Fondazione Eni Enrico Mattei

Experience with Market-Based Environmental Policy Instruments

Robert N. Stavins

NOTA DI LAVORO 52.2002

JULY 2002

ETA – Economic Theory and Applications

Robert N. Stavins, *John F. Kennedy School of Government, Harvard University and Resources for the Future*

Experience with Market-Based Environmental Policy Instruments

Summary

Environmental policies typically combine the identification of a goal with some means to achieve that goal. This chapter for the forthcoming *Handbook of Environmental Economics* focuses exclusively on the second component, the means - the "instruments" - of environmental policy, and considers, in particular, experience around the world with the relatively new breed of economic-incentive or market-based policy instruments. I define these instruments broadly, and consider them within four categories: charge systems; tradable permits; market friction reductions; and government subsidy reductions. Within charge systems, I consider: effluent charges, deposit-refund systems, user charges, insurance premium taxes, sales taxes, administrative charges, and tax differentiation. Within tradable permit systems, I consider both credit programs and cap-and-trade systems. Under the heading of reducing market frictions, I examine: market creation, liability rules, and information programs. Finally, under reducing government subsidies, I review a number of specific examples from around the world. By defining market-based instruments broadly, I cast a large net for this review of applications. As a consequence, the review is extensive. But this should not leave the impression that market-based instruments have replaced, or have come anywhere close to replacing, the conventional, command-and-control approach to environmental protection. Further, even where these approaches have been used in their purest form and with some success, such as in the case of tradable-permit systems in the United States, they have not always performed as anticipated. In the final part of the paper, I ask what lessons can be learned from our experiences. In particular, I consider normative lessons for: design and implementation; analysis of prospective and adopted systems; and identification of new applications.

Keywords: Environmental policy, market-based instruments, economic-incentive instruments

Prepared for

The Handbook of Environmental Economics

Edited by

Karl-Göran Mäler and Jeffrey Vincent

General Editors: Kenneth Arrow and Michael Intriligator

Amsterdam: North-Holland/Elsevier Science

Address for correspondence:

Robert N. Stavins

John F. Kennedy School of Government

Harvard University

79 John F. Kennedy St.

02138 Cambridge MA

USA

E-mail: robert_stavins@harvard.edu

TABLE OF CONTENTS

EXPERIENCE WITH MARKET-BASED ENVIRONMENTAL POLICY INSTRUMENTS

Robert Stavins[*]

1. WHAT ARE MARKET-BASED POLICY INSTRUMENTS?

Environmental policies typically combine the identification of a goal (either general or specific) with some means to achieve that goal. In practice, these two components are often linked within the political process. This chapter focuses exclusively on the second component, the means — the "instruments" — of environmental policy, and considers, in particular, experience around the world with the relatively new breed of economic-incentive or market-based policy instruments.[1]

1.1 Definition

Market-based instruments are regulations that encourage behavior through market signals rather than through explicit directives regarding pollution control levels or methods.[2] These policy instruments, such as tradable permits or pollution charges, are often described as "harnessing market forces"[3] because if they are well designed and implemented, they encourage firms (and/or individuals) to undertake pollution control efforts that are in their own interests and that collectively meet policy goals.

By way of contrast, conventional approaches to regulating the environment are often referred to as "command-and-control" regulations, since they allow relatively little flexibility in the means of achieving

---

[*]Albert Pratt Professor of Business and Government, and Faculty Chair, Environment and Natural Resources Program, John F. Kennedy School of Government, Harvard University, and University Fellow, Resources for the Future. Sheila Cavanagh provided exceptionally valuable research assistance, contributing greatly to the quality of the final product. Helpful comments on previous versions were provided by Scott Barrett, Peter Bohm, David Dreisen, Denny Ellerman, Karen Fisher-Vanden, Robert Hahn, Erik Haites, Suzi Kerr, Juan-Pablo Montero, Wallace Oates, William Pizer, Ronaldo Serôa da Motta, Thomas Sterner, Tom Tietenberg, Jeffrey Vincent, and Tomasz òylicz. The author alone is responsible for any remaining errors.

[1]There is considerable overlap between environmental and natural resource policies. This chapter focuses on market-based policy instruments in the environmental realm, chiefly those that reduce concentrations of pollution, as opposed to those that achieve various goals of natural resource management. This means, for example, that tradeable development rights (Field and Conrad 1975; Bellandi and Hennigan 1977; Mills 1980) are not reviewed, nor are tradeable permit systems used to govern the allocation of fishing rights (Batstone and Sharp 1999).

[2]This section of the chapter draws, in part, on: Hockenstein, Stavins, and Whitehead (1997); and Stavins (2000).

[3]See: Organization for Economic Cooperation and Development (1989, 1991, 1998a); Stavins (1988, 1991); and U.S. Environmental Protection Agency (1991). Another strain of literature — known as "free market environmentalism" — focuses on the role of private property rights in achieving environmental protection (Anderson and Leal 1991).

goals. Such regulations tend to force firms to take on similar shares of the pollution-control burden, regardless of the cost.[4] Command-and-control regulations do this by setting uniform standards for firms, the most prevalent of which are technology- and performance-based standards. Technology-based standards specify the method, and sometimes the actual equipment, that firms must use to comply with a particular regulation. A performance standard sets a uniform control target for firms, while allowing some latitude in how this target is met.

Holding all firms to the same target can be expensive and, in some circumstances, counterproductive. While standards may effectively limit emissions of pollutants, they typically exact relatively high costs in the process, by forcing some firms to resort to unduly expensive means of controlling pollution. Because the costs of controlling emissions may vary greatly among firms, and even among sources within the same firm, the appropriate technology in one situation may not be appropriate (cost-effective) in another. Thus, control costs can vary enormously due to a firm's production design, physical configuration, age of its assets, or other factors. One survey of eight empirical studies of air pollution control found that the ratio of actual, aggregate costs of the conventional, command-and-control approach to the aggregate costs of least-cost benchmarks ranged from 1.07 for sulfate emissions in the Los Angeles area to 22.0 for hydrocarbon emissions at all domestic DuPont plants (Tietenberg 1985).[5]

Furthermore, command-and-control regulations tend to freeze the development of technologies that might otherwise result in greater levels of control. Little or no financial incentive exists for businesses to exceed their control targets, and both technology-based and performance-based standards discourage adoption of new technologies. A business that adopts a new technology may be "rewarded" by being held to a higher standard of performance and not given the opportunity to benefit financially from its investment, except to the extent that its competitors have even more difficulty reaching the new standard.

1.2 Characteristics of Market-Based Policy Instruments

In theory, if properly designed and implemented, market-based instruments allow any desired level of pollution cleanup to be realized at the lowest overall cost to society, by providing incentives for the greatest reductions in pollution by those firms that can achieve these reductions most cheaply.[6] Rather than equalizing pollution levels among firms (as with uniform emission standards), market-based instruments equalize the incremental amount that firms spend to reduce pollution — their marginal cost (Montgomery 1972; Baumol and Oates 1988; Tietenberg 1995). Command-and-control approaches could — in theory

[4]But various command-and-control standards do this in different ways (Helfand 1991).

[5]One should not make too much of these numbers, since actual, command-and-control instruments are being compared with theoretical benchmarks of cost-effectiveness, i.e. what a perfectly functioning market-based instrument would achieve in theory. A fair comparison among policy instruments would involve either idealized versions of both market-based systems and likely alternatives; or realistic versions of both (Hahn and Stavins 1992).

[6]Under certain circumstances, substituting a market-based instrument for a command-and-control instrument can lower environmental quality, because command-and-control standards tend to lead to over-control (Oates, Portney, and McGartland 1989).

— achieve this cost-effective solution, but this would require that different standards be set for each pollution source, and, consequently, that policy makers obtain detailed information about the compliance costs each firm faces. Such information is simply not available to government. By contrast, market-based instruments provide for a cost-effective allocation of the pollution control burden among sources without requiring the government to have this information.

In contrast to command-and-control regulations, market-based instruments have the potential to provide powerful incentives for companies to adopt cheaper and better pollution-control technologies. This is because with market-based instruments, particularly emission taxes, it always pays firms to clean up a bit more if a sufficiently low-cost method (technology or process) of doing so can be identified and adopted (Downing and White 1986; Malueg 1989; Milliman and Prince 1989; Jaffe and Stavins 1995; and Jung, Krutilla, and Boyd 1996).

Most environmental policy instruments, whether conventional or market-based, can be directed to one of a range of "levels" of regulatory intervention: inputs (for example, a tax on the leaded content of gasoline); emissions (following the same example, a tax on emissions); ambient concentrations; exposure (whether human or ecological); and risk or damages. In general, administrative costs increase as one moves further along this set of points of regulatory intervention, but it is also the case that the instrument is more clearly addressing what is presumably the real problem.

One important characteristic of individual pollution problems that will affect the identification of the optimal point of regulatory intervention is the degree of mixing of the pollutant in the receiving body (airshed, watershed, or ground). At one extreme, uniformly mixed pollution problems (in their purest form, global commons problems such as stratospheric ozone depletion and global climate change) can be efficiently addressed through input or emissions interventions. At the other extreme, it would be problematic to address a highly non-uniformly mixed pollution problem through such an approach; instead, an intervention that focused on ambient concentrations, at a minimum, would be preferable.

Most applications of market-based instruments have been at the input or emission point of regulatory intervention, although a few have focused on ambient concentrations. Much the same can be said of nearly all conventional, command-and-control policy instruments in the environmental realm.

1.3 Categories of Market-Based Instruments

I consider market-based instruments within four major categories: pollution charges; tradable permits; market friction reductions; and government subsidy reductions (Organization for Economic Cooperation and Development 1994a, 1994b, 1994c, 1994d).[7]

---

[7]A significant recent trend in environmental policy has been the increased use of voluntary programs for the purpose of achieving various environmental objectives. Because voluntary actions can offer firms rewards such as public recognition, some observers have characterized these voluntary programs as incentive-based instruments for environmental protection. Having already cast an exceptionally large net for this review of experience, I do not include this approach to environmental management in my review of market-based instruments. For a review of the use of

Pollution charge systems assess a fee or tax on the amount of pollution that a firm or source generates (Pigou 1920). Consequently, it is worthwhile for the firm to reduce emissions to the point where its marginal abatement cost is equal to the tax rate. A challenge with charge systems is identifying the appropriate tax rate. Ideally, it should be set equal to the marginal benefits of cleanup at the efficient level of cleanup, but policy makers are more likely to think in terms of a desired level of cleanup, and they do not know beforehand how firms will respond to a given level of taxation. A special case of pollution charges is a *deposit refund system*, where consumers pay a surcharge when purchasing potentially polluting products, and receive a refund when returning the product to an approved center, whether for recycling or for disposal (Bohm 1981; Menell 1990).[8]

Tradable permits can achieve the same cost-minimizing allocation of the control burden as a charge system, while avoiding the problem of uncertain responses by firms.[9] Under a tradable permit system, an allowable overall level of pollution is established and allocated among firms in the form of permits.[10] Firms that keep their emission levels below their allotted level may sell their surplus permits to other firms or use them to offset excess emissions in other parts of their facilities.

Market friction reductions can also serve as market-based policy instruments. In such cases, substantial gains can be made in environmental protection simply by reducing existing frictions in market activity. Three types of market friction reductions stand out: (1) *market creation* for inputs/outputs associated with environmental quality, as with measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation and use of scarce water supplies; (2) *liability rules* that encourage firms to consider the potential environmental damages of their decisions; and (3) *information programs*, such as energy-efficiency product labeling requirements.

Government subsidy reductions are the fourth category of market-based instruments. Subsidies, of course, are the mirror image of taxes and, in theory, can provide incentives to address environmental

---

voluntary initiatives in the United States, see: U.S. Environmental Protection Agency 2001.

[8]A deposit-refund system can also be viewed as a special case of a "performance bond."

[9]Thirty years ago, Crocker (1966) and Dales (1968) independently developed the idea of using transferable discharge permits to allocate the pollution-control burden among sources. Montgomery (1972) provided the first rigorous proof that such a system could provide a cost-effective policy instrument. A sizeable literature has followed, much of it stemming from Hahn and Noll (1982). Early surveys were provided by Tietenberg (1980, 1985). Much of the literature may be traced to Coase's (1960) treatment of negotiated solutions to externality problems.

[10]Allocation can be through free distribution (often characterized as "grandfathering") or through sale, including by auction. The program described above is a"cap-and-trade" program, but some programs operate as "credit programs," where permits or credits are assigned only when a source reduces emissions below what is required by existing, source-specific limits.

problems.[11] In practice, however, many subsidies promote economically inefficient and environmentally unsound practices.

1.4 Scope of the Chapter

This chapter focuses on market-based policy instruments in the environmental realm, chiefly those that reduce concentrations of pollution, as opposed to those that operate in the natural resources realm and achieve various goals of resource management. This means, for example, that tradeable development rights, wetlands mitigation banking, and tradeable permit systems used to govern the allocation of fishing rights are not reviewed in this chapter.[12]

Parts 2 through 5 of this chapter review experiences around the world with the four major categories of market-based instruments for environmental protection: charge systems; tradeable permit systems; market-friction reductions; and government subsidy reductions. Part 6 examines lessons that can be learned from these experiences.

Although much of the chapter is descriptive in nature, normative analysis of the implementation of market-based instruments is surveyed in those cases in which evidence is available. That normative analysis focuses on the criteria of static and dynamic cost-effectiveness; little or no attention is given to efficiency *per se*. In other words, in this chapter, the targets of respective environmental policies are taken as given, and are not subjected to economic analyses.

Despite the chapter's expressed purpose of reviewing and providing some understanding about experiences with market-based instruments, virtually no attention is given to the important set of positive political economy questions that are raised by the increasing use of these instruments, such as the following. Why was there so little use of market-based instruments, relative to command-and-control instruments, over the 30-year period of major environmental regulation that began in 1970, despite the apparent advantages in many situations of the former? Why has the political attention given to market-based environmental policy instruments increased dramatically in recent years? Such questions of the positive political economy of instrument choice are, for the most part, ignored, not because they are without interest, but because they are addressed in Chapter 23 of this volume.

[11] In many countries, subsidies have been advocated (and sometimes implemented) as means of *improving* environmental quality. Although such subsidies could, in theory, advance environmental quality (see, for example, Jaffe and Stavins 1995), it is also true that subsidies, in general, have important and well-known disadvantages relatives to taxes (Baumol and Oates 1988). They are not considered as a distinct category of market-based instruments in this chapter. Although the prevalence of subsidies intended to improve environmental quality is not very great in developed market economies, they are more common in transition and, to a lesser extent, developing economies (òylicz 2000). Most environmental funds in transition economies, however, fail to select efficient projects or calculate efficient subsidies (Anderson and òylicz 1999, Peszko and òylicz 1998).

[12] The distinction between environmental and natural resource policies is somewhat arbitrary. Some policy instruments which are seen to bridge the environmental and natural resource realm, such as removing barriers to water markets, are considered.

2. CHARGE SYSTEMS

The conventional wisdom is that European environmental policy has made limited use of pollution taxes, while this approach has been totally ignored in the United States. This is not strictly correct, particularly if one defines charge systems broadly, in which case a significant number of applications around the world can be identified.

For purposes of this review, I identify seven categories of charge systems, but it should be noted at the outset that the categories are neither precisely defined nor mutually exclusive. Hence, the assignment of individual policy instruments to one or another category inevitably involves judgement, if not an arbitrary element. Nevertheless, this set of categories may help readers navigate what would otherwise be a single, very long list of applications. I divide the categories of charges into two primary sets: those for which behavioral impacts are central to their design, implementation, and performance; and those for which anticipated behavioral impacts are secondary.

Within the first set, I distinguish among three categories of charge systems. First, *effluent charges* are those instruments which are closest to the textbook concept of a Pigouvian tax (section 2.1). Second, *deposit-refund systems* are a special case of Pigouvian taxes in which front-end charges (such as those on some beverage containers) are combined with refunds payable when particular behavior (such as returning an empty container to an approved outlet) is carried out (section 2.2). Third, *tax differentiation* refers to tax cuts, credits, and subsidies for environmentally desirable behavior (section 2.7).

The second set of charge systems, those for which behavioral impacts appear to be a secondary consideration, includes four categories of instruments. First, *user charges* provide a mechanism whereby the direct beneficiaries of environmental services finance its provision (section 2.3). Second, *insurance premium taxes* are levied on particular groups or sectors to finance insurance pools against potential risks associated with the production or use of the taxed product (section 2.4). Third, *sales taxes* are levied on the sales or value-added of specific goods and services in the name of environmental protection (section 2.5). Fourth and finally, *administrative charges* are used to raise revenues to help cover the administrative costs of environmental programs (section 2.6).[13]

2.1 Effluent Charges

Most applications of charge systems probably have not had the incentive effects typically associated with a Pigouvian tax, either because of the structure of the systems or because of the low levels at which charges have been set. Nevertheless, a limited number of these systems may have affected behavior.

[13]For useful surveys of the use of environmentally related taxes in OECD countries, see: Organization for Economic Cooperation and Development 1993d, 1995d, 2001.

Within the category of effluent charges, which comes closest to what most economists think of as a pollution tax, member countries of the Organization of Economic Cooperation and Development (OECD) other than the United States have led the way (Blackman and Harrington 1999).[14] Selected effluent charges are summarized in Table 1, where I distinguish among ten areas of application: carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x), combined industrial air pollutants, biological oxygen demand (BOD) load, total suspended solids (TSS), combined industrial water emissions, nitrogen and phosphorous, and landfill, incinerator, and hazardous waste discharges.

Several European countries have moved to implement pollution taxes within the framework of ecological or "green tax reform," which seeks a systematic shift of the tax burden away from labor and/or capital and toward the use of environmental resources. As of 1997, environmental taxes in Sweden, Denmark, and Finland were part of a framework green tax reform (Ekins 1999).

2.1.1 Effluent Charges in Western Europe

Seven OECD countries in western Europe have implemented emissions fees to reduce air pollution, but most of the fees are assessed on input proxies, possibly because of monitoring and enforcement costs (Speck 1998). Although the effects of direct emissions charges will differ from those of input taxes, both are considered here, following the practice of the OECD (1994a)[15]

As of 1999, six OECD nations levied carbon taxes: Denmark, Finland, Italy, the Netherlands, Norway, and Sweden. Finland's carbon tax, the world's first, was introduced in 1990 (Haugland 1993). Italy's carbon tax is a revenue-generating mechanism, part of a broad-ranging attempt to use indirect taxation to compensate for weaknesses in the direct taxation system (Schlegelmilch 1998). Carbon taxes in Denmark, Norway, and Sweden are intended to have an incentive effect, in addition to a revenue-generating effect, but it has been difficult to determine the actual impacts of these policies (Blackman and Harrington 1999).

Claims have been made that the Swedish and Norwegian taxes have reduced carbon emissions (Bohlin 1998; Larsen and Nesbakken 1997), but in all the Nordic countries, except Finland, a variety of tax exemptions have made effective carbon tax rates significantly lower than nominal rates, thereby increasing skepticism regarding the efficacy of these policies. For example, Sweden's manufacturing tax exemptions and reductions result in effective CO_2 tax rates ranging from 19 to 44 percent of nominal rates (Ekins and Speck 1999). Danish industry has obtained tax relief on process energy, and power stations are exempt from coal taxes. Norway taxes only 60 percent of domestic CO_2 emissions, and only 25

[14]Effluent charges have been used more extensively in Europe than in the United States, although — as indicated in the text — it is not clear that the levels have been sufficient to affect behavior in significant ways. For a discussion of the economics and politics surrounding taxation of sulfur dioxide, nitrous oxide, and carbon dioxide in the Scandinavian nations, the Netherlands, France, and Germany, see: Cansier and Krumm 1998; and Organization for Economic Cooperation and Development 1993a, 1995a.

[15]See also: O'Connor 1994.

percent of SO_2 emissions, when exemptions and reductions are taken into account (Ekins and Speck 1999).

Norway, Sweden, France, Denmark, Italy, and the Spanish autonomous region of Galicia tax sulfur emissions or the sulfur content of fuels. The Swedish tax seems to have reduced sulfur emissions (Lövgren 1994), not surprising given that it is very high by international standards (OECD 1996). Indeed, Sweden met its national sulfur emissions targets well ahead of schedule through fuel-switching and emission reductions that have been attributed to the tax (World Bank 1997b).

France, Italy, Sweden, and Galicia tax nitrogen oxide emissions, but only the Swedish tax has reduced emissions (Blackman and Harrington 1999). Energy plants in Sweden with production of 25 GWh or more pay $5/kg on NO_x emissions. The tax is revenue-neutral, with payees (plants) receiving rebates in proportion to energy output.[16] In the first two years of the program, total emissions from monitored plants fell by 40 percent (Blackman and Harrington 1999), attributed to the emissions fee system (Lövgren 1994; Sterner and Hoglund 1998), but only about 3 percent of Sweden's domestic NO_x emissions are taxed under the program (Ekins and Speck 1998).

