that is interesting. Like Hahn, Tietenberg is also somewhat ambiguous in these early assessments. While problems of various kinds were pointed out (high transaction costs, non-competitive markets, lack of evidence of innovations stimulated by the program, etc.) as well as the lack of comprehensive data, he expressed great faith in the superiority of the market mechanism (Tietenberg, 1991). As to effects on air quality, he pointed out in 1991 that it was 'virtually impossible to say how much of the improvement can be attributed to the emissions trading program'. But in a later version he more categorically maintains that 'emissions trading program has also produced an improvement in air quality' (Tietenberg, 1995).

In a quite recent study of the results of the tradeable permits approach in Los Angeles smog control, Vivien Foster and Robert W. Hahn (Foster and Hahn, 1995) argue for 'a vigorous effort to assess the properties of these systems as they are actually implemented'. This investigation of tradeable permits is based on the most extensive economic data set to date according to the authors. Previous studies have been hampered by 'the almost complete absence of price data'. (If this is true, earlier estimates of cost efficiency would seemingly have been guesstimates!). Even if price data, also in this study, were collected from only 25% of the trades, it is the first one to include micro-level data on trading prices.

Summing up previous experience of environmental markets, the authors maintain that three points are central: '(1) Rules governing trades can have a dramatic effect on transaction costs and hence on the efficiency of these markets; (2) politics plays an important role in determining the structure and performance of markets and taxes; and (3) the support of the bureaucracy charged with implementing the program is frequently crucial for the success of the program''.

The peculiarity of this market is that real trade between firms (the so-called offset market for assisting the transfer of emission credits between new sources of emission and sources that are closing down or reducing their emissions) does not provide sources of emissions with a choice between abatement and the purchase of credits. Consequently, this aspect of the market does not provide direct evidence on the cost savings properties of tradeable permits schemes. On the other hand, where such cost savings in fact are realized, namely through so-called netting, which allows a firm to choose between abatement or purchase of credits by creating a new source of emissions in plant by reducing emissions from another source in the same plant, they are based on credits only from the firm's own sources of emission. The paradoxical structure of this market is, as far as I can see, that cost control takes place where proper trade does not exist, while no cost control takes place where proper trade does exist! The link between market-based price formation on the one hand and cost-minimizing efforts on the other hand is evidently missing in this mechanism. Furthermore, it is found, first, that prices exhibit wide variation within and across years. This is explained with reference to the fact that the traded goods (the emission reduction credits) are so heterogeneous; sometimes the credits may be a free good, as when they arise because of a shutdown; sometimes they may be quite costly, as when they are created by means of a process change. The absence of a strong link between costs and trading and this heterogeneity of traded goods, as well as the ensuing price dispersion, show that we are far from an efficient market providing information and incentives for choice between opportunity costs. Second, in spite of the marked movements of maximum prices, the minimum price is very low and very stable, which 'suggests a reservation price that is invariant to market conditions', possibly suggesting the presence of high transaction costs. Other findings in this study are that search costs are very high (finding a suitable partner can

take anywhere from a day to a year and a half); that half of all proposed trades fall through during the negotiation process; that it takes between a half year to one year to obtain bureaucratic approval; that 40% of all trades proposed are flatly rejected because of difficulties in certifying the claimed emissions reduction and in agreeing on the benchmark against which the reduction is measured; and that, as a consequence, transaction costs of trades frequently exceed the market value of credits purchased. Lastly, the authors note that markets for pollution control become segmented and consequently, because they must be sensitive to the location of emissions, also are 'thin'.

Summing up the results of the study, Foster and Hahn find, that: (1) the magnitude of transaction costs have effects on incentives to engage in external trades; (2) the market in tradeable permits is not likely to be in a classical equilibrium with a set of well-defined prices; and that (3) information on changes in the aggregate-level of emissions is critical for assessing the environmental effectiveness of market-based programs. (Another conclusion not noted here, is that banking facilities play an important role in the functioning of a tradeable permits scheme).

These findings are also predictable. Even if the market mechanism in environmental management probably is still an insufficiently utilized policy instrument, it must by necessity, since it is a tool of regulation, have properties that differentiate it from proper market mechanisms and that have consequences for its efficiency. These properties are conditioned by constraints that are evident. In the first place, environmental regulation is essentially a political-administrative process and this process creates frameworks, constraints and institutions for environmental markets. Second, and due to the fact that the market institution itself as a part of the economic system contributes to the creation of those conflicts between nature and economy that environmental policy should try to mitigate, environmental policy must not only control the market but also impose new and sometimes unexpected constraints for its operation. This gives rise to a structural uncertainty and limitations on property rights that are unavoidable. Since the environmental markets should serve environmental goals, the realization of these goals, third, necessitates segmentation of markets and segmentation in its turn gives rise to 'thin' and, therefore, imperfect markets. Because of all this, we should not expect that the market mechanism in environmental management should be capable of solving the main problems in environmental management.