Effluent charges have also been used in western Europe for water pollution. Since 1970, the Netherlands has assessed effluent fees on heavy metals discharges from large enterprises, and organic discharges from urban and farm households, and small, medium, and large enterprises. The Dutch charges were originally earmarked to finance construction of wastewater treatment facilities, but the high cost of facilities resulted in very high charges, in some cases equal to marginal abatement costs at high levels of cleanup (Wheeler *et al*. 2000). By 1990, the charges had reduced total organic discharges by one-half, and industrial organic emissions by 75 percent (Wheeler *et al.* 2000). Germany also levies wastewater effluent charges, with revenues earmarked for water pollution control programs (OECD 1993b). France has a system of water pollution charges, the revenues from which are reinvested in water infrastructure and pollution control (Cadiou and Duc 1994; OECD 1997b).

2.1.2 Effluent Charges in the Transition Economies

Some transition economies in central and eastern Europe and the former Soviet republics may view air and water pollution charges as means of efficient restructuring of their environmental management and regulatory systems (Bluffstone and Larson 1997). In other cases, effluent charge systems were introduced well before the beginnings of the economic transitions in the late 1980's: the former Czechoslovakia introduced charges in the 1960's; Bulgaria, Hungary, and Poland in the 1970's, and parts of the former Soviet Union in the 1980's (Vincent and Farrow 1997).

Although effluent fees have been implemented throughout the region, Poland is the only country in which the fees may have reduced emissions. Poland restructured its emissions fee system for airborne pollutants in 1991, increasing fees dramatically to twenty times their levels under Communist rule (Anderson

[16]The program's administrative costs, less than 1 percent of tax revenues, are deducted before the re-distribution.

and Fiedor 1997), so that Polish effluent fees are now among the highest in the world. Typically, the Polish fees include a "normal fee" levied on emissions below the regulatory standard, and a penalty fee for emissions thereafter.[17] While fees have been nominally calculated from ambient air quality guidelines and marginal abatement costs, they have been heavily influenced by political factors and revenue requirements (Anderson and Fiedor 1997). Fee revenues — on the order of $450 to $500 million annually — flow to national and regional environmental funds.

In other parts of the region, air and water effluent charges have been ineffective for a number of reasons: (1) legislated charges have been significantly eroded by the high inflation that has accompanied economic transition; (2) charges typically have been set below marginal abatement costs (Morris *et al.* 1997; Stepanek 1997; òylicz 1996); (3) pollution limits — the point above which emissions are charged at a penalty rate — are typically set too high to influence firm behavior (Brunenieks *et al.* 1997); (4) tax rates are often the result of implicit or explicit negotiation between industries and state or regional governments (Gornaja *et al.* 1997; Kozeltsev and Markandya 1997); (5) many countries set upper bounds on pollution charge liabilities; (6) unprofitable enterprises are often exempted (Kozeltsev and Markandya 1997, Owen *et al.* 1997); and (7) regulatory systems are insufficient to support adequate monitoring and enforcement (Gornaja *et al.* 1997; Kozeltsev and Markandya 1997; Morris *et al.* 1997; Bluffstone and Larson 1997). While pollution charges rarely induce abatement in eastern Europe and the former Soviet republics, they do raise revenue for environmental projects, and some argue that they are contributing to the establishment and acceptance of a "polluter pays principle" (Bluffstone and Larson 1997).

2.1.3 Effluent Charges in Other Countries[18]

A number of other countries have utilized effluent charges, albeit typically at levels too low to induce behavioral changes. For example, China assesses levies on 29 pollutants in wastewater, 13 industrial waste gases, and various forms of industrial solid and radioactive waste (World Bank 1997b). Regulated substances include SO_2, NO_x, CO, hydrogen sulfide, dust, mercury, and lead (Yang et al. 1998). Plants pay a fee for emissions greater than the regulatory standard for each substance, but when more than one pollutant exceeds the standard, plants pay only for the single pollutant which will result in the largest fee. Firms that pay penalty charges, rather than reducing emissions, face a five percent annual charge increase beginning in the third year of noncompliance.

Chinese pollution fees are often lower than the marginal cost of abatement. For example, the World Bank estimates that SO_2 emission charges in Zhengzhou would have to be increased more than fiftyfold to equalize marginal abatement costs and marginal social damages (Wheeler *et al.* 2000). Of the fees collected, 80 percent are used for grants and low-interest loans for pollution control projects, and the

[17]This is one of an exceptionally small number of non-linear effluent charges. See discussion in section 6.3, below.

[18]The closest that any charge system in the United States comes to operating as a Pigouvian tax may be the unit-charge approach to financing municipal solid waste collection, where households (and businesses) are charged the incremental costs of collection and disposal. I discuss these later within the category of "user charges" for municipal environmental services.

remaining 20 percent are dedicated to local administration and monitoring activities (World Bank 1997a). These effluent charges appear to have helped reduce both water and air pollution intensity during the period of rapid industrial growth in China since 1979. Each 1 percent increase in the water pollution levy has reduced the intensity of organic water pollution by 0.8 percent; each 1 percent rise in the air pollution levy has reduced the pollution intensity of industrial air emissions by 0.4 percent (Wang and Wheeler 1996, Wang and Wheeler 1999). The effluent fees are also a major source of revenue for environmental projects (Sterner 1999, Wheeler 2000). In 1995, pollution levies were applied to 368,200 Chinese enterprises and raised about $460 million, or 0.6 percent of national income (Wang and Lu 1998). Of the fees collected, 80 percent are used for grants and low-interest loans for pollution control projects, and the remaining 20 percent refund local administration and monitoring activities (World Bank 1997a).

Malaysia was one of the first countries to use effluent charges, having introduced effluent fees, paired with licensing, to control pollution from the palm oil industry as early as 1978 (World Bank 1997b). The Philippines instituted environmental fees for wastewater discharge from industrial sources in 1997 (World Bank 1997b), although the program is active in only one area of the country, Laguna Lake. BOD discharges from affected plants dropped 88 percent between 1997 and 1999 (Wheeler *et al.* 2000). South Korea imposes charges for emissions in excess of regulatory limits on ten air pollutants and fifteen water pollutants (OECD 1997c), and Japan assesses a minor charge on industrial SO_2 emissions (Wuppertal Institute 1996).

Colombia implemented a pilot program of water effluent charges after experiencing no success in pollution reduction with command and control regulations. Industrial polluters pay effluent fees based on BOD and TSS (World Bank 1999). Although emission decreases have been recorded since the program came into existence, it is difficult to separate the effect of the charges from that of voluntary agreements (World Bank 1999). The municipality of Quito, Ecuador has implemented a water effluent charge system (Huber *et al*. 1998), whereby enterprises discharging above national standards for organic content and TSS pay a per-unit charge equal to the cost of municipal treatment. In addition, Quito assesses fines on mobile air pollution sources, including cars, trucks, and buses in an effort to reduce air pollution in the city's central historical district. The fines are set above the cost of installing low-emissions technology or obtaining a tune-up. Mexico created a system of water effluent fees in 1991 in order to regulate BOD and TSS from municipal and industrial sources. Most municipalities and a large proportion of industrial dischargers do not pay the fees (Serôa da Motta 1998). Penalties for non-compliance were established in 1997, but no study has shown whether enforcement has been sufficient to induce abatement, or payment of fees and penalties.

2.2 Deposit-Refund Systems

Policies intended to reflect the social costs of waste disposal (such as waste-end fees, discussed in section 2.3.2) can have the effect of increasing the experienced cost of legal disposal, and thereby providing unintended incentives for improper (illegal) disposal. For waste that poses significant health or ecological impacts, *ex post* clean up is frequently an especially unattractive option. For these waste products, the prevention of improper disposal is particularly important. One alternative might seem to be a front-end tax on waste precursors, since such a tax would give manufacturers incentives to find safer substitutes and to recover and recycle taxed materials. But substitutes may not be available at reasonable costs, and once wastes are generated, incentives that affect choices of disposal methods are unaffected.

This dilemma can be resolved with a front-end charge (deposit) combined with a refund payable when quantities of the substance in question are turned in for recycling or (proper) disposal. In principle, for economic efficiency, the size of the deposit should be set equal to the marginal social cost of the product being disposed of illegally (at the efficient level of return) minus the real welfare costs of the program's operation, assuming that these costs are proportional to the quantity of returns. As the product changes hands in the production and consumption process (through wholesalers and distributors to consumers), the purchaser of the product pays a deposit to the seller. Deposit-refund systems are most likely to be appropriate when the incidence and the consequences of improper disposal are great (Bohm 1981; Russell 1988; Macauley, Bowes, and Palmer 1992).

The major applications of this approach in the United States have been in the form of ten state-level "bottle bills" for beverage containers (Table 2). A brief examination of these systems provides some insights into the merits *and* the limitations of the approach. In most programs, consumers pay a deposit at the time of purchase which can be recovered by returning the empty container to a redemption center. Typically, the deposit is the same regardless of the type of container.

In some respects, these bills seem to have accomplished their objectives; in Michigan, for example, the return rate of containers one year after the program was implemented was 95 percent (Porter 1983); and in Oregon, littering was reduced and long-run savings in waste management costs were achieved (U.S. General Accounting Office 1990). But by charging the same amount for each type of container material, these programs do not encourage consumers to choose containers with the lowest product life-cycle costs (including those of disposal).

Analysis of the effectiveness, let alone the cost-effectiveness or efficiency, of beverage container deposit-refund systems has been limited. The few rigorous studies that have been carried out of the benefits and costs of bottle bills have found that social desirability depends critically on the value of the time it takes consumers to return empty containers and the willingness to pay for reduced litter (Porter 1978). By requiring consumers to separate containers and deliver them to redemption centers, deposit-refund systems can foster net welfare losses, rather than gains.

Deposit-refund systems are most likely to be appropriate where: (1) the objective is one of reducing illegal disposal, as opposed to such objectives as general reductions in the waste stream or increased recycling; and (2) there is a significant asymmetry between *ex ante* (legal) and *ex post* (illegal or post-littering) clean-up costs. For these reasons, deposit refund systems may be among the best policy options to address disposal problems associated with containerizable hazardous waste, such as lead in motor vehicle batteries (Sigman 1995).

As a means of reducing the quantity of lead entering unsecured landfills and other potentially sensitive sites, several U.S. states have enacted deposit-refund programs for lead acid motor vehicle batteries (Table 2).[19] Under these systems, a deposit is collected when manufacturers sell batteries to distributors, retailers, or original equipment manufacturers; likewise, retailers collect deposits from consumers at the time of battery purchase. Consumers can collect their deposits by returning their used batteries to redemption centers; these redemption centers, in turn, redeem their deposits from battery manufacturers. The programs are largely self-enforcing, since participants have incentives to collect deposits on new batteries and obtain refunds on used ones, but a potential problem inherent in the approach is an increase in incentives for battery theft. A deposit of $5 to $10 per battery, however, appears to be small enough to avoid much of the theft problem, but large enough to encourage a substantial level of return.

Glass container deposit-refund systems are widely used in other OECD countries, including Australia, Austria, Belgium, Canada, Denmark, Finland, Iceland, the Netherlands, Norway, Portugal, Sweden, Germany, Sri Lanka, and Switzerland (OECD 1993a). Non-glass systems include a plastic shopping bag deposit-refund system in Italy, and a small chemicals container system in Denmark. In addition, Austria's deposit-refund system includes flourescent light bulbs and refrigerators (OECD 1995a), and since 1975, Sweden has maintained a deposit-refund system to encourage proper disposal of old vehicles.[20]

Japan's beer bottle deposit-refund system involves a levy paid by wholesale dealers, retail shops, and consumers, and refunded at each distribution stage upon bottle collection. Mexico requires the return of car batteries for deposit refund at the wholesale level (Huber *et al.* 1998). Taiwan has a deposit-refund system for polyethylene terephthalate (PET) soft drink bottles (World Bank 1997b); South Korea for beverage containers, tires, batteries, and lubricants (OECD 1997c); and the Czech Republic for glass and polyethylene bottles (OECD 1999a). Voluntary deposit-refund systems for glass containers have been instituted in Barbados, Bolivia, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico and Venezuela (Huber *et al.* 1998).

2.3 User Charges

Environmental user charges are typically structured to require those who directly benefit from a specific environmental service to finance its provision. Thus, I define user charges as those designed to fund environmentally related services, in contrast with effluent charges which I previously defined as those intended to influence behavior. In many cases, the distinction between this category of charge mechanism and effluent charges (or true Pigouvian taxes) is clear. But the distinction is somewhat clouded in the case of those charges that combine the following characteristics: they are directly related to pollutant emission

[19]Minnesota was the first state to implement deposit refund legislation for car batteries in 1988. By 1991, there were ten states with such legislation: Arizona, Arkansas, Connecticut, Idaho, Maine, Michigan, Minnesota, New York, Rhode Island, and Washington. Deposits range from $5 to $10.

[20]Over the period of the program's existence, however, inflation has eroded the deposit in real terms so that it is currently less than 10 percent of its original value (Bohm 1999).

levels (Pigouvian in principle); set too low to influence behavior (not Pigouvian in practice); and have their revenues earmarked for the provision of closely related environmental services. I consider three sub-categories of user charges: transportation; municipal services; and product disposal (Table 3).[21]

2.3.1 Transportation

Motor-vehicle fuels are heavily taxed in many parts of the world, including European nations, but the income from these taxes typically flows to general revenues.[22] Although the levels of such taxes in the United States are set relatively low, they fall more clearly within the user charge category, because revenues are dedicated exclusively to highway construction and maintenance (and now mass transit).[23] Likewise, revenues from U.S. noncommercial motor boat fuels are turned over to an Aquatic Resource Trust Fund; revenues from an inland waterways fuels tax are dedicated to the Inland Waterways Trust Fund; revenues from non-highway recreational fuels and small-engine motor fuels taxes are turned over to recreational trusts; and excise taxes on trucks, sport fishing and hunting equipment, and fishing and hunting licenses are similarly dedicated to specific, closely related uses (Table 3).

In European countries, airline traffic taxes are frequently used to finance noise pollution abatement. Aircraft landing charges in Belgium, France, Germany, the Netherlands, and Switzerland resemble Pigouvian taxes, as they relate the charge level to noise levels (McMorran and Nellor 1994), and in Germany, France, Italy, the Netherlands, Sweden, and Switzerland, revenues from aircraft landing taxes are used to finance noise abatement programs (Speck 1998).

In the late 1970s, Singapore implemented a comprehensive traffic management program. In order to drive a vehicle through the city center at peak travel periods, drivers must purchase monthly licences (Panayotou 1998; Sterner 1999). In Seoul, South Korea, drivers pay congestion surcharges for vehicles carrying fewer than three passengers through particular tunnels (OECD 1997c). The Norwegian cities of Oslo, Bergen, and Trondheim charge vehicles for entry into the urban core, but the fees are not differentiated by time of day and have had little incentive effect (Ekins 1999). Milan, Italy has introduced a peak-period licensing program which has been credited with a 50 percent reduction in traffic in the urban center (Ekins 1999).

---

[21]A considerable number of user charges are for parks and recreation, but these fall within the natural resource area and so are considered to be outside of the scope of this chapter. For a discussion of the history of recreation fees on U.S. public lands, see: Reiling and Kotchen 1996.

[22]Exceptions include Austria, Kenya, New Zealand, the United States, and Switzerland, where motor fuel tax revenues are partially or fully dedicated to road construction and other public transportation projects (Ayoo and Jama 1999; Speck 1998).

[23]In addition, Federal taxes on automobile and truck tires flow to the U.S. Highway Trust Fund.

2.3.2 Municipal Environmental Services

The closest that any charge system in the United States comes to operating as a Pigouvian tax may be the unit-charge approach to financing municipal solid waste collection, where households (and businesses) are charged the incremental costs of collection and disposal. So called "pay-as-you-throw" policies, where users pay in proportion to the volume of their waste, are now used in well over 4,000 communities in 42 states, reaching an estimated 10 percent of the U.S. population (U.S. Environmental Protection Agency 2001). This collective experience provides evidence that unit charges have been somewhat successful in reducing the volume of household waste generated (Efaw and Lanen 1979; McFarland 1972; Skumatz 1990; Stevens 1978; Wertz 1976; Lave and Gruenspecht 1991; Repetto *et al.* 1992; Dower *et al.* 1992; Jenkins 1993; Fullerton and Kinnaman 1996; Miranda *et al.* 1994).[24]

Like many U.S. cities, Switzerland has instituted a pay-as-you-throw system for solid waste disposal, in which ratepayers pay per bag. The system finances waste disposal and seeks to encourage lower volume. The evidence indicates that the volume of municipal solid waste has indeed decreased as a result of the program, but increased illegal disposal may be part of the explanation (OECD 1998e). In New Zealand, as many as 25 percent of communities employ volume-based charges for municipal solid waste collection (New Zealand Ministry for the Environment 1997). Similarly, Bolivia, Venezuela, Jamaica, and Barbados have adopted volume-based fees for solid waste collection (Huber, Ruitenbeek and Serôa da Motta 1998).

More broadly, there is significant movement in many developing countries and transition economies toward cost-recovery (full-cost) pricing of environmental services, such as electric power, solid waste collection, drinking water, and wastewater treatment.[25] Full-cost pricing for municipal environmental services is becoming increasingly common in Latin America and the Caribbean (Huber *et al.* 1998), but major problems persist. Since 1993, for example, Colombian law has required water charges to incorporate the cost of service and environmental damages, but 90 percent of Colombia's regional governments have declared the law too difficult to implement.

The pace of progress in the transition economies of Eastern Europe and the former Soviet Union is somewhat faster. Decentralization of public services and the lifting of restrictions on tariff increases has reduced municipal reliance on state transfers for environmental services. Between 1989 and 1995, for

---

[24]Volume-based pricing can provide incentives, however, for citizens to compact their waste prior to disposal, so that reductions in quantity of waste (measured by weight, for example) may be significantly less than volume reductions. Also, as the costs of legal disposal increase, incentives for improper (illegal) disposal also increase. Hence, waste-end fees designed to cover the costs of disposal, such as unit curbside charges, can lead to increased incidence of illegal dumping (Fullerton and Kinnamann 1995).

[25]While the text focuses on progress in environmental service cost-recovery in developing and transition economies, this is not to imply that economically rational tariffs fully characterize conditions in industrialized nations. For example, water metering is not used in many urban areas in Canada, and many Canadian municipal water and wastewater charges are not related to actual volumes consumed or produced (OECD 1995b). Likewise, Japan raises less than five percent of the cost of municipal waste collection, treatment, and disposal through user charges (OECD 1994a).

example, the Hungarian central government's subsidy of public water supplies decreased from 100 percent to 30 percent (World Bank 1997b). Drinking water services in cities such as Budapest, Prague, and Zagreb have been privatized, bringing tariffs from minimal levels to ones sufficient to support full operating, and in some cases, capital cost recovery (World Bank 1997b; OECD 1999a).

2.3.3 Product Disposal

Product taxes are used in many European countries to reduce the volume of materials in the waste stream. Where the size of such product taxes is insufficient to induce behavioral response, and revenues are used to cover disposal costs, the taxes can be considered user charges. In those cases in which product tax revenues go into general funds, I consider them sales taxes (see Section 2.5, below); product taxes that induce significant behavioral impact are rightly considered pollution taxes.

Thus, the classification of product taxes as user charges is complicated. For example, four EU member states (Belgium, Denmark, Italy, and Sweden) tax batteries. No attempts to measure the behavioral impacts associated with these taxes have been reported. The battery taxes in both Sweden and Denmark are earmarked to cover battery collection and recycling costs, and so these could be considered user charges, provided the taxes do not significantly influence battery purchases. Belgium's battery tax revenues are earmarked for environmental purposes. Italy's battery tax is differentiated according to lead content, but revenues go into general funds and are not used for environmental purposes.

Tire taxes in Denmark, Finland and Sweden can be considered user charges, as revenues are earmarked for tire collection and recycling, and there appear to be no behavioral impacts. France, Finland, and Italy levy lubricant oil taxes, the revenues from which cover disposal expenses. Surplus manure charges in Belgium and the Netherlands might also be considered user charges, as revenues are earmarked for transport, storage, and processing. Finland levies nuclear waste management charges that are earmarked for waste processing (Speck 1998). Finally, South Korea imposes waste disposal charges on containers from insecticides and toxic substances, and on butane gas, cosmetics, confectionery packaging, batteries, and antifreeze (OECD 1997c).

2.4 Insurance Premium Taxes

In a relatively small number of countries, taxes are levied on industries or groups to fund insurance pools against potential environmental risks associated with the production or use of taxed products (Table 4). Such taxes can have the effect of encouraging firms to internalize environmental risks in their decision making, but, in practice, these taxes have frequently not been targeted at respective risk-creating activities. In the United States, for example, to support the Oil Spill Liability Trust Fund, all petroleum products are taxed, regardless of how they are transported, possibly creating small incentives to use less petroleum, but not to use safer ships or other means of transport. The fund can be used to meet unrecovered claims from oil spills.

An excise tax on specified hazardous chemicals is used to fund (partially) the clean-up of hazardous waste sites through the Superfund program in the United States. The tax functions as an insurance premium to the extent that funds are used for future clean-ups (Barthold 1994). The Leaking Underground Storage Trust Fund, established in 1987, is replenished through taxes on all petroleum fuels. Finally, the Black Lung Disability Trust Fund was established in 1954 to pay miners who became sick and unable to work because of prolonged exposure to coal dust in mines. Since 1977, it has been financed by excise taxes on coal from underground and surface mines.

Finland maintains an Oil Pollution Compensation Fund, financed by an oil import fee, to cover spill preparedness, clean-up, and damages (OECD 1997a). Since 1989, Sweden has had a compulsory insurance system to compensate for damages when polluters cannot be identified (OECD 1996), managed by private insurance companies and financed by 10,000 "operators of dangerous facilities." France requires operators of quarries and waste storage facilities to post financial guarantees protecting the public from potential non-payment of mitigation expenses (OECD 1997b), and Belgium requires insurance for waste import and export, and for the operation of oil storage yards. Spain requires pollution liability insurance of companies handling hazardous waste in the chemical industry (OECD 1997d), and operators of waste and tire disposal sites in the Canadian province of Quebec deposit a required financial guarantee and take out mandatory environmental liability insurance to cover disposal costs and potential damage costs (OECD 1995b). Similarly, in the United States, under the 1977 Surface Mining Control and Reclamation Act, the purchase of performance bonds[26] are required before surface coal mining and reclamation permits are issued.

2.5 Sales Taxes

Nations around the world have levied sales and value-added taxes, frequently in the name of environmental protection, on diverse goods and services, including motor fuels, other energy products, new automobiles, pesticides, fertilizers, chlorinated solvents, volatile organic compounds, lubricating oils, non-refillable containers, ozone-depleting substances, and new tires (Table 5). I focus on four categories of such taxes: motor fuels; ozone-depleting chemicals; agricultural inputs; and product taxes.

2.5.1 Motor Fuels

All EU member states tax motor fuels to raise revenues for general funds. Rates are typically differentiated for leaded and unleaded gasoline, diesel fuel, light heating fuels, and heavy fuel oil, indicating that these taxes may also have environmental functions. Motor fuel taxes in European countries also include value-added taxes, ranging from 12 percent (Luxembourg) to 25 percent (Denmark and Sweden). In Mexico, the fuel tax includes a special surcharge in Mexico City, the revenues from which are used to fund gas station modifications to reduce volatile organic compound emissions (OECD 1998d).

---

[26]Although I consider performance bonds under the heading of insurance premium taxes, this instrument can also be considered be the generic form of a deposit-refund system, since the amounts deposited with a performance bond can be refunded only when the affected firm fulfills particular obligations.

2.5.2 Ozone-Depleting Chemicals

It has been argued that only two U.S. national sales taxes have affected behavior in the manner of a Pigouvian tax: the "gas guzzler tax" on new cars, discussed later, and the excise tax on ozone-depleting chemicals (Barthold 1994), although it is far from clear that the chloroflourocarbon (CFC) tax actually affected business decisions (Table 5). To meet international obligations established under the Montreal Protocol to limit the release of chemicals that deplete stratospheric ozone, the Federal government set up a tradable permit system (discussed below in Section 3.2.1) and levied an excise tax on specific CFCs in 1989. Producers are required to have adequate allowances, and users pay a fee (set proportional to a chemical-specific ozone depleting factor). There is considerable debate regarding which mechanism should be credited with the successful reduction in the use of these substances (Hahn and McGartland 1989; U.S. Congress 1989; U.S. Congress, Office of Technology Assessment 1995; Cook 1996). Denmark and Australia also tax ozone-depleting chemicals (ODCs), and the Danish ODC tax seems to have affected use (Blackman and Harrington 1999).

2.5.3 Agricultural Inputs

Several states in the United States impose taxes on fertilizers and pesticides, but at levels below those required to affect behavior significantly. The taxes generate revenues that are used to finance environmental programs (Moriandi 1992; International Institute for Sustainable Development 1995). Likewise, Sweden imposes sales taxes on agrochemicals, including commercial fertilizers (containing nitrogen and phosphorous) and pesticides (OECD 1996). There is evidence that the Swedish taxes have reduced nitrogen use by 10 percent and total pesticide use by 35 percent (Ekins and Speck 1998). Denmark and Finland also tax pesticides (Speck 1998; OECD 1999b).

2.5.4 Product Taxes

The U.S. Energy Tax Act of 1978 established a "gas guzzler" tax on the sale of new vehicles that fail to meet statutory fuel efficiency levels, set at 22.5 miles per gallon. The tax ranges from $1,000 to $7,700 per vehicle, based on fuel efficiency; but the tax does not depend on actual performance or on mileage driven. The tax is intended to discourage the production and purchase of fuel inefficient vehicles (U.S. Congress 1978), but it applies to a relatively small set of luxury cars, and so has had limited effects.[27]

In the European Union, disposable products as diverse as cameras, light bulbs, and razors are taxed, in addition to disposable containers and packaging. Denmark's carrier bag tax, differentiated so that plastic bags are more expensive than paper (though both are taxed), is an example of such a sales tax; revenues go to the general budget. Belgium's disposable camera, disposable razor, and beverage container taxes are earmarked for general environmental purposes (Speck 1998).

---

[27]Light trucks, which include "sport utility vehicles," are fully exempt from the tax (Bradsher 1997). Ontario, Canada has a gas-guzzler tax combined with a rebate for fuel-efficient vehicles, but because the coverage of the tax is very limited and the rates are very low, the overall effect is negligible (Haites 1999).

2.6 Administrative Charges

These charges raise revenues to help cover the administrative costs of environmental programs (Table 6); the charges are not intended to change behavior. For example, under the National Pollution Discharge Elimination System of the U.S. Clean Water Act, charges by individual states for discharge permits are based in some states on the quantity and type of pollutant discharged. Likewise, the Clean Air Act Amendments of 1990 allow states to tax regulated air pollutants to recover administrative costs of state programs, and allow areas in extreme non-compliance to charge higher rates. Under this structure, the South Coast Air Quality Management District (SCAQMD) in Los Angeles has the highest permit fees in the country (U.S. Congress, Office of Technology Assessment 1995).

Sweden has implemented registration charges for pesticides and other chemicals, as well as a CFC charge, which pays for inspections (OECD 1996). Belgium levies licensing charges on pesticides, radioactive materials, and hazardous waste import and export, which cover inspection and control costs (OECD 1998c). Annual charges for pesticide use increase with pesticide toxicity, and hazardous material license fees are based on an index that accounts for fire, explosion, and toxicity risks. A pesticide registration charge has also been implemented in Finland (Speck 1998). Malaysia uses a licensing system to reduce effluents from the palm oil industry. Firms pay a non-refundable annual license processing fee that is reduced for mills that develop pollution-reducing technologies (World Bank 1997b). But the effluent fee should not be given excessive credit for Malaysia's significant reductions in water pollutant emissions (Vincent and Ali 1997). Canada recovers part or all of its regulatory costs in some sectors through permit fees (OECD 1995b).

2.7 Tax Differentiation

I use the phrase, "tax differentiation," to refer to credits, tax cuts, and subsidies for environmentally desirable behavior (Table 7). These serve as implicit taxes on environmentally undesirable behavior.

A number of U.S. national and state taxes have been implemented in attempts to encourage the use of renewable energy sources, implicitly taking into account externalities associated with fossil fuel energy generation and use. Under the Energy Policy Act of 1992, for example, electricity produced from wind and biomass fuels received a 1.5 cent per kWh credit, and solar and geothermal investments received up to a 10 percent tax credit. Although economists' natural response to energy-related externalities is to advise that fuels or energy use be taxed, there is econometric evidence that energy-efficient technology adoption subsidies may be more effective — in some circumstances — than proportional energy taxes (Jaffe and Stavins 1995). In other programs, from 1979 to 1985, employers could provide implicit subsidies to employees for certain commuting expenses, such as free van pools and mass transit passes on a tax-free basis. Likewise, subsidies from utilities to households for energy conservation investments have been excludable from individual income taxes.

European countries have used tax differentiation to reduce vehicle-related emissions by encouraging the switch from leaded to unleaded gasoline (as did New Zealand) and by encouraging clean car sales

(Panayotou 1998). The drastic reduction in the market share of leaded gasoline in Europe between 1985 and 1995 can be attributed, in part, to the tax differentiation of leaded and unleaded gasoline, and to the tax preferences afforded vehicles with catalytic converters, which require unleaded gasoline (Ekins and Speck 1998).

Many European countries assess differentiated taxes and fees on vehicles according to cylinder capacity, age, fuel efficiency, and other environmentally relevant grounds (Speck 1998). Iceland has differentiated import levies to promote smaller, more fuel efficient cars (OECD 1993c). Spain granted rebates on purchases of new cars during 1994 and 1995, provided that old cars were removed from use, a program subsequently replaced by a differential vehicle registration tax (OECD 1997d). Austria offers tax incentives for environmental investment enterprises, household energy saving measures, low-noise vehicles, catalytic converters, and electric cars (OECD 1995a); and Germany, Sweden, and the Netherlands report significant changes in consumer behavior due to vehicle-related tax differentiation (Panayotou 1998). Mexico has reduced its sales tax on new cars and raised fees on older vehicles in an attempt to reduce emissions. A number of other countries have implemented differentiated motor vehicle taxes to discourage vehicle use and fuel consumption, including Côte d'Ivoire (Ivory Coast), Kenya, Australia, Japan, Russia, Italy, Portugal, and Argentina (McMorran and Nellor 1994).

Subsidized credit and tax or tariff relief for environmentally desirable investments are common in Latin America and the Caribbean (Huber, Ruitenbeek and Serôa da Motta 1998). Since 1995, an Argentinian tax exemption has encouraged the switch from diesel and gasoline-powered vehicles to those that use compressed natural gas. Brazil and Colombia offer subsidies for industrial pollution abatement investments, as well as income tax and value-added tax rebates for clean technology adoption. Ecuador offers subsidies and tax relief for mining sector mercury recovery investments. Jamaica offers tax and tariff relief for pollution abatement investments. Mexico offers subsidies for industrial pollution abatement investments, and a set of pollution control equipment is exempt from import taxation. Venezuela offers tax and tariff relief for industrial abatement investments. However, weak enforcement and sporadic monitoring of investments have minimized the effects of these policies (World Bank 1997b).

Many countries include environmentally-friendly provisions within their corporate tax systems (McMorran and Nellor 1994). South Korea offers tax deductions for companies involved in environmental conservation, and for investments in anti-pollution facilities and waste recycling (OECD 1997c). Japan offers a capital allowance for solar energy equipment, and Germany offers accelerated depreciation for energy-saving and pollution-reducing equipment.

3. TRADEABLE PERMIT SYSTEMS

It is well known that over the past decade tradeable permit systems have been adopted for pollution control with increasing frequency in the United States (U.S. Environmental Protection Agency 1992; Tietenberg 1997b), but it is also true that this market-based environmental instrument has begun to be applied in a number of other countries as well. World wide, these programs are of two basic types: credit programs and cap-and-trade systems. Under credit programs, credits are assigned (created) when a source reduces emissions below the level required by existing, source-specific limits; these credits can enable the same or another firm to meet its control target. Under a cap-and-trade system, an allowable overall level of pollution is established and allocated among firms in the form of permits, which can be freely exchanged among sources. In theory, the allocation can be carried out through free distribution or through sale (for example, auction) by the government.

3.1 Credit Programs

There have been several significant applications of the credit program model: the U.S. Environmental Protection Agency's (EPA's) Emissions Trading Program (including a variety of state-level credit programs); the phasedown of leaded gasoline in the United States; U.S. heavy duty motor vehicle engine emissions trading; water quality permit trading; and two Canadian pilot programs (Table 8).[28] Activities implemented jointly (AIJ) under the United Nations Framework Convention on Climate Change (FCCC) are included in section 3.1.6, below, even though they are pilot projects and do not generate credits toward greenhouse gas (GHG) commitments for investing nations and firms. There is, as yet, no international agreement in force to provide a framework for international GHG emissions credit programs.

3.1.1 EPA's Emissions Trading Program

Beginning in 1974, EPA experimented with "emissions trading" as part of the Clean Air Act's program for improving local air quality through the control of volatile organic compounds (VOCs), CO, SO_2, particulates, and NO_x. Firms that reduced emissions below the level required by law received "credits" usable against higher emissions elsewhere. Companies could employ the concepts of "netting" or "bubbles" to trade emissions reductions among sources within the firm, so long as total, combined emissions did not exceed an aggregate limit (Tietenberg 1985; Hahn 1989; Foster and Hahn 1995). By the mid-1980s, EPA had approved more than 50 bubbles, and states had authorized many more under EPA's framework rules. Estimated compliance cost savings from these bubble programs exceeded $430 million (Korb 1998).

The "offset" program, which began in 1977, goes further in allowing firms to trade emission credits. Firms wishing to establish new sources in areas that are not in compliance with ambient standards must

---

[28] Also, California has used a vehicle retirement program that operates much like a credit system to reduce mobile-source air emissions by removing the oldest and most polluting vehicles from the road (Kling 1994; Alberini, Harrington, and McConnell 1995;Tietenberg 1997b).

offset their new emissions by reducing existing emissions. This can be accomplished through internal sources or through agreements with other firms. Finally, under the "banking" program, firms may store earned emission credits for future use. Banking allows for either future internal expansion or the sale of credits to other firms.

EPA codified these programs in its Emissions Trading Program in 1986, but the programs have not been widely used. States are not required to use the programs, and uncertainties about their future course may have made firms reluctant to participate (Liroff 1986). Nevertheless, companies such as Armco, DuPont, USX, and 3M have traded emissions credits, and a market for transfers has long since developed (Main 1988). Even this limited degree of participation in EPA's trading programs may have saved between $5 billion and $12 billion over the life of the programs (Hahn and Hester 1989b).

State-level emissions credit programs authorized under the U.S. EPA framework include ones operating in California, Colorado, Georgia, Illinois, Louisiana, and New York. In California, sources that exceed VOC standards for one product can offset excess emissions through over-compliance in other products. Since 1996, Colorado has allowed sources to generate emission reduction credits by reducing production or changing processes and materials. Mobile sources can generate credits by scrapping high-emission vehicles and replacing them with cleaner ones, by fuel switching, or by trip reduction (Bryner 1999). In Telluride, Colorado, residents must turn in two existing wood-burning stove or fireplace permits for every new permit.

Georgia allows vehicle fleet operators to earn credits for vehicles that over-comply with Federal clean-fueled fleet regulations, and to bank and trade credits. Illinois instituted a program in 1993 that purchases and scraps pre-1980 automobiles. The program allows "allotment trading units" to be earned by scrapping vehicles (after tailpipe emissions and fuel evaporation have been measured). The trading units can be purchased by stationary sources operating in areas that violate Federal air quality standards. Stationary sources in Louisiana, within areas with current or past ozone pollution problems, can obtain NO_x and VOC allowances by scrapping old vehicles purchased from motorists at fair market value (Bryner 1999). New York's New Source Review Offset Program allows new sources to offset emissions with credits generated by all types of emission reductions, including shutdowns of old facilities.

3.1.2 Lead Trading

The purpose of the U.S. lead trading program, developed in the 1980s, was to allow gasoline refiners greater flexibility in meeting emission standards at a time when the lead-content of gasoline was reduced to 10 percent of its previous level. In 1982, EPA authorized inter-refinery trading of lead credits, a major purpose of which was to lessen the financial burden on smaller refineries, which were believed to have significantly higher compliance costs. If refiners produced gasoline with a lower lead content than was required, they earned lead credits. Unlike a cap-and-trade program, there was no explicit allocation of permits, but to the degree that firms' production levels were correlated over time, the system implicitly awarded property rights on the basis of historical levels of gasoline production (Hahn 1989).

In 1985, EPA initiated a program allowing refineries to bank lead credits, and subsequently firms made extensive use of this option. In each year of the program, more than 60 percent of the lead added to gasoline was associated with traded lead credits (Hahn and Hester 1989a), until the program was terminated at the end of 1987, when the lead phasedown was completed.[29]

The lead program was clearly successful in meeting its environmental targets, although it may have produced some (temporary) geographic shifts in use patterns (Anderson, Hofmann and Rusin 1990). Although the benefits of the trading scheme are more difficult to assess, the level of trading activity and the rate at which refiners reduced their production of leaded gasoline suggest that the program was relatively cost-effective (Kerr and Maré 1997; Nichols 1997). The high level of trading between firms far surpassed levels observed in earlier environmental markets.[30] EPA estimated savings from the lead trading program of approximately 20 percent over alternative programs that did not provide for lead banking, a cost savings of about $250 million per year (U.S. Environmental Protection Agency, Office of Policy Analysis 1985). The program provided measurable incentives for cost-saving technology diffusion (Kerr and Newell 2000).

3.1.3 Heavy Duty Motor Vehicle Engine Emission Trading

For nearly a decade, the U.S. Environmental Protection Agency (EPA) has allowed averaging, banking, and trading of credits for NO_x and particulate emissions reductions among eleven heavy-duty truck and bus engine manufacturers. EPA introduced these provisions to facilitate compliance with stricter emissions standards (Haites 1997). Emissions reduced below the "standard rate" can be credited to offset emissions for other engines manufactured by the same firm in the same year (averaging), banked to offset emissions for other engines manufactured by the same firm in a future year (banking), or sold to another firm to offset emissions for engines manufactured in the same or a future year (trading).[31]

Manufacturers appear to have used averaging more often than banking, and banking tends to be most common immediately prior to changes in standards; the first inter-firm credit trade occurred in 1997 (Haites 1997). EPA has created similar programs for manufacturers of non-road diesel engines, including ones for agricultural and construction equipment, locomotive engines, and certain classes of marine engines.

[29]Under the banking provisions of the program, excess reductions made in 1985 could be banked until the end of 1987, thereby providing an incentive for early reductions to help meet the lower limits that existed during the later years of the phasedown. The official completion of the phasedown occurred on January 1, 1996, when lead was banned as a fuel additive (Kerr and Newell 2000).

[30]The program did experience some relatively minor implementation difficulties related to imported leaded fuel. It is not clear that a comparable command-and-control approach would have done better in terms of environmental quality (U.S. General Accounting Office 1986).

[31]Credits cannot be used to offset emissions above a "maximum rate."

3.1.4 Water Quality Permit Trading

In contrast with air quality programs, the United States has had very limited experience with tradable permit systems for controlling water pollution. Several experimental, pilot, and new programs are described here.

Nonpoint sources, particularly agricultural and urban runoff, may constitute the major, remaining American water pollution problem (Peskin 1986). An "experimental program" to protect water quality in Colorado demonstrated how tradable permits could be used to reduce nonpoint-source water pollution. Dillon Reservoir is the major source of water for the city of Denver. Nitrogen and phosphorus loading threatened to turn the reservoir eutrophic, despite the fact that point sources from surrounding communities were controlled to best-available technology standards (U.S. Environmental Protection Agency, Office of Policy Analysis 1984). Rapid population growth in Denver, and the resulting increase in urban surface water runoff, further aggravated the problem. In response, state policy makers developed a point-nonpoint-source control program to reduce phosphorus flows, mainly from nonpoint urban and agricultural sources. The program was implemented in 1984 (Kashmanian 1986); it allowed publicly owned sewage treatment works to finance the control of nonpoint sources in lieu of upgrading their own treated effluents to drinking water standards (Hahn 1989).

EPA estimated that the plan could save over $1 million per year (Hahn and Hester 1989a), due to differences in the marginal costs of control between nonpoint sources and the sewage treatment facilities. However, very limited trading occurred under the program, for a variety of reasons, including: implementation of other regulations that reduced non-point source run off; lower than expected cost for installation of additional treatment facilities; and relatively high regional precipitation that diluted concentrations in the reservoir.