9. Concluding remarks

This paper has been motivated by certain exaggerated claims made for the use of the market mechanism in environmental management. I have tried to show that: (1) Due to the complexity of environmental functions it is, prima facie, difficult to believe that the market mechanism should be the most prominent policy instrument in environmental management. (2) This intuition is strengthened by what we know about the conditions for well-functioning markets. (3) It is true that the market mechanisms plays a role in environmental management and that this role probably can be expanded. (4) But experiences of the market mechanism in environmental management indicate that the expectations on what it can perform should not be exaggerated. A successful coping with the relationship between an expanding social and a limited natural system has for the foreseeable future to rely, not on less but on more use of political-administrative mechanisms, bargaining, agreements, legal enactments, education, etc.

Acknowledgements

The author would like to thank the participants in the SCASSS conference on 'Ethics, Economics and Environment' and three anonymous reviewers for valuable comments. I also thank Dr Alla Frolova, SCASSS, for criticism and editorial assistance.

References

Baumol, W., Oates, W.E., 1988. The Theory of Environmental Policy, 2nd edn. Cambridge University Press, Cambridge.

Bohm, P., Russel, C., 1985. Comparative analysis of alternative policy instruments. In: Handbook of Natural Resource and Energy Economics, vol. I. North Holland, Amsterdam.

Cairncross, F., 1995. Green. Earthscan Publications, London, pp. 56.

Commoner, B., 1989. An assessment of environmental progress: The reason for failure. In: Archibugi, F., Nijkamp, P. (Eds.), Economy and Ecology: Towards Sustainable Development. Kluwer, Dordrecht, pp. 151–167.

Costanza, R. (Ed.), 1991. Ecological Economics. The science and management of sustainability. Columbia University Press, New York.

Cropper, M.L., Oates, W.E., 1992. Environmental economics: A survey. J. Econom. Lit. XXXX, 699.

Dale, J.H., 1968. Land, Water and Ownership. Can. J. Econom. I:4, Nov.

de Groot, R.S., 1992. Functions of Nature. Evaluation of nature in environment, planning management and decision making. Wolters-Noordhoff, Amsterdam.

Donahue, J., 1989. The Privatization Decision. Public Ends, Private Means. Basic Books, New York.

Folke, C., Kåberger, T., 1992. Recent Trends in Linking the Natural Environment and the Economy. Essays from the Eco-Eco Group. Kluwer, Dordrecht, Reprint.

Foster, V., Hahn, R.W., 1995. Designing more efficient markets: Lessons from Los Angeles smog control. J. Law Econom. 38, 9–47.

Gruenspecht, H.K., Lave, L.B., 1989. The Economics of Health, Safety and Environmental Regulation. In Handbook of Industrial Organization, vol. II, North-Holland, Amsterdam.

Hahn, R., 1989. Economic Prescriptions for Environmental Problems: How the patient followed the doctor's orders. J. Econom. Perspect. III (2), 95–114.

Hahn, R., Hester, G., 1989. Where did all the markets go? An analysis of EPA's Emission Trading Program. Yale J. Regul. 6, 109–153.

Holling, C.S., 1994. New science and new investment for a sustainable biosphere. In: Jansson, A.M., Hammer, M., Folke, C., Costanza, R. (Eds.), Investing in Natural Capital. The Ecological Economics Approach to Sustainability. Island Press. Washington DC, pp. 57.

Jansson, A.M., Hammer, M., Folke, C., Constanza, R. (Eds.), 1994. Investing in Natural Capital. The Ecological Economics Approach to Sustainability. Island Press. Washington DC.

Kriström, B., Wibe, S., 1992. En effektiv miljö politik. Bilaga 6 till LU 92, Stockholm.

McNeely, J.A., 1988. Economics and Biological Diversity. IUCN, Gland.

Molander, P., 1995. Miljön som långsiktig restriktion. LU 1995, bil. 2. Stockholm, pp. 124.

Panayotou, T., 1993. Green Markets. The Economics of Sustainable Development. ISC Press, San Francisco, pp. 2.

Swanson, T.M., 1994. The International Regulation of Extinction. Macmillan, London, pp. 6.

Swierzbinski, J.E., 1994. Guilty until proven—Regulation with costly and limited enforcement. J. Environ. Econom. Manage. 27, 127–146.

Thijssen, G., Laan, A., 1992. Taxes versus regulation in the dutch intensive livestock sector. In: Krabbe, J.J., Heijman, J.M. (Eds.), National Income and Nature: Externalities, Growth and Steady State. Kluwer, Dordrecht, pp. 104–125.

Tietenberg, T., 1991. Economic instruments for environmental regulation. In: Helm, D. (Ed.), Economic Policy towards the Environment. Basil Blackwell, Oxford.

Tietenberg, T., 1992. Environmental and Natural Resource Economics, 3rd edn. Harper-Collins, New York.

Tietenberg, T., 1994. Economics in Environmental Policy. Edward Elgar, Aldershot.

Tietenberg, T., 1995. Transferable discharge permits and global warming. In: Bromley, D.W. (Ed.), Handbook of Environmental Economics. Blackwell, Oxford, pp. 330.

Wibe, S., 1991. Regleringar och produktivitet. In Konkurrens, regleringar och produktivitet. Expertrapport Nr 7 till Produktivitetsdelegationen. SOU 1991, 82, Stockholm.

Wicksteed, P.H., 1933. The Common Sense of Political Economy, vol. I, Routlege and Kegan Paul, London, pp. 28.