Other states have implemented statewide and local trading programs. In 1981, Wisconsin introduced a discharge trading program to control biological oxygen demand (BOD) on a 45-mile section of the Fox River, which contains the heaviest concentration of paper mills in the world (Svendsen 1998). Participants included 15 paper mills and six municipal wastewater treatment plants, but trading activity has been almost nonexistent (one trade), due in part to the fact that paper mills have met permit limits by introducing less water-intensive technologies and recycled wastewater into production processes, rather than trading (Svendsen 1998). North Carolina introduced a nitrogen and phosphorous trading system in the Tar-Pamlico River basin in 1989 to control nutrient discharge (OECD 1999c). The trading association covers a dozen sewage treatment plants and one industrial discharger. Membership is voluntary, but dischargers that choose not to join are subject to standard individual pollution permits. Members of the trading association can either reduce nutrients internally, trade within the group, or pay a fee of US$56/kg, revenues from which go toward non-point source reductions. Overall discharge of nutrients into the basin was reduced 28 percent between 1989 and 1999, despite an 18 percent increase in average effluent discharge.

Formal rule making for a water quality trading program in Michigan began in January, 2000. The program allows voluntary nutrient trading among and between point and nonpoint sources, consistent with the Clean Water Act and other Federal regulations. A two-year demonstration project for the statewide program, focusing on phosphorous in the Kalamazoo River watershed, was to be completed in June, 2000 (State of Michigan Department of Environmental Quality 2000). The Minnesota Pollution Control Agency has allowed a producer of malt for brewing to meet the provisions of its National Pollution Discharge Elimination System (NPDES) permit through point-nonpoint water quality trading. The firm, which discharges in the Minnesota River basin, offsets its discharges by paying upstream nonpoint sources to reduce phosphorous discharges, in part by purchasing land easements (Minnesota Pollution Control Agency 1997).

Overall, by 2001, the U.S. Environmental Protection Agency was actively involved in the development or implementation of 35 effluent trading projects in California, Colorado, Connecticut, the District of Columbia, Florida, Iowa, Idaho, Massachusetts, Maryland, Michigan, Minnesota, North Carolina, New Jersey, Nevada, New York, Ohio, Pennsylvania, Virginia, and Wisconsin (U.S. Environmental Protection Agency 2001).

3.1.5 Two Canadian Pilot Programs: PERT and GERT

Canada's Pilot Emission Reduction Trading (PERT) and Greenhouse Gas Emission Reduction Trading (GERT) projects are pilot credit programs. Since 1996, PERT has facilitated the voluntary registry of emission reduction credits in Ontario for industrial emissions reduction greater than required by regulations or voluntary commitments.[32] Ownership of registered credits can be contractually transferred between parties. The initial focus was NO_x and VOC emissions, but in 1997, the program was expanded to include CO_2, SO_2, and CO.

Through 1997, PERT registered 14,000 tons of NO_x, 6,000 tons of SO_2, and more than 1 million tons of CO_2 credits. The volume of registered credits has grown, and there have been a number of purchases of reduction credits. For example, in 1997, the Hartford (Connecticut) Steam Company purchased NO_x reduction credits created by Ontario Hydro and Detroit Edison Company to meet requirements of the Connecticut Department of Environmental Protection (Pilot Emission Reduction Trading 1999).

The GERT pilot project began in 1997 and was scheduled to end in December 1999. The project applies to six Canadian provinces: Alberta, British Columbia, Manitoba, Nova Scotia, Saskatchewan, and Quebec. The program's administrators review projects and evaluate trades. Government partners, such as provincial and federal environmental agencies, are included. These partners reserve the right to restrict emissions reductions considered under the pilot. GERT reviews only matched trades, i.e. those with both a buyer and a seller, one of which must be Canadian. Five matched applications were reported through

[32]PERT reviews but does not approve credits as they are registered. This "buyer beware" approach differs from that of GERT.

June 1999 (Greenhouse Gas Emission Reduction Trading 1999). The Canadian government counts GERT-recognized trades against any subsequent emission commitments (Sonneborn 1999).

3.1.6 Activities Implemented Jointly under the Framework Convention on Climate Change

Following the 1992 "Earth Summit" in Rio de Janeiro, Brazil, countries that had ratified the Framework Convention on Climate Change (FCCC) met in Berlin in 1995 for the first Conference of the Parties (COP 1). There they decided to establish a pilot phase for "activities implemented jointly" (AIJ), whereby industrialized nations or firms within those nations can finance projects in other countries to reduce net emissions of greenhouse gases and thereby attempt to (partially or fully) meet their own greenhouse gas (GHG) "commitments."[33]

A number of countries have established national AIJ programs, including Japan, Norway, Sweden, Switzerland, and the United States. For example, the U.S. Initiative on Joint Implementation (USIJI), established in 1993, approved 22 projects through 1997, 17 of which were in Latin American countries, including Costa Rica, Honduras, Belize, Bolivia, Mexico, Nicaragua, and Panama (Panayotou 1998). Land use and energy appear to be the most common sectors for such programs (World Bank 1997b).

Specific examples of AIJ projects include: a Norway-Mexico co-financing arrangement for a lighting project in Guadalajara and Monterrey, with additional funding from the World Bank's Global Environmental Facility; and a project switching a district heating plant in Decin, Czech Republic from coal to natural gas, with financing from several U.S. electric utilities (Dudek and Wiener 1996). According to one source, 133 AIJ projects had been accepted, approved, and endorsed by designated national authorities for the host and investing countries by September, 1999 (Jepma 1999). Limiting attention to those AIJ projects that had been approved by international authorities under the FCCC by mid-1999, the 94 projects included: 62 from the public sector and 32 from private firms; with project lives of one to sixty years; involving CO_2-equivalent reductions of 13 tons to 57 million tons; and average investments of approximately $6 million (Woerdman and Van der Gaast 1999; Dixon 1999).

These projects cannot really be characterized as true emission credit programs, because the projects are — by definition — pilot programs for which the investing firm or nation receives no actual credit. Furthermore, the likely efficacy of implemented, non-pilot versions of such programs is in doubt due to the fact that they would rely upon hypothetical baselines, i.e. what host nations would have done — in terms of emissions — in the absence of respective investment projects. Nevertheless, AIJ merits mention because it may be a precursor of future attempts to use emission credit and/or cap-and-trade programs for global climate change, whether under the Kyoto Protocol or some other future international agreement.

[33]Developing nations, such as Costa Rica, have also established AIJ programs. In any event, this should be distinguished from the more recent use of the phrase "joint implementation," which refers to prospective use of project-level credits among industrialized countries, each of which has targets under the Kyoto Protocol.

3.2 Cap-and-Trade Programs

When economists, other scholars, and policy-makers reflect on experiences with market-based instruments for environmental protection, they typically highlight several prominent cap-and-trade systems employed in the United States. A complete list is somewhat longer: CFC trading under the Montreal Protocol to protect the ozone layer; SO_2 allowance trading under the U.S. Clean Air Act Amendments of 1990; NO_x trading, initiated in 1999 to control regional smog in the eastern United States; the Regional Clean Air Markets (RECLAIM) program in the Los Angeles area; the use of auctioned bus licenses and particulates trading in Chile; and other quantity instruments of various degrees of flexibility and cost-effectiveness.

3.2.1 CFC Trading

A market in tradable permits was used in the United States to help comply with the Montreal Protocol, an international agreement aimed at slowing the rate of stratospheric ozone depletion. The Protocol called for reductions in the use of CFCs and halons, the primary chemical groups thought to lead to ozone depletion.[34] The market places limitations on both the production and consumption of CFCs by issuing allowances that limit these activities. The Montreal Protocol recognizes the fact that different types of CFCs are likely to have different effects on ozone depletion, and so each CFC is assigned a different weight on the basis of its depletion potential. If a firm wishes to produce a given amount of CFC, it must have an allowance to do so, calculated on this basis (Hahn and McGartland 1989).

Through mid-1991, there were 34 participants in the market and 80 trades (Feldman 1991). However, the overall efficiency of the market is difficult to determine, because no studies were conducted to estimate cost savings. The timetable for the phaseout of CFCs was subsequently accelerated, and a tax on CFCs was introduced, principally as a "windfall-profits tax" to prevent private industry from retaining scarcity rents created by the quantity restrictions (Merrill and Rousso 1990). The tax may have become the binding (effective) instrument. Nevertheless, low transaction costs associated with trading in the CFC market suggest that the system was relatively cost-effective.

In similar fashion, production quotas for ozone-depleting substances (ODS) were transferred within and among European Union (EU) countries between 1991 and 1994, until production was nearly phased out. During that period, there were 19 transfers (all but two of which were intrafirm), accounting for 13 percent of the EU's allowable ODS production.

Singapore has operated a tradeable permit system for ODS since 1991. The government records ODS requirements and bid prices for registered end-users and distributors, and total national ODS consumption (based on the Montreal Protocol) is distributed to registered firms by auction and free allocation. Firms can trade their allocations. Auction rents, captured by the government, have been used

[34]The Montreal Protocol called for a 50 percent reduction in the production of particular CFCs from 1986 levels by 1998. In addition, the Protocol froze halon production and consumption at 1986 levels beginning in 1992.

to subsidize recycling services and environmentally-friendly technologies (Annex I Expert Group of the United Nations Framework Convention on Climate Change 1997). Likewise, New Zealand implemented a CFC import permit system in 1986, whereby CFC permits are distributed by the Ministry of Commerce (based on the Montreal Protocol), and trading is allowed among permit holders.

Canada has also experimented with cap-and-trade systems for ozone-depleting substances since 1993. A system of tradeable permits for CFCs and methyl chloroform operated from 1993 to 1996, when production and import of these substances ceased. Producers and importers received allowances for use of CFCs and methyl chloroform equivalent to consumption in the base year and were permitted to transfer part or all of their allowances with the approval of the federal government. There were only a very small number of transfers of allowances during the three years of market operation, however (Haites 1996).

Canada first distributed tradeable allowances for methyl bromide in 1995. Due to concerns about the small number of importers (five), allowances were distributed directly to Canada's 133 users of methyl bromide. Use and trading of allowances was active among large allowance holders. In addition, Canada has operated an HCFC allowance system since 1996, distributing consumption permits for its maximum allowable use under the Montreal Protocol, but no HCFC transfers were recorded through 1999.

3.2.2 SO_2 Allowance Trading System

The most important application ever made of a market-based instrument for environmental protection is arguably the tradable permit system in the United States that regulates SO_2 emissions, the primary precursor of acid rain. This system, which was established under Title IV of the U.S. Clean Air Act Amendments of 1990, is intended to reduce sulfur dioxide and nitrogen oxide emissions by 10 million tons and 2 million tons, respectively, from 1980 levels.[35] The first phase of sulfur dioxide emissions reductions was started in 1995, with a second phase of reduction initiated in the year 2000.

In Phase I, individual emissions limits were assigned to the 263 most SO_2-emissions intensive generating units at 110 plants operated by 61 electric utilities, and located largely at coal-fired power plants east of the Mississippi River. After January 1, 1995, these utilities could emit sulfur dioxide only if they had adequate allowances to cover their emissions.[36] During Phase I, the EPA allocated each affected unit, on an annual basis, a specified number of allowances related to its share of heat input during the baseline period (1985-87), plus bonus allowances available under a variety of special provisions.[37] Cost-

[35]For a description of the legislation, see: Ferrall 1991.

[36]Under specified conditions, utilities that had installed coal scrubbers to reduce emissions could receive two-year extensions of the Phase I deadline plus additional allowances.

[37]Utilities that installed scrubbers receive bonus allowances for early clean up. Also, specified utilities in Ohio, Indiana, and Illinois received extra allowances during both phases of the program. All of these extra allowances were essentially compensation intended to benefit Midwestern plants that rely on high-sulfur coal. On the political origins of this aspect of the program, see: Joskow and Schmalensee 1998.

effectiveness is promoted by permitting allowance holders to transfer their permits among one another and bank them for later use.

Under Phase II of the program, beginning January 1, 2000, almost all electric power generating units were brought within the system. Certain units are exempted to compensate for potential restrictions on growth and to reward units that are already unusually clean. If trading permits represent the carrot of the system, its stick is a penalty of $2,000 per ton of emissions that exceed any year's allowances (and a requirement that such excesses be offset the following year).

A robust market of bilateral SO_2 permit trading has emerged, resulting in cost savings on the order of $1 billion annually, compared with the costs under some command-and-control regulatory alternatives (Carlson, Burtraw, Cropper, and Palmer 2000). Although the program had low levels of trading in its early years (Burtraw 1996), trading levels increased significantly over time (Schmalensee *et al*. 1998; Stavins 1998; Burtraw and Mansur 1999; Ellerman *et al.* 2000).

Concerns were expressed early on that state regulatory authorities would hamper trading in order to protect their domestic coal industries, and some research indicates that state public utility commission cost-recovery rules have provided poor guidance for compliance activities (Rose 1997; Bohi 1994). Other analysis suggests that this has not been a major problem (Bailey 1996). Similarly, in contrast to early assertions that the structure of EPA's small permit auction market would cause problems (Cason 1995), the evidence now indicates that this has had little or no effect on the vastly more important bilateral trading market (Joskow, Schmalensee, and Bailey 1998).

The allowance trading program has apparently had exceptionally positive welfare effects, with benefits being as much as six times greater than costs (Burtraw, Krupnick, Mansur, Austin, and Farrell 1998). The large benefits of the program are due mainly to the positive human health impacts of decreased local SO_2 and particulate concentrations, not to the ecological impacts of reduced long-distance transport of acid deposition. This contrasts with what was assumed and understood at the time of the program's enactment in 1990.

Ever since the program's initiation, downwind states, in particular, New York, have been somewhat skeptical about the effects of the trading scheme. This skepticism was translated into specific legislation passed by the New York State legislature and signed by the Governor in May of 2000. The legislation, which is subject to court challenge because of its implicit barrier to interstate commerce, would prevent electric utilities in New York State from selling surplus allowances to sources in upwind states, such as Ohio (Hernandez 2000). This legislation was driven by concern that the emissions trading program was failing to curb acid deposition in the Adirondacks in northern New York State (Dao 2000).

The empirical evidence indicates that New York's concern is essentially misplaced. The first question is whether acid deposition has increased in New York State. If the baseline for comparison is the absence of the Clean Air Act Amendments of 1990, then clearly acid deposition is less now than it would have been otherwise. If the baseline for comparison is the original allocation of permits under the 1990 law, but with no subsequent trading, then acid deposition in New York State is approximately unchanged (slightly increased, but within error bounds). But, such comparisons ignore the fact, as emphasized above, that the greatest benefits of the program have been with regard to human health impacts of localized pollution. When such effects are also considered, it becomes clear that the welfare effects of allowance trading on New York State, using *either* baseline, have been positive and significant (Burtraw and Mansur 1999; Swift 2000). Thus, the pending New York State ban on upwind trading would increase in-state emissions, increase ambient concentrations of SO_2 and particulates, and hence have net *negative* welfare effects on the State.

3.2.3 RECLAIM Program

The South Coast Air Quality Management District, which is responsible for controlling emissions in a four-county area of southern California, launched a tradable permit program in January, 1994, to reduce nitrogen oxide and sulfur dioxide emissions in the Los Angeles area.[38] One prospective analysis predicted 42 percent cost savings, amounting to $58 million annually (Anderson 1997). As of June 1996, 353 participants in this Regional Clean Air Incentives Market program, had traded more than 100,000 tons of NO_x and SO_2 emissions, at a value of over $10 million (Brotzman 1996). One particularly interesting aspect of the trading program is its zonal nature, whereby trades are not permitted from downwind to upwind sources. In this way, this geographically-differentiated emissions trading program represents one step toward an ambient trading program.

3.2.4 Ozone Transport Region NO_x Budget Program in the Northeast

Under U.S. Environmental Protection Agency guidance, twelve northeastern states and the District of Columbia implemented a regional NO_x cap-and-trade system in 1999 to reduce compliance costs associated with the Ozone Transport Commission (OTC) regulations of the 1990 Amendments to the Clean Air Act[39]. Required reductions are based on targets established by the OTC, which require reduction in emissions by large stationary sources. The program, known as the Northeast Ozone Transport Region, includes three geographic zones.[40] Emissions restrictions from 1999-2003 are to be 35 percent of 1990 emissions in the Inner Zone, and 45 percent in the Outer Zone. After 2003, Inner and Outer Zone sources must reduce to 25 percent of 1990 emissions, and Northern Zone sources to 45 percent (Farrell et al. 1999).

---

[38]For a detailed case study of the evolution of the use of economic incentives in the SCAQMD, see chapter 2 in National Academy of Public Administration 1994. Also see: Thompson 1997; and Harrison 1999.

[39]Seven OTC states have also implemented state-level NOx trading programs: New Jersey, Connecticut, Delaware, New York, Massachusetts, New Hampshire and Maine (Solomon 1999). See Section 3.2.5.

[40]The Inner Zone includes the Atlantic coast from Northern Virginia to New Hampshire, to varying distances inland. The Outer Zone is adjacent to the Inner Zone, from western Maryland through most of New York State. The Northern Zone includes northern New York and New Hampshire, and all of Vermont and Maine.

EPA distributes NO_x allowances to each state, and states then allocate allowances to sources in their jurisdictions. Each source receives allowances equal to its restricted percentage of 1990 emissions, and sources must turn in one allowance for each ton of NO_x emitted over the ozone season. Sources may buy, sell, and bank allowances. Potential compliance cost savings of 40 to 47 percent have been estimated for the period 1999-2003, compared to a base case of continued command-and-control regulation without trading or banking (Farrell et al. 1999).

NO_x emissions trading may be complicated by existing command-and-control regulations on many sources, the seasonal nature of ozone formation, and the fact that problems tend to result from a few high-ozone episodes and are not continuous (Farrell et al. 1999). The potential for "wrong-way" trades, which would trade emissions reductions near the coastal or northern boundary (downwind of a non-attainment area) for reductions to the south or west (upwind), may also complicate the system (Farrell et al. 1999).

3.2.5 State-Level NO_x and VOC Emissions Trading Programs

Many of the states within the Northeast Ozone Transport Region have established in-state trading programs that coordinate with the regional system in order to meet their statewide caps. Delaware implemented trading and banking of NO_x and VOCs among mobile and stationary sources in 1996, with all credits discounted by 10 percent. Credits can be retroactive for reductions as early as 1991, and trading can include sources outside Delaware within the NOTR. Maine instituted a trading program for NO_x and VOCs among stationary sources in 1998. Credits generated within another New England state require a 15 percent "surcharge" — an in-state source needing a 100-ton credit must purchase 115 tons from an out-of-state source. Credits generated within a state outside of New England, but within the NOTR, require a 100 percent surcharge (Bryner 1999). New Jersey created the Open Market Emissions Trading program in 1996, which authorizes trading of emissions reductions for NO_x and VOCs. Credits are discounted by 10 percent, and may be purchased from other states in the NOTR.

NO_x emissions trading and banking for stationary and mobile sources in Connecticut began in 1995. Mobile source emissions are discounted 10 percent, and emissions during the summer ozone season cannot be offset by credits generated at other times of the year (Bryner 1999). Massachusetts' program, which covers NO_x, VOCs, and CO, began in 1994. Sources of credits include more stringent controls, source reduction, fuel switching, energy conservation, fleet conversion, lawn and garden equipment trade-in, vehicle scrapping, and ride sharing (Bryner 1999). New Hampshire's Emissions Reduction Credits Trading Program allows stationary and mobile sources to generate credits for NO_x, VOC, and CO emissions reductions. Credits cannot be banked, and credits from facility shutdowns cannot be traded. Pennsylvania operates the NO_x Allowance Requirements Program, a mandatory cap-and-trade program that covers fossil-fuel-powered electric generating plants during the summer ozone season. Allowances are allocated each summer, and other types of sources may voluntarily opt in.

While not within the NOTR, Michigan and Illinois also have established NO_x emissions trading programs. The Michigan Department of Environmental Quality began a trading program in 1996 which allows emissions averaging (bubbling) and emissions reduction credit trading for most stationary and mobile sources and for all criteria pollutants other than ozone (O_3). Although the U.S. EPA has yet to approve Michigan's program, by mid-1998, 25,000 NO_x credits and 500 VOC credits were registered with the state (Solomon and Gorman 1998; Solomon 1999). The area around Chicago in northeast Illinois began a five-month summer season VOC cap-and-trade system in 2000. The program is mandatory for a set of large stationary sources that account for 26 percent of regional emissions

3.2.6 Gasoline Constituent and Tier 2 Emission Standard Trading

The U.S. Clean Air Act Amendments of 1990 imposed more stringent mobile source emissions standards through two routes — requiring automobile manufacturers to reduce tailpipe emissions on new models, and requiring refineries to develop and market reformulated fuels. In 1992, the U.S. Environmental Protection Agency established a trading program for oxygenates in gasoline (to reduce emissions of carbon monoxide during the winter months). Although the trading program could — in theory — increase cost-effectiveness, virtually none of the affected jurisdictions chose to develop trading rules, citing monitoring costs, and the one area that did develop rules experienced no trading.

In 2000, EPA promulgated new standards for NO_x emissions from motor vehicles and for the sulfur content of gasoline. Vehicle manufacturers are permitted to average their NO_x emissions to comply with a corporate average standard, much like under the Corporate Average Fuel Economy Standards, discussed below. In this case, however, trading (and banking) with other manufacturers is also allowed. Similarly, beginning in 2004, refiners and importers must satisfy corporate average gasoline standards on sulfur content. Both banking and inter-refinery trade are to be allowed.

3.2.7 Chilean Bus Licenses

Since 1991, Chile has had an auctioning system in place for bus licenses to address congestion-related pollution in Santiago (Huber *et al.* 1998). Deregulation of Santiago's urban public bus system in the late 1970s had resulted in a significant expansion of the system (Hartje *et al.* 1994), with congestion thereby increasing traffic-related emissions. In 1991, the Chilean Ministry of Transportation began auctioning access rights to buses and taxis in congested areas. Congestion has apparently been reduced by these measures, with emissions reduced proportionately, although actual emission reductions have not been measured (Panayotou 1998). Although the system has characteristics of a cap-and-trade system for vehicle congestion, it is not a cap-and-trade system for emissions control *per se*, because in order to bid for a license, a bus must first comply with the prevailing uniform emissions standard (indeed, through specified technology).

3.2.8 Chilean TSP Tradeable Permits

Chile also has implemented a tradeable permit system for total suspended particulates (TSP) from stationary sources in the Santiago area. Initial allocations were based on 1992 emissions, and new sources must offset all incremental emissions. Trading began in 1995. Emissions have decreased, due to the introduction of natural gas as an alternative fuel, but the volume of emissions trading has been low (Montero and Sánchez 1999). Regulatory uncertainty, high transaction costs (especially with respect to a lengthy and uncertain approval process), inadequate enforcement, and market concentration may be partly to blame for the low trading volume. An unexpected benefit of the Chilean TSP system was that the offer of free (and potentially valuable) tradeable permits provided a significant incentive to incumbent polluters to identify themselves and report their emissions, in order to claim their permits. Prior to the program's existence, the government authorities had a very limited inventory of sources and emissions.

3.2.9 Other Flexible Quantity-Based Instruments

Limited regulatory flexibility has been introduced within the context of several conventional quantity-based instruments in various countries, representing — in some cases — movements toward the use of tradeable permit approaches. For this reason, I review in this section such flexible quantity-based instruments.

The U.S. Energy Policy and Conservation Act of 1975 established a program of Corporate Average Fuel Economy (CAFE) standards for automobiles and light trucks. The standards require manufacturers to meet a minimum sales-weighted average fuel efficiency for their fleet of cars sold in the United States. A penalty is charged per car sold per unit of average fuel efficiency below the standard. The program operates like an internal-firm tradeable permit system or "bubble" scheme, since manufacturers can undertake efficiency improvements wherever they are cheapest within their fleets. Firms that do better than the standard can "bank" their surpluses and — in some cases — are permitted to borrow against their future rights.[41]

In an effort to increase flexibility, the U.S. EPA allows air toxics averaging *within individual facilities* when firms are seeking compliance with the 1990 Clean Air Act Amendments. Likewise, EPA permits the use of "bubbling" of water effluent from iron and steel plants under the U.S. Clean Water Act, but imposes tight constraints on its use (U.S. Environmental Protection Agency 2001).

European national authorities have increased flexibility under a number of existing national and EU emissions standards to create limited quota and trading arrangements, although none have involved inter-firm financial transfers (Klaassen and Nentjes 1997). For example, in Denmark, the Ministry of Environment fixes annual emissions ceilings in the power generation industry as a whole, and leaves allocation of the annual ceilings to the country's two power plant consortia. From 1991 to 1997, the United Kingdom allowed intra-firm trading of SO_2 allowances among large combustion plants, as part of its plan for compliance with the EU's Large Combustion Plant Directive, aimed at acid rain control. Inter-firm trading was not allowed, and in the power sector, only part of a firm's annual emissions limitation was tradable (Sorrell 1999; Pototschnig 1994). In the Netherlands, electric power producers face emission standards for SO_2 and NO_x, but can comply through cost-sharing arrangements, whereby plants with higher

[41]For reviews of the literature on CAFE standards, with particular attention to the program's costs relative to "equivalent" gasoline taxes, see Crandall *et al*. 1986; and Goldberg 1997. Light trucks, which are defined by the Federal government to include "sport utility vehicles," face significantly weaker CAFE standards (Bradsher 1997).

abatement costs are compensated. The system has resulted in intra-firm trading, with estimated savings of $245 million (Klaassen and Nentjes 1997).

In Germany, the transfer of emission reduction obligations among firms in air quality non-attainment areas is allowed. Since 1974, firms have been allowed to locate new plants in non-attainment areas, provided they replace existing plants in the same area, and the "replaced" plant need not be owned by the same firm. Since 1983, existing plant renovations can also be used to offset new plant emissions in non-attainment areas (Klaassen and Nentjes 1997). The cost savings associated with these rules have been very limited, however (Shärer 1994). Germany began a pilot project on tradable permits for VOC emissions among small vehicle refinishing shops in 1998 (Schärer 1999).

From 1991 to 1992, an experimental program was carried out in Chorzów, one of Poland's most polluted municipalities (òylicz 1999). Although emissions trading was not recognized by Polish law at the project's start, the Chorzów pilot project allowed the city's steel mill and power plant to negotiate collective emissions reductions for particulates, sulfur dioxide, carbon monoxide, and hydrocarbons.

4. REDUCING MARKET FRICTIONS

In some situations, environmental protection can be fostered by reducing or eliminating frictions in market activity. I consider three types of such market friction reductions: (1) *market creation* for inputs/outputs associated with environmental quality, as with measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation and use of scarce water supplies; (2) *liability rules* that encourage firms to consider the potential environmental damages of their decisions; and (3) *information programs*, such as energy-efficiency product labeling requirements.

4.1 Market Creation for Inputs/Outputs Associated with Environmental Quality

Two examples of using market creation as an instrument of environmental policy stand out: measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation and use of scarce water supplies; and particular policies that facilitate the restructuring of electricity generation and transmission.

First, the western United States has long been plagued by inefficient use and allocation of its scarce water supplies, largely because users do not have incentives to take actions consistent with economic and environmental values. For more than a decade, economists have noted that Federal and state water policies have been aggravating, not abating, these problems (Anderson 1983; Frederick 1986; El-Ashry and Gibbons 1986; Wahl 1989). As recently as 1990, in the Central Valley of California, farmers were paying as little as $10 for water to irrigate an acre of cotton, while just a few hundred miles away in Los Angeles, local authorities were paying up to $600 for the same quantity of water. This dramatic disparity provided evidence that increasing urban demands for water could be met at relatively low cost to agriculture or the environment (i.e., without constructing new, environmentally-disruptive dams and reservoirs). Subsequent reforms allowed markets in water to develop, so that voluntary exchanges could take place. For example, an agreement was reached to transfer 100,000 acre-feet of water per year from the farmers of the Imperial Irrigation District (IID) in southern California to the Metropolitan Water District (MWD) in the Los Angeles area.[42] Subsequently, policy reforms spread throughout the west, and transactions soon emerged elsewhere in California, and in Colorado, New Mexico, Arizona, Nevada, and Utah (MacDonnell 1990).

In Colorado, water-rights trading has continued to develop (OECD 1997e). Water rights holders in one district, the Colorado River Basin, send, on average, 5 to 15 applications per month for water transfers to the district's Water Court, which reviews all transfers. Prices depend on the characteristics of the region and the particular water right: rights near Grand Junction trade for approximately $0.06 per cubic meter, while rights near rapidly-developing Summit City trade for $65 per cubic meter (OECD 1997e). Quantities traded range from 300 to 54,000 cubic meters per year. The Colorado market includes 22,000 water rights located in 11,000 diversion structures. All public and private parties, including government agencies, are treated alike in proposed transfer evaluations. For example, the state government must purchase rights to promote ecological uses, like wetlands and in-stream flows.

In February, 2000, Azurix, formerly a division of Enron Corporation, launched an Internet exchange for buying, selling, storing and transporting water in the western U.S., but it is too early to assess whether or how this system will enhance water market activity (Azurix 2000).[43] In Chile, water rights trading was reintroduced in 1981, having existed from the 1920s through the 1960s, but prohibited in 1969 when water became state property (Huber *et al.* 1998). Transactions are relatively rare, however. Australia has permitted water trading in parts of the country since 1982 (OECD 1998b).

A second example of "market creation" is the worldwide revolution in electricity restructuring that is motivated by economic concerns[44] but possibly bringing significant environmental impacts. For many years, utilities in the United States — closely overseen by state public utility commissions (PUCs) — have provided electricity within exclusive service areas. The utilities were granted these monopoly markets and guaranteed a rate of return on their investments, conditional upon their setting reasonable rates and meeting various social objectives, such as universal access. The Energy Policy Act of 1992 allowed independent electricity generating companies to sell power directly to utilities, and in 1996, the Federal Energy Regulatory Commission (FERC) required utilities with transmission lines to transmit power for other parties

[42]In March of 1983, the Environmental Defense Fund (EDF) published a proposal calling for MWD to finance the modernization of IID's water system in exchange for use of conserved water (Stavins 1983). In November, 1988, after five years of negotiation, the two water giants agreed on a $230 million water conservation and transfer arrangement, much like EDF's original proposal to trade conservation investments for water (Morris 1988).

[43]The exchange is located at http://www.Water2Water.com.

[44]The primary arguments for restructuring are: (1) the electricity industry is no longer a natural monopoly, since small generation technologies are now competitive with large centralized production; (2) consumers will benefit from buying cheaper electricity from more efficient producers, who currently face significant barriers to entry; and (3) the old system with cost-of-service pricing provides poor incentives for utilities to reduce costs (Brennan *et al*. 1996).

at reasonable rates. The purpose of these regulatory changes was to encourage competition at the wholesale (electricity generation) level, but many states moved to facilitate competition at the retail level as well, so that consumers can contract directly for their electricity supplies. Legislation has been introduced in the U.S. Congress to establish guidelines for retail competition throughout the nation (Kriz 1996).

These changes have environmental implications. First, as electricity prices fall in the new competitive environment, electricity consumption is expected to increase. This might be expected to increase pollutant emissions, but to whatever degree electricity substitutes for other, more polluting forms of energy, the overall effect may be environmentally beneficial. Second, deregulation will unquestionably make it easier for new firms and sources to enter markets. Since new power plants tend to be both more efficient and less polluting (relying more on natural gas), environmental impacts may decrease.[45] Third, more flexible and robust markets for electricity can be expected to increase the effectiveness of various market-based incentives for pollution control, such as the SO_2 allowance trading system.[46]

4.2 Liability Rules

Liability rules can have the effect of providing strong incentives for firms to consider the potential environmental damages of their decisions.[47] In theory, a liability rule can be cost effective as a policy instrument, because technologies or practices are not specified. For example, taxing hazardous materials or their disposal creates incentives for firms to reduce their use of those materials, but does *not* provide overall incentives for firm to reduce societal *risks* from those materials. An appropriately designed liability rule can do just that (Revesz 1997). On the other hand, transaction costs associated with litigation may make liability rules appropriate only for acute hazards. It is in these situations, in fact, that this approach has been most frequently employed, particularly in the case of liability for toxic waste sites and for the spill of hazardous materials.

The U.S. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 established retroactive liability for companies that are found responsible for the existence of a site

---

[45]There is considerable debate on this point, since — in the short run — more electricity may be generated from old surplus capacity coal plants in the Midwest, increasing pollutant emissions. In any event, in the long run, competition will encourage a more rapid turnover of the capital stock (Palmer and Burtraw 1997).

[46]Environmental advocates, however, are very concerned that state PUCs will have much less influence than previously over the industry. In the past, PUCs encouraged "demand side management" and supported the use of renewable forms of electricity generation through the investment approval process or by requiring full-cost pricing for generation. Several policies have been proposed to provide these functions in the new, more competitive environment: for example, a system of tradable "renewable energy credits," wherein each generator would need to hold credits for a certain percentage of their generation; and a tax on the transmission of electricity, used to subsidize renewable generation.

[47]These incentives are frequently neither simple nor direct, because firms and individuals may choose to reduce their exposure to liability by taking out insurance. In this regard, see the earlier discussion in this chapter of "Insurance Premium Taxes."

requiring clean up.[48] Governments can collect cleanup costs and damages from waste producers, waste transporters, handlers, and current and past owners and operators of a site.[49] Similarly, the Oil Pollution Act makes firms liable for cleanup costs, natural resource damages, and third party damages caused by oil spills onto surface waters; and the Clean Water Act makes responsible parties liable for cleanup costs for spills of hazardous substances.

The Nordic countries have strict environmental liability rules. Sweden has held polluters strictly liable for full damage compensation since 1986 (OECD 1996); and Norway and Finland enforce strict liability for environmental damage (OECD 1997a). Germany, Belgium, France, and the Netherlands enforce strict liability for a variety of polluting activities (OECD 1995c; 1997b; 1998c). In the emerging market economies of central and eastern Europe, environmental liability rules have played particularly important roles in the process of economic transition (Panayotou, Bluffstone, and Balaban 1994).

Among developing countries, the nation of Trinidad and Tobago has established a voluntary policy of full compensation for environmental damages, but has not legislated mandatory liability (Huber *et al.* 1998). Mexico has established strict liability of parties who degrade the environment (OECD 1998d), but in Latin American and Caribbean countries, as in many developing nations, lack of resources among executive and judiciary institutions makes enforcement of these policies relatively uncommon.

4.3 Information Programs

Since well-functioning markets depend, in part, on the existence of well-informed producers and consumers, information programs can — in theory — help foster market-oriented solutions to environmental problems.[50]

---

[48]Retroactive liability provisions can of course provide incentive effects only for future actions which might be subject to liability rules.

[49]For economic analyses of the Superfund program, see, for example: Hamilton 1993; Gupta,Van Houtven, and Cropper 1996; and Hamilton and Viscusi 1999.

[50]For a comprehensive review of information programs and their apparent efficacy, see: Tietenberg 1997a. For an overview of international experience with "eco-labels," see: Morris and Scarlett 1996. A number of studies have measured statistically significant reactions of stock values to positive and negative environmental news in the U.S. and Canadian markets (Muoghalu et al. 1990, Lanoie and Laplante 1994, Klassen and McLaughlin 1996, Hamilton 1995, Laplante et al. 1997). Recent work at the World Bank indicates that the same may be true in developing countries (Dasgupta et al. 1997). The International Standards Organization's (ISO) latest benchmark, ISO 14001, was issued in draft form in 1996 and includes new standards for environmental management systems. In order to obtain ISO 14001 certification, firms must commit to environmental performance targets, among other things. More than 8,000 plants worldwide had obtained certification through 1999 (Wheeler 2000).

4.3.1 Product Labeling Requirements

One approach to government improving the set of information available to consumers is a product labeling requirement (Table 9). The U.S. Energy Policy and Conservation Act of 1975 specifies that certain appliances and equipment (including air conditioners, washing machines, and water heaters) carry labels with information on products' energy efficiency and estimated annual energy costs (U.S. Congress, Office of Technology Assessment 1992). More recently, EPA and the U.S. Department of Energy (DOE) developed the Energy Star program, in which energy efficient products can display an *EnergyStar* label. The label does not provide specific information on the product, but signals to consumers that the product is, in general, "energy efficient." This program is much broader in its coverage than the appliance labeling program; by 1997, over 13,000 product models carried the *Energy Star* label (U.S. Department of State 1997). There has been little economic analysis of the efficacy of such programs, but limited econometric evidence suggests that product labeling (specifically appliance efficiency labels) can have significant impacts on efficiency improvements, essentially by making consumers (and therefore producers) more sensitive to energy price changes (Newell, Jaffe, and Stavins 1999).

The European Union established an "Eco-label" in 1993; it was initially intended to replace proliferating (and possibly trade-restricting) national labels in Europe, but the European Parliament voted in 1998 to continue to allow national labels. By 1999, the Eco-label had been applied to 200 products, including detergents, light bulbs, linens and t-shirts, appliances, paper, mattresses, and paints.

The EU Eco-label has not supplanted older and more extensive European national systems. The German "Eco-Angel" label program, the world's first, began in 1977. More than 4,200 products in dozens of sectors have received the label, including almost 600 foreign products. Hungary's eco-label, introduced in 1995, borrows its issuance guidelines from the German Eco-Angel program. The Nordic Swan has been applied in Norway, Sweden, Finland, and Iceland since 1989, and now covers 1,000 products. The market share of eco-labeled laundry detergents in Sweden increased from zero in 1990 to 80 percent by 1997, but analysts see no major improvement in environmental quality as a result of the switch to eco-labeled detergents (Sterner 1999). The French "NF Environnement" label has been granted for paint products and garbage bags (OECD 1997b), and Spain's environmental label, administered by a private, non-profit organization, has been applied to ten classes of consumer products. The Czech Republic uses eco-labels on the basis of product life cycle analysis tests (paid for by applicants), and has issued 262 labels in 21 chiefly industrial product categories (OECD 1999a).

Canada awards an "environmental choice" label on licensed products including appliances, automotive products, cleansers, office products, paints, paper products, printing services, plastic products, film, and other items. The program, operated in the private sector through an exclusive license agreement, has granted labels to 1,400 products. Environmental labeling programs also exist in several Asian nations, including: Japan (initiated in 1989); Taiwan (1993); China (1994); Thailand (1994); and Indonesia (1997). Australian energy efficiency labels include technical information on energy consumption and a simple rating system (World Bank 1997b).

4.3.2 Reporting Requirements

A second type of government information program is a reporting requirement. The first such program was New Jersey's Community Right-to-Know Act, established in the United States in 1984. Two years later, a similar program was established at the national level. The U.S. Toxics Release Inventory (TRI), initiated under the Emergency Planning and Community Right-to-Know Act (EPCRA), requires firms to report to local emergency planning agencies information on use, storage, and release of hazardous chemicals. Such information reporting serves compliance and enforcement purposes, but may also increase public awareness of firms' actions, which may be linked with environmental risks.[51] This public scrutiny can encourage firms to alter their behavior, although the evidence is mixed (U.S. General Accounting Office 1992; Hamilton 1995; Singh 1995; Bui and Mayer 1997; Konar and Cohen 1997; Ananathanarayanan 1998; and Hamilton and Viscusi 1999). In 1989, the Commonwealth of Massachusetts instituted its Toxics Use Reduction Act, which is similar to EPCRA, but includes several additional business cagtegories (SIC codes).

The Safe Drinking Water Act and Toxic Enforcement Act were adopted in California as a ballot initiative ("Proposition 65") in 1986. The law covers consumer products and facility discharges, and requires firms to provide a "clear and reasonable warning" if they expose populations to certain chemicals. A year later, California enacted its Air Toxics Hot Spots Information and Assessment Act, which sets up an emissions reporting system to track emissions of over 700 toxic substances. The law requires the identification and assessment of localized risks of air contaminants and provides information to the public about the possible impact of those emissions on public health.

One other U.S. example of environmental reporting requirements is provided by the Drinking Water Consumer Confidence Reports required by EPA since 1999. Under this program, all suppliers of drinking water in the United States must provide households with information on the quality of their drinking water, including specified information regarding water sources and actual and potential contamination.

Indonesia introduced the Program for Pollution Control, Evaluation and Rating with the help of the World Bank (1997b) in 1995. Plants are assigned ratings based on environmental performance, and plants with the lowest ratings were notified privately and given six months to improve performance, after which information was released to the public. The administrative costs of the program have been kept at relatively low levels (Tietenberg and Wheeler 1998) — on the order of $1 per day per plant — for 187 plants over the first 18 months, and the process resulted in a 40 percent reduction in BOD emissions. The Philippines has instituted EcoWatch, a similar system of public disclosure of plant environmental performance, with rating results announced in the news media (World Bank 1997b). Mexico and Colombia are launching information programs based on Indonesia's system (Tietenberg and Wheeler 1998).

---

[51] A non-governmental advocacy group, Environmental Defense (formerly the Environmental Defense Fund), has established an Internet site that provides TRI information in an accessible form: http://www.scorecard.org/.

The Scandinavian countries have focused considerable attention on environmental information dissemination (OECD 1996, 1997a). The Swedish national environmental regulatory agency regularly produces and circulates information to educators, public authorities, environmental managers, business leaders, and the general public (OECD 1996), and the Danish Ministry of the Environment and Energy publishes annual environmental indicators (OECD 1999b). In addition, Belgium has developed regional pollution release and transfer registers that are available to the public, and Austria issues a comprehensive set of environmental data every three years (OECD 1995a, 1998c). But, other than the U.S. and Indonesian studies cited above, there have been no analyses of the effectiveness (or complete costs) of these various policy instruments.

5. REDUCING GOVERNMENT SUBSIDIES

A final category of market-based instruments is government subsidy reduction. Since subsidies are the mirror image of taxes, they can — in theory — provide incentives to address environmental problems. But, in practice, a variety of subsidies are believed to promote economically inefficient and environmentally unsound practices, despite the fact that governments frequently have implemented these subsidies in order to achieve specific goals, such as support of infant industries or income redistribution. Thus, in this section, I consider cases in which direct or indirect subsidies with adverse environmental impacts have been reduced or eliminated (or in which serious consideration has been given to doing so).

According to the World Bank (1997b), subsidies to energy, road transportation, water use, and agriculture in developing and transition economies totaled over $240 billion per year in the 1990s, representing a substantial reduction over the 1980s. A significant increase in energy prices toward efficient levels in transition economies is one important change underlying this trend. A second factor has been reduced protection of inefficient (and ecologically harmful) domestic industries, as a result of greater acceptance of free trade (Fischer and Toman 1998).

China has reduced energy subsidies drastically since the mid 1980s (World Bank 1997b). For example, subsidy rates for coal, which fueled more than 70 percent of China's energy production as of 1994, fell from 61 percent in 1984 to 11 percent in 1995. Through development of private coal mining and removal of price controls, nearly 80 percent of China's coal was sold at unsubsidized international prices by 1995. Many state-owned enterprises, however, face soft-budget constraints, and so higher energy prices have not necessarily led to efficiency improvements, since these firms are insulated from market forces by the central government (Fisher-Vanden 1999).

Bangladesh and Indonesia have reduced pesticide and fertilizer subsidies significantly. In the late 1970s, fertilizer subsidies accounted for fully four percent of the national budget of Bangladesh (World Bank 1997b); the government began reducing subsidies in 1978, and completely deregulated retail fertilizer prices in 1983. Direct subsidies for pesticides in Indonesia, which in the early 1980s were as high as 85 percent, were phased out in 1986-1989 (World Bank 1997b); domestic pesticide production was reduced by one-half between 1985 and 1990, and imports fell to one-third the level of the mid-1980s.

Ecuador has completely phased out subsidies on agricultural inputs (pesticide and fertilizer), fuel oil, and motor fuels, with the exception of diesel (Huber *et al*. 1998). Likewise, India, Mexico, South Africa, Saudi Arabia, Brazil, and Jamaica cut fuel subsidies significantly in the mid-1990s (Fischer and Toman 1998; Huber *et al*. 1998). In 1985, New Zealand's removal of agricultural subsidies apparently led to significant abandonment of marginal lands and consequent reductions in land degradation (New Zealand Ministry for the Environment 1997).

Despite these trends, significant subsidies (of environmental consequence) are common in many parts of the world, particularly on energy production and use. For example, many EU countries, including Germany, the United Kingdom, Spain, and France, continue to subsidize coal production (Ekins and Speck 1999). But assessing the magnitude, let alone the effects, of these subsidies is difficult, a point that is illustrated by the case of the United States. Because of concerns about global climate change, increased attention has been given to Federal subsidies and other programs that promote the use of fossil fuels. An EPA study indicates that eliminating these subsidies would have a significant effect on reducing carbon dioxide (CO_2) emissions (Shelby *et al*. 1997). The Federal government is involved in the energy sector through the tax system and through a range of individual agency programs. One study indicates that these activities together cost the government $17 billion annually (Alliance to Save Energy 1993).

A substantial share of these U.S. subsidies and programs were enacted during the "oil crises" to encourage the development of domestic energy sources and reduce reliance on imported petroleum. They favor energy supply over energy efficiency.[52] Although there is an economic argument for government policies that encourage new technologies that have particularly high risk or long term payoffs, mature and conventional technologies currently receive nearly 90 percent of the subsidies. Furthermore, within fossil fuels, the most environmentally benign fuel — natural gas — receives only about 20 percent of the subsidies. On the other hand, it should also be recognized that Federal user charges (Table 3) and insurance premium taxes (Table 4) include significant levies on fossil fuels, and that Federal tax differentiation has tended to favor renewable energy sources and non-conventional fossil fuels (Table 7).

6. LESSONS THAT EMERGE FROM EXPERIENCE

In this chapter, I have defined "market-based instruments" broadly and thereby cast a large net for this review of applications of this relatively new set of policy approaches. As a consequence, the review is extensive, but this should not leave the reader with the impression that market-based instruments have replaced, or have come anywhere close to replacing, the conventional, command-and-control approach to environmental protection. Further, even when and where these approaches have been used in their purest form and with some success, such as in the case of tradeable-permit systems in the United States, they have not always performed as anticipated. In this part of the chapter, therefore, I ask what lessons can be learned from our experiences. In particular, I consider normative lessons for: design and

[52]The Alliance to Save Energy study (1993) claims that end-use efficiency receives $1 from a wide variety of implicit and explicit Federal subsidies for every $35 received by energy supply.

implementation of market-based instruments; analysis of prospective and adopted systems; and identification of new applications.[53]

6.1 Lessons for Design and Implementation

The performance to date of market-based instruments for environmental protection provides valuable evidence for environmentalists and others that market-based instruments can achieve major cost savings while accomplishing their environmental objectives. The performance of these systems also offers lessons about the importance of flexibility, simplicity, the role of monitoring and enforcement, and the capabilities of the private sector to make markets of this sort work. Most of the references in this section are to U.S. programs, simply because those programs have been the subject of more analyses, particularly economic analyses, than have programs in other countries. Similar lessons have been reported for other parts of the world, however (Bluffstone and Larson 1997; World Bank 1997b; OECD 1997e, 1999c)

In regard to flexibility, it is important that market-based instruments should be designed to allow for a broad set of compliance alternatives, in terms of both timing and technological options. For example, allowing flexible timing and intertemporal trading of permits — that is, banking allowances for future use — played an important role in the SO_2 allowance trading program's performance (Ellerman *et al.* 1997), much as it did in the U.S. lead rights trading program a decade earlier (Kerr and Maré 1997). One of the most significant benefits of using market-based instruments is simply that technology standards are thereby avoided.[54] Less flexible systems would not have led to the technological change that may have been induced by market-based instruments (Burtraw 1996; Ellerman and Montero 1998; Bohi and Burtraw 1997), nor the induced process innovations that have resulted (Doucet and Strauss 1994).

In regard to simplicity, transparent formulae — whether for permit allocation or tax computation — are difficult to contest or manipulate. Rules should be clearly defined up front, without ambiguity. For example, prior government approval of individual trades may increase uncertainty and transaction costs, thereby discouraging trading; these negative effects should be balanced against any anticipated benefits due to prior government approval. Such requirements hampered EPA's Emissions Trading Program in the 1970s, while the lack of such requirements was an important factor in the success of lead trading (Hahn and Hester 1989a). In the case of SO_2 trading, the absence of requirements for prior approval has reduced uncertainty for utilities and administrative costs for government, and contributed to low transactions costs (Rico 1995).

[53]The lessons reviewed here are normative lessons. There is another set which could be characterized as positive (political economy) lessons — Why has the command-and-control approach dominated environmental policy? Why has there been a relatively recent upsurge in attention given by policy makers to market-based instruments? I have addressed these and related questions elsewhere (Hahn and Stavins 1991; Keohane, Revesz, and Stavins 1998; Stavins 1998), but I do not consider such questions in this chapter, because they fall within the scope of Chapter 23 of this volume.

[54]This is also true, of course, of other performance-based approaches.

Experience also argues for using absolute baselines, not relative ones, as the point of departure for credit programs. The problem is that without a specified baseline, reductions must be credited relative to an unobservable hypothetical — what the source would have emitted in the absence of the regulation. A hybrid system — where a cap-and-trade program is combined with voluntary "opt-in provisions" — creates the possibility for "paper trades," where a regulated source is credited for an emissions reduction (by an unregulated source) that would have taken place in any event (Montero 1999). The result is a decrease in aggregate costs among regulated sources, but this is partly due to an unintentional increase in the total emissions cap. As was experienced with EPA's Emissions Trading Program, relative baselines create significant transaction costs by essentially requiring prior approval of trades as the authority investigates the claimed counterfactual from which reductions are calculated and credits generated (Nichols, Farr, and Hester 1996).

Experiences with market-based instruments also provide a powerful reminder of the importance of monitoring and enforcement. These instruments, whether price or quantity based, do not eliminate the need for such activities, although they may change their character. In the many programs reviewed in this chapter where monitoring and/or enforcement have been deficient, the results have been ineffective policies. One counter-example is provided by the U.S. SO_2 allowance trading program, which includes (costly) continuous emissions monitoring of all sources (Burtraw and Swift 1996). On the enforcement side, the Act's stiff penalties (much greater than the marginal cost of abatement) have provided sufficient incentives for the very high degree of compliance that has been achieved (Stavins 1998).

In nearly every case of implemented cap-and-trade programs, permits have been allocated freely to participants. The same characteristic that makes such allocation attractive in positive political economy terms — the conveyance of scarcity rents to the private sector — makes free allocation problematic in normative, efficiency terms (Fullerton and Metcalf 1997). It has been estimated that the costs of SO_2 allowance trading would be 25 percent less if permits were auctioned rather than freely allocated, because auctioning yields revenues that can be used to finance reductions in pre-existing distortionary taxes (Goulder, Parry, and Burtraw 1997).[55] Furthermore, in the presence of some forms of transaction costs, the post-trading equilibrium — and hence aggregate abatement costs — are sensitive to the initial permit allocation (Stavins 1995). For both reasons, a successful attempt to establish a politically viable program through a specific initial permit allocation can result in a program that is significantly more costly than anticipated.

Improvements in instrument design will not solve all problems. One potentially important cause of the mixed performance of implemented market-based instruments is that many firms are simply not well equipped internally to make the decisions necessary to fully utilize these instruments. Since market-based instruments have been used on a limited basis only, and firms are not certain that these instruments will be

[55] Although the positive political economy of instrument choice is outside the scope of this chapter, it should be recognized that the European experience with environmental taxes clearly illustrates that if tax revenues (or tradeable-permit auction revenues) are used to reduce distortionary taxes, those same revenues cannot generally be used to encourage acceptance of the program. The choice in Europe has been to dedicate environmental tax revenues to the environmental resources degraded by the taxed activity.

a lasting component on the regulatory landscape, most companies have chosen not to reorganize their internal structure to fully exploit the cost savings these instruments offer. Rather, most firms continue to have organizations that are experienced in minimizing the costs of complying with command-and-control regulations, not in making the strategic decisions allowed by market-based instruments.[56]

The focus of environmental, health, and safety departments in private firms has been primarily on problem avoidance and risk management, rather than on the creation of opportunities made possible by market-based instruments. This focus has developed because of the strict rules companies have faced under command-and-control regulation, in response to which companies have built skills and developed processes that comply with regulations, but do not help them benefit competitively from environmental decisions (Reinhardt 2000). Absent significant changes in structure and personnel, the full potential of market-based instruments will not be realized.

6.2 Lessons for Analysis

When assessing market-based environmental programs, economists need to employ some measure by which the gains of moving from conventional standards to an economic-incentive scheme can be estimated. When comparing policies with the same anticipated environmental outcomes, aggregate cost savings may be the best yardstick for measuring success of individual instruments. The challenge for analysts is to make fair comparisons among policy instruments: either idealized versions of both market-based systems and likely alternatives; or realistic versions of both (Hahn and Stavins 1992).

It is not enough to analyze static cost savings. For example, the savings due to banking allowances should also be modeled (unless this is not permitted in practice). It can likewise be important to allow for the effects of alternative instruments on technology innovation and diffusion (Milliman and Prince 1989; Jaffe and Stavins 1995; Doucet and Strauss 1994), especially when programs impose significant costs over long time horizons (Newell, Jaffe, and Stavins 1999). More generally, it is important to consider the effects of the pre-existing regulatory environment. For example, the level of pre-existing factor taxes can affect the total costs of regulation (Goulder, Parry, and Burtraw 1997), as indicated above.

6.3 Lessons for Identifying New Applications

Market-based policy instruments are now considered for nearly every environmental problem that is raised, ranging from endangered species preservation[57] to what may be the greatest of environmental

[56] There are some exceptions. Enron, for example, has attempted to use market-based instruments for its strategic benefit by becoming a leader in creating new markets for trading acid rain permits. Other firms have appointed environmental, health, and safety leaders who are familiar with a wide range of policy instruments, not solely command-and-control approaches, and who bring a strategic focus to their company's pollution-control efforts (Hockenstein, Stavins, and Whitehead 1997).

[57] See, for example: Goldstein 1991; and Bean 1997.

problems, the greenhouse effect and global climate change.[58] Experiences with market-based instruments offer some guidance to the conditions under such approaches are likely to work well, and when they may face greater difficulties.

First, where the cost of abating pollution differs widely among sources, a market-based system is likely to have greater gains, relative to conventional, command-and-control regulations (Newell and Stavins 1999). For example, it was clear early on that SO_2 abatement cost heterogeneity was great, because of differences in ages of plants and their proximity to sources of low-sulfur coal. But where abatement costs are more uniform across sources, the political costs of enacting an allowance trading approach are less likely to be justifiable.

Second, the greater is the degree of mixing of pollutants in the receiving airshed or watershed, the more attractive will a market-based system be, relative to a conventional uniform standard. This is because taxes or tradeable permits, for example, can lead to localized "hot spots" with relatively high levels of ambient pollution. Most applications of market-based instruments have not addressed the hot-spot or hot-time issues, differences in damages associated with emissions from different geographical points or at different times. This is a significant distributional issue, and it can also become an efficiency issue if damages are non-linearly related to pollutant concentrations. These issues can, in principle, be addressed by appropriate differentiation in taxes or permit prices.[59]

Third, the efficiency of price-based (tax) systems compared with quantity-based (tradeable permit) systems depends on the pattern of costs and benefits. If uncertainty about marginal abatement costs is significant, and if marginal abatement costs are quite flat and marginal benefits of abatement fall relatively quickly, then a quantity instrument will be more efficient than a price instrument (Weitzman 1974). Furthermore, when there is also uncertainty about marginal benefits, and marginal benefits are positively correlated with marginal costs (which, it turns out, is not uncommon), then there is an additional argument in favor of the relative efficiency of quantity instruments (Stavins 1996). On the other hand, the regulation of stock pollutants will often favor price instruments when the optimal stock level rises over time (Newell and Pizer 2000). It should also be recognized that despite the theoretical efficiency advantages of hybrid systems — non-linear taxes, or quotas combined with taxes — in the presence of uncertainty (Roberts and Spence 1976; Kaplow and Shavell 1997),[60] virtually no such hybrid systems have been adopted.

Fourth, the long-term cost-effectiveness of tax systems versus tradeable permit systems is affected by their relative responsiveness to change. This arises in at least three dimensions. In the presence of rapid

[58]See, for example: Fisher *et al*. 1996; Hahn and Stavins 1995; Schmalensee 1996; and Stavins 1997. More broadly, see: Ayres 2000.

[59]Neither problem arose, however, in the case of the U.S. SO_2 allowance trading program, because dirtier plants had lower marginal abatement costs, and hence made the largest emissions reductions.

[60]In addition to the efficiency advantages of non-linear taxes, they also have the attribute of reducing the total (although not the marginal) tax burden of the regulated sector, relative to an ordinary linear tax, which is potentially important in a political economy context.

rates of economic growth (important in the case of some developing countries), a fixed tax leads to an increase in aggregate emissions, whereas with a fixed supply of permits there is no change in aggregate emissions (but an increase in permit prices). In the context of general price inflation, a unit (but not an *ad valorem*) tax decreases in real terms, and so emissions levels increase; whereas with a permit system, there is no change in aggregate emissions. In the presence of exogenous technological change in pollution abatement, a tax system leads to an increase in control levels, i.e. a decrease in aggregate emissions, while a permit system maintains emissions, with a fall in permit prices (Stavins and Whitehead 1992).

Fifth, tradeable permits will work best when transaction costs are low, and experience demonstrates that if properly designed, private markets will tend to render transaction costs minimal. Sixth, a potential advantage of freely-allocated tradeable permit systems over other policy instruments is associated with the incentive they provide for pollution sources to identify themselves and report their emissions (in order to claim their permits). This was illustrated by Chile's experience with its TSP system , and could be a significant factor in countries where monitoring costs are relatively high and/or self-reporting requirements are ineffective.

Seventh and finally, considerations of political feasibility point to the wisdom (more likely success) of proposing market-based instruments when they can be used to facilitate a cost-effective, aggregate emissions reduction (as in the case of the U.S. SO_2 allowance trading program in 1990), as opposed to a cost-effective reallocation of the status quo burden (as in the case of the earlier U.S. EPA Emissions Trading Program). Policy instruments that appear impeccable from the vantage point of research institutions, but consistently prove infeasible in real-world political institutions, can hardly be considered "optimal."

6.4 Conclusion

Given that most experience with market-based instruments has been generated very recently, one should be cautious when drawing conclusions about lessons to be learned. A number of important questions remain. For example, little is known empirically about the impact of these instruments on technological change. Also, much more empirical research is needed on how the pre-existing regulatory environment affects performance, including costs. Moreover, the successes with tradeable permits have involved air pollution: acid rain, leaded gasoline, and chloroflourocarbons. Experience (and success) with water pollution is much more limited (Hahn 1989), and in other areas, there has been no experience at all. Even for air pollution problems, the tremendous differences between SO_2 and acid rain, on the one hand, and the combustion of fossil fuels and global climate change, on the other, indicate that any rush to judgement regarding global climate policy instruments is unwarranted.

Despite these and other uncertainties, market-based instruments for environmental protection now enjoy proven successes in reducing pollution at low cost. Such cost effectiveness is the primary focus of economists when evaluating these public policies, but the political system gives greater weight to distributional concerns. Indeed, individual constituencies, each fighting for its own version of distributional equity, frequently negate efficiency and cost effectiveness.

There are sound reasons why the political world has been slow to embrace the use of market-based instruments for environmental protection, including the ways economists have packaged and promoted their ideas in the past: failing to separate means (cost-effective instruments) from ends (efficiency); and treating environmental problems as little more than "externalities calling for corrective taxes." Much of the resistance has also been due, of course, to the very nature of the political process and the incentives it provides to both politicians and interest groups to favor command-and-control methods instead of market-based approaches.[61]

But, despite this history, market-based instruments have moved center stage, and policy debates look very different from the time when these ideas were characterized as "licenses to pollute" or dismissed as completely impractical. Of course, no single policy instrument — whether market-based or conventional — will be appropriate for all environmental problems. Which instrument is best in any given situation depends upon characteristics of the specific environmental problem, and the social, political, and economic context in which the instrument is to be implemented.

[61]See Keohane, Revesz, and Stavins 1998; and Chapter 23 in this volume.

TABLE 1:
EFFLUENT FEES

Regulated Substance	Country	Rate	Use of Revenues
CO	Czech Republic[1]	\$22/ton permitted; \$33/ton above	State Environmental Fund
	Estonia[2]	\$0.27/ton permitted; \$1.36/ton above	Estonian Environmental Funds national (50%); county (50%)
	Lithuania[3]	\$1.75/ton	Municipal environmental funds (70%); General budget (30%)
	Poland[4]	\$22/ton	National, regional and municipal environmental funds
	Russia[5]	\$0.02/ton permitted; \$0.09/ton above	National and regional environmental funds
	Slovakia[6]	\$20/ton	Slovak Environmental Fund
CO_2	Denmark	\$42/m^3, diesel, kerosene, gas oil \$38/ton, coal \$17/ton, LPG \$0.03/m^3, natural gas \$0.02/kWh, electricity	General budget
	Finland	\$38/m^3, leaded and unleaded gasoline \$43/m^3, diesel and kerosene \$39/ton, coal \$0.02/m^3, natural gas \$0.003 - \$0.006/kWh, electricity	General budget
	Netherlands	\$45/m^3, gas oil and kerosene \$54/m^3, LPG \$0.05/m^3, natural gas \$0.02/kWh, electricity	Corporate and income tax relief
	Norway	\$59/m^3, mineral oil \$59/ton, coal \$0.11/m^3 natural gas (only applied to offshore oil and gas activities)	General budget
	Sweden	\$106/m^3 leaded and unleaded gasoline \$131/m^3 diesel, kerosene, gas oil \$127/ton LPG \$135/m^3 heavy fuel oil \$114/ton coal \$0.03/m^3 natural gas \$0.02/kWh electricity	General budget

Regulated Substance	Country	Rate	Use of Revenues
SO_2	Bulgaria[7]	$0.02/kg	National environmental fund (70%) and polluter's municipality (30%)
	Czech Republic[1]	$30/ton permitted; $45/ton above	State Environmental Fund
	Denmark	All fuels, electricity taxed in proportion to resulting SO_2 emissions, $1.60/kg of SO_2	General budget
	Estonia[2]	$2/ton permitted; $95/ton above	Estonian Environmental Funds national (50%); county (50%)
	Finland	$30/m^3 of diesel or gas oil	General budget
	France[8]	$32/ton of direct emissions	Pollution reduction (75%); research (25%)
	Hungary[9]	$2.40/ton	Central Environmental Protection Fund (70%); local government budgets (30%)
	Italy	$62/ton of direct emissions	Reduction of environmental impacts
	Japan	n.a.	Compensation of individuals with chronic breathing problems attributable to pollution
	Lithuania[3]	$46/ton	Municipal environmental funds (70%); general budget (30%)
	Norway[10]	Fuels taxed in proportion to resulting SO_2 emissions, $0.01 per liter of fuel per 0.25% sulfur content	General budget
	Poland[4]	$83/ton	National, regional and municipal environmental funds
	Russia[5]	$1.22/ton permitted; $6.10/ton above	National and regional environmental funds
	Slovakia[6]	$33/ton	Slovak Environmental Fund
	Spain - Galicia	Industrial energy products taxed on sum of SO_2 and NO_x emissions; rate is $35/ton , emissions between 1,001 and 50,000 tons; $39/ton above 50,000 tons.	Regional budget
	Sweden	Liquid fuels $3.33/^{m3} for each 0.1% by weight of sulfur content; coal and other solid or gaseous fuels $3.70/^{m3}.	General budget

Regulated Substance	Country	Rate	Use of Revenues
NO_x	Bulgaria[7]	$0.05/kg	National environmental fund (70%) and polluter's municipality (30%)
	Czech Republic[1]	$30/ton permitted; $45/ton above	State Environmental Fund
	Estonia[2]	$4/ton permitted; $216/ton above	Estonian Environmental Funds national (50%); county (50%)
	France	$27/ton, based on direct measurement of emissions	Pollution reduction (75%); research (25%)
	Hungary[9]	$4/ton	Central Environmental Protection Fund (70%); local government budgets (30%)
	Italy	$123/ton of direct emissions	Reduction of environmental impacts
	Lithuania[3]	$67/ton	Municipal environmental funds (70%); General budget (30%)
	Poland[4]	$83/ton	National, regional and municipal environmental funds
	Russia[5]	$1.02/ton permitted; $5.08/ton above	National and regional environmental funds
	Slovakia[6]	$27/ton	Slovak Environmental Fund
	Sweden	Combustion and incineration plants pay $5/kg of NO_x	Redistributed to payees (plants) in proportion to energy produced
Combined industrial air emissions	Latvia[11]	$1.65 to $440/ton, depending on emissions hazard class	National, regional and local general budgets
	China	Varies with pollutants, including SO_2, H_2S, NO_x, HCl, CO, H_2SO_4, Pb, Hg, dust.	Grants, low-interest pollution control loans (80%); local monitoring and administration (20%)
BOD load	Bulgaria	$0.11/kg	National environmental fund (70%); polluter's municipality (30%)
	Colombia	Río Negro basin only, rate n.a.	Wastewater treatment plants (50%); industrial clean technology equipment (30%); research, administration (20%)
	Estonia[2]	BOD_5 $77/ton permitted; $386/ton above	Estonian Environmental Funds national (50%); county (50%)

Regulated Substance	Country	Rate	Use of Revenues
	Lithuania[3]	BOD_7 $75/ton	Municipal environmental funds (70%); General budget (30%)
	Malaysia	BOD from palm oil industry; current rates n.a.	n.a.
	Philippines	BOD in Laguna de Bay watershed, rates n.a.	Water quality management, monitoring & enforcement (80%); local government budgets (20%)
	Poland[4]	BOD_5 $172 to $1,722/ton, depending on source	National, regional and municipal environmental funds
	South Korea[12]	n.a.	n.a.
TSS	Bulgaria[7]	$0.04/kg	National environmental fund (70%); polluter's municipality (30%)
	Colombia	Río Negro basin only, rate n.a.	Wastewater treatment plants (50%); industrial clean technology equipment (30%); research, administration (20%)
	Estonia[2]	$39/ton permitted; $386/ton above	Estonian Environmental Funds national (50%); county (50%)
	Lithuania[3]	$15/ton	Municipal environmental funds (70%); General budget (30%)
	Poland[4]	$74/ton	National, regional and municipal environmental funds
	South Korea[12]	n.a.	n.a.
Combined industrial water emissions	China	Varies with pollutants.	Grants, low-interest pollution control loans (80%); local monitoring and administration (20%)
	France[13]	Varies by river basin	Water pollution control
	Germany[14]	$42 per "pollution unit"	Water quality management
	Latvia[11]	$1.65 to $27,600/ton, depending on effluent hazard class	National, regional and local general budgets
	Netherlands	Varies by flow and load	Water quality policy
	Slovakia[6]	Varies by effluent load and quantity (not quality) of receiving waters	Slovak Environmental Fund
Nitrogen and Phosphorous	Denmark	N $3.10/kg; P $17.30/kg discharged to surface waters	General budget

Regulated Substance	Country	Rate	Use of Revenues
	Estonia[2]	N \$65/ton permitted; \$320/ton above P \$115/ton permitted; \$580/ton above discharged to surface water, ground water or soil	Estonian Environmental Funds national (50%); county (50%)
	Lithuania[3]	N \$75/ton; P \$260/ton	Municipal environmental funds (70%); General budget (30%)
Landfill, incinerator or hazardous waste	Denmark[15]	\$53/ton, landfill waste \$41/ton, incinerator waste \$393/ton, hazardous waste	General budget
	Estonia[2]	\$0.06 to \$54/ton permitted; \$0.32 to \$27,000/ton above for waste dumping or burying, depending on hazard class	Estonian Environmental Funds national (50%); county (50%)
	Finland	\$18/ton, landfill waste	n.a.
	Latvia[11]	\$0.14/m^3, non-toxic waste disposal \$0.83/m^3, toxic waste disposal \$28/m^3, highly toxic waste disposal	National, regional and local general budgets
	Netherlands	\$16/ton, landfill waste \$34/ton, combustible waste disposed of in landfill	General budget
	Poland[4]	\$1.60 to \$21.50/ton waste disposal, depending on hazard class	National, regional and municipal environmental funds
	United Kingdom	landfill tax, \$17/ton on "active" waste; \$3/ton on inert waste	General budget

Note: CO is carbon monoxide, SO_2 is sulfur dioxide, and NO_x is nitrogen oxide; BOD is an acronym for biological oxygen demand and TSS is an acronym for total suspended solids. BOD load is the total amount of oxygen that a given amount of effluent will use in biochemical oxidation, during a period of three days at a temperature of 30EC (86EF). Conversion of all currencies to \$US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

1. Charges from medium and large industrial enterprises in the Czech Republic go to the State Environmental Fund, while charges from small enterprises become part of municipal government budgets. The Czech Republic has established effluent fees for 90 air and 5 water pollutants, though only a few are listed here.
2. In Estonia, exceeding a permit is not illegal, so long as an enterprise is able to pay the additional effluent fee. Estonia has established effluent fees for 139 air and 8 water pollutants, though only a few are listed here.
3. Lithuania assesses fines on all air and water pollutants, but rates are available only for those listed here.
4. Poland's effluent charges are divided among national, regional and municipal environmental funds in specified percentages that vary by substance. For example, NO_x charges are divided between the national (90%) and municipal (10%) funds, while most other air emissions are divided among the national (36%), regional (54%) and municipal (10%) funds. Poland assesses fees on 62 air and 6 water pollutants, though only a few are listed here.
5. Russia assesses fees on more than 100 air and more than 100 water pollutants, though only a few are listed here.
6. Slovakia assesses fees on 123 air and five water pollutants, though only a few are listed here.
7. Bulgaria assesses fees on 16 air and 27 water pollutants, though only a few are listed here.

8. France taxes sulfur hydrogen and hydrochloric acid emissions at the same rate as sulfur dioxide.
9. Hungary's air emissions fines vary according to height of emissions and the factor by which permitted levels are exceeded. The charges listed here are "base fines," or those assessed when actual emissions exceed permitted levels by a factor of 1.00-2.00. Hungary has established fines for 150 air and 32 water pollutants, though only a few are listed here.
10. Gasoline and fuels with sulfur content less than 0.05% (includes most auto diesel used in Norway) are excluded from Norway's SO_2 tax.
11. Latvia assesses fees on seven air and ten water pollutants, though only a few are listed here.
12. South Korea's effluent fees are assessed on emissions exceeding 30 percent of maximum allowable limit; penalty fees, assessed on emissions above the allowable maximum, equal the expense of treating actual volume of emitted pollutants. South Korea assesses fees on 10 air pollutants and 15 water pollutants, though only two are listed here.
13. In 1993, rates ranged from $16/kg of suspended solids in the Loire-Bretagne river basin to $446/kg of soluble salts in the Seine-Normandie basin. See Cadiou and Duc (1994).
14. In Germany, water pollution units are determined by flow and load; the per unit charge can be reduced by pollution control equipment investment.
15. Average rate; Danish waste disposal charge depends on type of waste.

SOURCES: Speck (1998); Gornaja, Kraav, Larson and Türk (1997); Brunenieks, Kozlovska and Larson (1997); Sem•nien•, Bluffstone and „ekanavi…ius (1997); Yang et al. (1998); Kozeltsev and Markandya (1997); Stepanek (1997); Morris, Tiderenczl and Kovács (1997); Anderson and Fiedor (1997); Owen, Myjavec, and Jassikova (1997); Matev and Nivov (1997); Wuppertal Institute (1996); Organization for Economic Cooperation and Development (1997c); World Bank (1997a, 1997b); Panayotou (1998); and World Bank (1999).

TABLE 2:
DEPOSIT-REFUND SYSTEMS

Regulated Products	Country	Jurisdiction/ Size of Deposit or Description
Specified Beverage Containers	Australia	South Australia / 3¢ (aluminum cans) to 13¢ (glass bottles)
	Austria	National / 40¢ (reusable plastic bottles)
	Barbados	Local / glass containers
	Belgium	National / beer, soft drink containers
	Bolivia	Local / glass and plastic containers
	Brazil	Regional / glass and aluminum containers
	Canada	Newfoundland / 4¢ deposit, 2¢ return; Nova Scotia / 7¢ deposit, full return on refillables, 4¢ return on non-refillables; Quebec / 4¢; British Columbia, Alberta, Yukon / deposit n.a. (specified containers)
	Chile	Local / glass and plastic containers
	Colombia	Local / glass containers
	Czech Republic	National / 9 to 15¢ (glass bottles); 15 to 30¢ (PET bottles)
	Denmark	National / 18¢ to 70¢ (glass bottles)
	Ecuador	Local / glass containers
	Finland	National / 9¢ (small bottle); 46¢ (liter bottle); 18¢ (can)
	Iceland	National / various containers
	Jamaica	Local / glass containers
	Japan[1]	National / $2.40 per case (glass bottles)
	Mexico	Local / glass containers
	Netherlands	National / up to 28¢ (glass bottles); 50¢ (PET bottles)
	Norway	National / glass and PET bottles, up to 28¢
	Sri Lanka	National/7¢ (glass bottle)
	Sweden	National / 33¢ (glass bottles); 8¢ (cans); 60¢ (PET bottles)
	Switzerland	National / various containers; operated by private sector
	Taiwan[2]	National / 8¢ (PET bottles)
	United States[3]	Connecticut, Delaware, Iowa, Maine, Massachusetts, New York/ 5¢; Vermont 5¢ & 15¢; Oregon, 3¢ & 5¢; Michigan 5¢ & 10¢; California, 2.5¢ & 5¢

Regulated Products	Country	Jurisdiction/ Size of Deposit or Description
	Venezuela	Local / glass containers
Auto Batteries	United States	Arizona, Connecticut, Idaho, Minnesota, New York, Rhode Island, Washington, Wisconsin / $5.00; Michigan / $6.00; Arkansas, Maine / $10.00
	Mexico	Old battery must be returned to purchase new battery
Scrap Autos	Sweden	National/ $160 deposit paid on new car purchase; $185 returned when consumer renders old car being replaced
Small Chemical Containers	Denmark	National
Tires	South Korea	National/5¢ to 50¢, depending on size
Plastic Shopping Bags	Italy	National / 5¢ per bag
Packaging Waste	France	National / Eco-emballages; operated by private sector
	Germany	National / Duales System; operated by private sector
Flourescent Light Bulbs	Austria	National / $1.20 per bulb
Refrigerators	Austria	National / $10 to $100

1. Japan's deposit fee for glass bottles includes approximately 60¢ for the bottles, and 80¢ for the case or container.
2. Taiwan's deposit-refund system for PET bottles pays 8¢ to consumers bringing bottles to collection locations, and 2¢ for collectors bringing bottles to recycling centers.
3. Oregon's rate for refillables is 3¢. California's deposit for containers smaller than 24 oz. is 2.5¢, and 5¢ for containers 24 oz. and larger.

NOTE: Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

SOURCES: U.S. Environmental Protection Agency (1992); Organization for Economic Cooperation and Development (1993a, 1993c, 1995a, 1995b, 1997a, 1998b, 1998e, 1999a, 1999b); Huber *et al*. (1997); Smitheman and Cooper (1997); Steele (1999); and Rhee (1994).

TABLE 3:
USER CHARGES

Country	Item Taxed	Rate	Use of Revenues
Austria	Motor fuels	Varies by fuel type	Public transport investments
	Annual vehicle use	(kW-24)*$.47/month, plus 20% for cars without catalytic converter	Partially earmarked for public transport subsidies
	Natural gas Electricity	$\$.05/m^3$ $.009/kWh	Partially earmarked for energy-saving measures and public transport
	Landfill waste disposal	$5 to $9/ton	Contaminated site cleanup
Belgium	Landfill and incinerator waste Hazardous waste	$4 to $26/ton $11 to $87/ton	National environmental expenditure
	Batteries[1] Disposable beverage containers[1] Disposable razors Disposable cameras[1] Packaging of solvents[1] Packaging of glue[1] Packaging of inks[1] Packaging of pesticides[1]	$.58/battery $.44/container $.29/razor $8.73/camera $.15/5 liters $.73/10 liters $.73/2.5 liters $.73/5 liters	Regional environmental expenditure
	Surplus manure	Based on kg of phosphate and nitrogen	Funds manure transport and disposal
Denmark	Batteries	NiCd $.94 to $5.66 Lead $1.89 to $3.77	Funds collection and recycling of old batteries
	Tires	$1.26/tire (new or used) $.63/tire made of recycled material	Funds tire collection and recycling
Finland	Tires	$2.50 to $50/tire	Funds tire recovery and recycling[2]
	Lubricant oils and greases	$.05/kg	Funds treatment of oil wastes
	Hazardous waste	$336/ton	Funds waste processing
	Nuclear power generation	$2.40 to $3.20/MWh	Funds waste processing

Country	Item Taxed	Rate	Use of Revenues
France	Lubricant oils, oil products	\$27/ton	Funds collection, recycling of used oil and oil products
	Conventional waste Industrial & hazardous waste	\$7.20/ton, landfill disposal \$7.20/ton, treated; \$14.40/ton, stored	Funds research, treatment and equipment for contaminated site cleanup
	Automobile use of bridges to islands	\$3.58/vehicle[3]	Funds protection of island environments
	Use of inland waterways	Varies	Finances inland waterways authority
Italy	Lubricant oils	\$.03/kg	Funds collection, reuse and dumping costs
Kenya	Gasoline Diesel	\$34/m^3 \$17/m^3	Finances road maintenance
Netherlands	Surplus manure	\$.13 to \$.26/kg[4]	Funds manure transport, storage and processing
South Korea	Toxic substance containers Cosmetics containers Batteries Anti-freeze containers Flourescent light bulbs Chewing gum Disposable diapers	1¢/container over 500 ml 0.2¢ to 0.7¢/container 0.2¢/battery (all types) 2¢/container 0.6¢/bulb 0.25% of sale price 0.1¢/diaper	Funds waste disposal
	Commercial operations and tourism within national parks	n.a.	Finances Korea National Park Authority (40%)
Spain	Pollutant spills into coastal waters	Varies with content and quantity of spill	Funds spill cleanup and sea quality improvement.
Sweden	Fertilizers	\$0.22/kg N for N > 2%; \$3.70/g Cd for Cd > 5 g/ton of phosphorous	Finances environmental improvements in agriculture
	Tires	\$1.50, automobiles; \$37, trucks; \$9.30 tractors	Finances recovery and recycling of used tires[5]
	Batteries	Lead, \$4.90; NiCd, \$5.70 Alkaline and HgO, \$2.80	Covers used battery collection and disposal costs
Switzerland	Motorway use (cars & trucks) Leaded gasoline Unleaded gasoline Diesel fuel	Varies by weight, distance \$588/m^3 \$529/m^3 \$552/m^3	Finances road construction and other road-related expenditures

Country	Item Taxed	Rate	Use of Revenues
United States	Motor fuels Annual use of heavy vehicles Trucks & trailers (excise tax) Auto and truck tires	$.183/gal $100-$500/vehicle 12% $0.15/lb (> 40 lbs) $4.50 + $0.30/lb (> 70 lbs) $10.50 + $0.50/lb (> 90 lbs)	Highway Trust Fund/ Mass Transit Account
	Noncommercial motorboat fuels	$.183/gal	Aquatic Resource Trust Fund
	Inland waterways fuels	$.233/gal	Inland Waterways Trust Fund
	Non-highway recreational fuels and small-engine motor fuels	$.183/gal gasoline $.243/gal diesel	National Recreational Trails Trust Fund and Wetlands Account of Aquatic Resources Trust Fund
	Sport fishing equipment	10% (outboard motors, 3%)	Sport Fishing Restoration Account of Aquatic Resources Trust Fund
	Bows and arrows Firearms and ammunition	11% 10%	Federal Aid to Wildlife Program

1. Belgium exempts these products from the tax when organized deposit-refund or collection system exists and minimum recycling or collection targets are achieved.
2. Finland's tire recycling is managed by a private company. Rates are lower for tires made of recycled materials.
3. Maximum rate.
4. The Netherlands' manure charge is based on amount of manure produced per hectare: $.13/kg for amounts between 125 and 200 kg/ha; double that amount for amounts greater than 200 kg/ha.
5. In Sweden, manufacturers, importers and sellers of tires are required to ensure that used tires are reused, recycled, or disposed of in an environmentally friendly manner.

NOTE: Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

SOURCE: Barthold (1994); Speck (1998); Organization for Economic Cooperation and Development (1997a); Ayoo and Jama (1999); and Rhee (1994).

TABLE 4:
INSURANCE PREMIUM TAXES

Country	Item/Action Taxed	First Enacted/Modified	Rate	Use of Revenues
Belgium	Ionizing radiation	1994	n.a.	Fund for Risks of Nuclear Accidents
Finland	Oil imports	1970s	$0.43/ton[1]	Oil Pollution Compensation Fund
United States	Chemical production	1980/1986	$.22 to $4.88/ton	Superfund (CERCLA)
	Petroleum production	1980/1986	$.097/barrel crude	
	Corporate income	1986	0.12%[2]	
	Petroleum and petroleum products	1989/1990	$.05/barrel	Oil Spill Liability Trust Fund
	Petroleum-based fuels, except propane	1986/1990 (expired 1995)	$.001/gal	Leaking Underground Storage Trust Fund
	Coal production	1977/1987	$1.10/ton underground $.55/ton surface	Black Lung Disability Trust Fund
	Surface coal mining and reclamation	1977	Varies with specific case	Repayment of performance bonds

1. Rate is twice as high for tankers without double hulls.
2. Rate is 0.12% of "alternative minimum taxable income" that exceeds $2 million.

NOTE: Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

SOURCES: Barthold(1994); Speck (1998); and Organization for Economic Cooperation and Development (1997a).

TABLE 5:
SALES AND VALUE-ADDED TAXES

Item/Action Taxed	Country	Rates	Use of Revenues
Motor fuel, other energy products (excise taxes)	Austria[1]	Gas oil: heating, $81/m^3$; industrial, $332/m^3$	General budget
	Belgium[2]	Gasoline: leaded, $648/m^3$; unleaded, $580/m^3$ Gas oil: heating,$6/m^3$; industrial, $22/m^3$	General budget
	China	Gasoline: $3.44/m^3$ Diesel Oil: $1.72/m^3$	General budget
	Denmark[3]	Gasoline: leaded, $632/m^3$; unleaded, $530/m^3$ Gas oil: heating, $267/m^3$; industrial, $267/m^3$	General budget
	Finland[4]	Gasoline: leaded, $709/m^3$; unleaded, $620/m^3$ Gas oil: heating and industrial, $22/m^3$	General budget
	France[5]	Gasoline: leaded, $737/m^3$; unleaded, $688/m^3$ Gas oil: heating and industrial, $91/m^3$	General budget
	Germany[6]	Gasoline: leaded, $648/m^3$; unleaded, $588/m^3$ Gas oil: heating and industrial, $48/m^3$	General budget
	Greece[7]	Gasoline: leaded, $454/m^3$; unleaded, $397/m^3$ Gas oil: heating, $150/m^3$; industrial, $275/m^3$	General budget
	Ireland[8]	Gasoline: leaded, $242/m^3$; unleaded, $198/m^3$ Gas oil: heating and industrial, $25/m^3$	General budget
	Italy[9]	Gasoline: leaded, $672/m^3$; unleaded, $618/m^3$ Gas oil: heating, $452/m^3$; industrial, $136/m^3$	General budget
	Kenya	Gasoline: premium, $100/m^3$; regular, $194/me; diesel, $98/m^3$	General budget
	Luxembourg[10]	Gasoline: leaded, $426/m^3$; unleaded, $371/m^3$ Gas oil: heating, $6/m^3$; industrial, $20/m^3$	General budget
	Netherlands[11]	Gasoline: leaded, $732/m^3$; unleaded, $656/m^3$ Gas oil: heating and industrial, $55/m^3$ Uranium-235, $17/g used in nuclear power generation	General budget
	Norway[12]	Gasoline: leaded, $575/m^3$; unleaded, $542/m^3$	General budget
	Portugal[13]	Gasoline: leaded, $591/m^3$; unleaded, $555/m^3$ Gas oil: heating, $117/m^3$; industrial, $324/m^3$	General budget
	Spain[14]	Gasoline: leaded, $465/m^3$; unleaded, $427/m^3$ Gas oil: heating and industrial, $91/m^3$	General budget
	Sweden[15]	Gasoline: leaded, $527/m^3$; unleaded, $446/m^3$ Gas oil: heating and industrial, $92/m^3$	General budget

Item/Action Taxed	Country	Rates	Use of Revenues
	United Kingdom[16]	Gasoline: leaded, \$819/m^3; unleaded, \$731/m^3 Gas oil: heating and industrial, \$49/m^3	General budget
Motor fuels, other energy products (VAT)	Austria	20%	General budget
	Belgium	21%; except coal and other solid fuels (12%)	General budget
	Denmark	25%	General budget
	Finland	22%	General budget
	France	20.6%; 5.5% on fixed charge portion of utility bills	General budget
	Germany	16%	General budget
	Greece	18%; natural gas and coal are exempt	General budget
	Ireland	21% motor fuels; 12.5 % other energy products; fuels for public transport are exempt	General budget
	Italy	19%, except coal (9%) and electricity (10%)	General budget
	Kenya	\$34/m^3 industrial diesel and fuel oil; \$52/m^3 LPG	General budget
	Luxembourg	15% motor fuels, except unleaded gasoline (12%); 12% gas oil, kerosene and coal; 6% LPG	General budget
	Netherlands	17.5%	General budget
	Norway	23%	General budget
	Portugal	17% motor fuels and kerosene; 12% electricity; 5% natural gas	General budget
	Spain	16%	General budget
	Sweden	25%	General budget
	Switzerland	6.5%	General budget
	United Kingdom	17.5%, except domestic heating fuels (5%)	General budget
New automobiles	Austria	[(fuel consumption per 100 km - 3 liters) * 2% of net price] ; electric cars are exempt	General budget
	Belgium	\$73 - \$5,800/vehicle, based on engine power	General budget
	China	Sedans, cross-country vehicles and minibuses: 3% to 8%, depending on cylinder volume	General budget
	France	Varies with engine power	Regional budget
	Germany	\$21 - \$30	General budget

Item/Action Taxed	Country	Rates	Use of Revenues
	Greece	Varies with cubic capacity; vehicles with anti-pollution technology subject to reduced rate	General budget
	Ireland	13.3 - 28 %, depending on cubic capacity	General budget
	Italy	$91 - $236, depending on type and size of vehicle	General budget
	Netherlands	Varies with vehicle type, weight, and fuel type	General budget
	Norway	Varies with weight, horsepower and piston displacement	General budget
	Portugal	$1.47 - $12 per 100 cc	General budget
	Spain	7% of sale price	General budget
	United States	$1,000 - $7,700/ auto exceeding fuel efficiency maxima	U.S. Treasury
Pesticides	Belgium	$.06/g of specified contents	General budget
	Denmark	3% - 37% of retail price, varies by toxicity	General budget
	Finland	2.5% of total annual sales	General budget
Fertilizers	Sweden	$0.16/kg Nitrogen; $0.30/kg Phosphorous	General budget
Chlorinated solvents	Denmark	$0.31/kg of tetrachlorethylene, trichloroethylene, and dichloromethane	General budget
VOC	Switzerland	$0.73/kg	General budget
Lubricant oils	Denmark	$0.28/liter	General budget
	Sweden	$0.14/liter	General budget
Non-refillable containers	Finland	$0.80/liter	General budget
	Sweden	$0.04 - $0.42/container	General budget
Ozone-depleting substances	Australia	$1,225/ton CFCs; $55/ton methyl bromide	General budget
	Denmark	$4.70/kg CFCs or halons	General budget
	United States	$4.35/pound	U.S. Treasury
New tires	United Sates	$.15 - $.50/pound	U.S. Treasury

Note: VAT is an acronym for value-added tax, and VOC is an acronym for volatile organic compounds. Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

1. Austria also assesses excise taxes on heavy fuel oil, LPG and kerosene, at varying rates. Gas oil for cogeneration is taxed at the same rate as domestic heating oil. Austria's motor fuel excise taxes are excluded here because revenues are used for public transport expenses and can therefore be considered user charges. See Table 3.

2. Belgium also assesses excise taxes on diesel, LPG and kerosene, at varying rates. In addition to excise taxes, most motor fuels and other energy products are subject to an energy tax of $10 to $15/m^3, the revenues from which are earmarked for a social security fund.

3. Denmark also assesses excise taxes on heavy fuel oil, LPG, kerosene, coal, natural gas, and electricity, at varying rates. Partial rebates are available for gas stations with vapor recovery systems.

4. Finland also assesses excise taxes on diesel and kerosene, at varying rates.

5. France also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

6. Germany also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

7. Greece also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

8. Ireland also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

9. Italy also assesses excise taxes on diesel, LPG, kerosene, heavy fuel oil, natural gas and electricity, at varying rates.

10. Luxembourg also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

11. The Netherlands also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates. All fuels are also subject to a general energy tax, which ranges from $13/m^3 for leaded and unleaded gasoline to $18/m^3 for LPG.

12. Norway also assesses excise taxes on diesel and electricity, at varying rates, although manufacturing enterprises are exempt from the tax on electricity.

13. Portugal also assesses excise taxes on diesel, LPG, kerosene, heavy fuel oil and electricity, at varying rates.

14. Spain also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

15. Sweden also assesses excise taxes on diesel, LPG, kerosene, heavy fuel oil, coal, natural gas and electricity, at varying rates.

16. The United Kingdom also assesses excise taxes on diesel, LPG, kerosene and heavy fuel oil, at varying rates.

SOURCES: Ayoo and Jama (1999); Barthold (1994); Zou and Yuan (1998); Speck (1998); and Organization for Economic Cooperation and Development (1997a, 1998b).

TABLE 6:
ADMINISTRATIVE CHARGES

Country	Item/Action Taxed	First Enacted/ Modified	Rate	Use of Revenues
Australia	Ozone-depleting substances	n.a.	$6,100 administration fee, $1,200 license fee	Covers cost of licensing and administration
Finland	Pesticides	n.a.	$990 one-time registration charge (new pesticides)	Covers cost of registration
France	Use of inland waterways	n.a.	Varies by waterway and type of craft	Earmarked for financing of inland waterways authority
Malaysia	Palm oil industrial effluent discharges	1978	$2.54 annually per enterprise	Covers license-processing costs
Sweden	Pesticides	1984	Inspection charge, plus 15.5% of wholesale price	Finances administrative costs of biocide registry
United Kingdom	Water pollutant discharges	1992	$840 one-time application charge, annual charge $650 per pollution unit	Finances national water discharge licensing policy
United States	Water Pollutant Discharges	1972	Varies by substance	State administrative cost of National Pollution Discharge Elimination System, Clean Water Act
	Criteria Air Pollutants	1990	Varies by implementing state	State administrative cost of state clean air programs under Clean Air Act

NOTE: Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

SOURCES: U.S. Office of Technology Assessment (1995); Speck (1998); and World Bank (1997b).

TABLE 7:
TAX DIFFERENTIATION

Item/Action Taxed	Country	Provision and Differentiated Rate
Motor Fuels Excise Tax Reductions and Exemptions[1]	Belgium	Tax exemptions for motor fuels used in development of environmentally friendly products, rail carriage of passengers and goods
	Denmark	Tax rebate of $.005/liter for gas stations with vapor recovery, full exemption for public transport
	Norway	Exemption for use of vapor recovery unit
	United States	Reduced rates for natural gas ($.07/gal); methanol ($.06/gal); and ethanol ($.054/gal)
	United Kingdom	Reduction of $33/m^3 for diesel with low sulfur content
Motor Fuels VAT Reductions and Exemptions[1]	Austria	Reduced rate for public transport services (10%)
	Belgium	Reduced rate for public transport services (6%)
	Denmark	Exemption for public transport services
	Finland	Reduced rate for public transport services (6%)
	France	Reduced rate for public transport services (5.5%)
	Germany	Reduced rate for urban public transport (7%)
	Greece	Reduced rate for public transport (8%)
	Ireland	Exemption for public transport
	Italy	Reduced rate for public transport (10%); urban bus/rail transit exempt
	Luxembourg	Reduced rate for public transport (3%)
	Netherlands	Reduced rate for public transport (6%)
	Portugal	Reduced rate for public transport (5%)
	Spain	Reduced rate for public transport (7%)
	Sweden	Reduced rate for public transport (12%)
Income Tax Credits and Deductions	Australia	Deductions for prevention of land degradation
	Austria	Deductions for household energy saving measures, purchase of low-noise trucks (double normal capital deduction); exemption for industrial/commercial environmental investments
	Belgium	Increased deductions for green investments, energy-saving devices
	Colombia	Credits and deductions for reforestation activities
	Denmark	Deductions for environmental improvement equipment on small farms

Item/Action Taxed	Country	Provision and Differentiated Rate
	Ireland	Deductions for investments in renewable energy (maximum 50% of capital expenditure, investment must be held five years)
	Netherlands	Credit (40-52%) for specified corporate energy investments
	Russia	Credit (100%) for environmental protection equipment investments
	Spain	Deductions (maximum 10% of investment) for investments in environmental protection
	United States	Alcohol fuels: methanol ($.60/gal) and ethanol ($.54/gal) Business Energy: solar (10%) and geothermal (10%) Non-conventional Fuels: $3.00/Btu-barrel equivalent of oil Wind Production (1.5¢/kWh) Biomass Production (1.5¢/kWh) Electric Automobiles (10% credit)
Other Income Tax Provisions	Australia	Accelerated depreciation for water conservation and capital expenditure on environmental impact studies
	Barbados	Income tax rebate for water conservation and solar energy equipment in the tourism sector
	Brazil	Income tax rebates for adoption of clean technology
	Colombia	Income tax rebates for industrial pollution abatement investments
	Ecuador	Income tax relief for investments in mercury recovery in mining
	Finland	Accelerated depreciation (maximum 25% of purchase price for four years) for environmental investments
	France	Accelerated depreciation : 100% in first year for specified energy-saving equipment; lesser percentages for industrial water pollution, air pollution and noise reduction technologies
	Germany	Accelerated depreciation for pollution reduction equipment
	Hungary	Reduced rate for manufacturers of environmental products
	Japan	Capital allowance for solar energy, pollution prevention and recycling equipment; reduced rate for specified facilities for air, water and noise abatement, asbestos emission reduction, oil desulfurization and waste recycling
	Kenya	Capital expenditure for preventing soil erosion or planting permanent crops treated as current expense
	Netherlands	Accelerated depreciation for specified environmental technologies
	Switzerland	Accelerated depreciation for energy-saving & solar energy investments
	Tanzania	Capital expenditure for prevention of soil erosion treated as current expenditure.

Item/Action Taxed	Country	Provision and Differentiated Rate
	United States	Van Pools: tax-free employer provided benefits
		Mass Transit Passes
		Utility Rebates: exclusion of subsidies from utilities for energy conservation measures
	Venezuela	Income tax relief for industrial pollution abatement investments
Sales Tax and VAT Provisions	Australia	Sales tax exemption for recycled paper, solar power equipment and conversion of engines to LPG or natural gas
	Brazil	VAT rebates for adoption of clean technology
	Colombia	VAT rebates for industrial pollution abatement investments
	Denmark	Energy-saving light bulbs exempt from sales tax
	Germany	Reduced energy product excise tax (50%) for hydroelectricity
	Hungary	Reduced VAT rate for cars with catalytic converters
	Portugal	Reduced energy VAT rate of 5% for equipment related to solar or geothermal energy, and for generation of energy from waste
	Sweden	Energy VAT reduction for cogeneration plants (50%), exemption for electricity generated by wind power
	United Kingdom	Reduced VAT rate of 5% on installation of household energy-saving equipment
Tax Exempt Private Activity Bonds	United States	Interest exempt from Federal taxation: mass transit, sewage treatment, solid waste disposal, water treatment, high speed rail

1. For full motor fuels excise tax and VAT rates in each country, see Table 5. For full rates in the United States and Austria, in which motor fuels taxes are used to finance road investments, see Table 3.

NOTE: Conversion of all currencies to $US made using U.S. Federal Reserve historical bilateral exchange rates for December of the year in which data were gathered, available at http://www.bog.frb.fed.us/releases/H10/hist.

SOURCES: Barthold (1994); Speck (1998); McMorran and Nellor (1994); and Huber *et al*. (1998).

TABLE 8:
TRADEABLE PERMIT SYSTEMS

Country	Program	Traded Commodity	Period of Operation	Environmental and Economic Effects
Canada	ODS Allowance Trading	CFCs and Methyl Chloroform HCFCs Methyl Bromide	1993-1996 1996-Present 1995-Present	Low trading volume, except among large methyl bromide allowance holders
	PERT GERT	NO_x, VOCs, CO, CO_2, SO_2 CO_2	1996-Present 1997-Present	Pilot program Pilot program
Chile	Santiago Air Emissions Trading	Total suspended particulates emission rights trading among stationary sources	1995-Present	Low trading volume; decrease in emissions since 1997 not definitively tied to TP system
European Union	ODS Quota Trading	ODS production quotas under Montreal Protocol	1991-1994	More rapid phaseout of ODS
Singapore	ODS Permit Trading	Permits for use and distribution of ODS	1991-Present	Increase in permit prices; environmental benefits unknown
United States	Emissions Trading Program	Criteria air pollutants under the Clean Air Act	1974-Present	Performance unaffected; savings = $5-12 billion
	Leaded Gasoline Phasedown	Rights for lead in gasoline among refineries	1982-1987	More rapid phaseout of leaded gasoline; $250 m annual savings
	Water Quality Trading	Point-nonpoint sources of nitrogen & phosphorous	1984-1986	No trading occurred, because ambient standards not binding
	CFC Trades for Ozone Protection	Production rights for some CFCs, based on depletion potential	1987-Present	Environmental targets achieved ahead of schedule; effect of TP system unclear
	Heavy Duty Engine Trading	Averaging, banking, and trading of credits for NO_x and particulate emissions	1992-Present	Standards achieved; cost savings unknown
	Acid Rain Reduction	SO_2 emission reduction credits; mainly among electric utilities	1995-Present	SO_2 reductions achieved ahead of schedule; savings of $1 billion/year
	RECLAIM Program	SO_2 and NO_x emissions among stationary sources	1994-Present	Unknown as of 2000
	N.E. Ozone Transport	Primarily NO_x emissions by large stationary sources	1999-Present	Unknown as of 2000

SOURCES: Hahn and Hester (1989); Hahn (1989); Schmalensee, Joskow, Ellerman, Montero and Bailey (1998); Montero, and Sánchez (1999); Klaassen (1999); and Haites (1996). "TP" refers to tradeable permits; ODS, ozone-depleting substances; CFCs, chlorofluorocarbons; and CA, State of California.

TABLE 9:
INFORMATION PROGRAMS

Country	Information Program	Year of Implementation
Australia	Energy Efficiency Labeling	late 1980s
Canada	Environmental Choice Label	n.a.
China	National Environmental Protection Agency Labeling	1994
EU Members	EU Eco-Label	1993
Nordic Countries	Nordic Swan Label	1989
France	NF Environnement Label	n.a.
Germany	Blue Eco-Angel Label	1977
Hungary	Eco-Label	1995
Indonesia	PROPER industrial environmental performance labeling	1995
	Tropical hardwood labeling	n.a.
Japan	Eco-mark	1989
Philippines	Eco-watch industrial environmental performance labeling	1997
Sweden	Good Environmental Choices Label	1990
Taiwan	Green Mark	1993
Thailand	Thai Green Label	1994
United States	Energy Efficiency Product Labeling	1975
	NJ Hazardous Chemical Emissions	1984
	Toxic Release Inventory	1986
	CA Hazardous Chemical Emissions	1987
	CA Proposition 65	1988
	Energy Star	1993

SOURCES: World Bank (1997a, 1997b); TerraChoice Environmental Services Inc. (1999); China Council Working Group on Trade and Environment (1996); European Union (1999); Organization for Economic Cooperation and Development (1997b); Federal Republic of Germany (1998); Sterner (1999); and Thailand Environment Institute (1999).

REFERENCES

Alberini, A., W. Harrington and V. McConnell (1995), "Determinants of Participation in Accelerated Vehicle Retirement Programs", *RAND Journal of Economics* 26:93-112.

Alliance to Save Energy (1993), *Federal Energy Subsidies: Energy, Environmental and Fiscal Impacts* (Lexington, MA).

Ananathanarayanan, A. (1998), "Is There a Green Link? A Panel Data Value Event Study of the Relationship Between Capital Markets and Toxic Releases", Rutgers University Working Paper.

Anderson, G. and B. Fiedor (1997), "Environmental Charges in Poland", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 187-208.

Anderson, G. and T. òylicz (1999), "The role of Polish environmental funds: Too generous or too restrictive?" *Environment and Development Economics* 4:413-448.

Anderson, R. (1997), *The U.S. Experience with Economic Incentives in Environmental Pollution Control Policy* (Environmental Law Institute, Washington, D.C.).

Anderson, R.C., L.A. Hofmann, and M. Rusin (1990), *The Use of Economic Incentive Mechanisms in Environmental Management*, Research Paper 51 (American Petroleum Institute, Washington, D.C.)

Anderson, T.L. (1983), *Water Crisis: Ending the Policy Drought* (Cato Institute, Washington, D.C.).

Anderson, T.L. and D.R. Leal (1991), *Free Market Environmentalism* (Westview Press, Boulder, CO).

Annex I Expert Group on the United Nations Framework Convention on Climate Change (1997), "International Greenhouse Gas Emission Trading", Working Paper No. 9, (OECD, Paris).

Ayoo, C. and M.A. Jama (1999), "Environmental Taxation in Kenya", in: T. Sterner, ed., *The Market and the Environment* (Edward Elgar, Cheltenham, UK) 301-318.

Ayres R.E. (2000), "Expanding the Use of Environmental Trading Programs Into New Areas of Environmental Regulation", *Pace Environmental Law Review* 18(1): 87-118.

Azurix Corporation (2000), "Azurix Corp. Introduces Water2Water.com, the Internet-based, Ariba-powered Marketplace for Buyers and Sellers of Water", Press Release, available at http://www.azurix.com.

Bailey, E.M. (1996), "Allowance Trading Activity and State Regulatory Rulings: Evidence from the U.S. Acid Rain Program", MIT-CEEPR 96-002 WP, Center for Energy and Environmental Policy Research, Massachusetts Institute of Technology.

Barthold, T.A. (1994), "Issues in the Design of Environmental Excise Taxes", *Journal of Economic Perspectives* 8(1):133-151.

Batstone, C.J. and B.M.H. Sharp (1999), "New Zealand's quota management system: the first ten years", *Marine Policy* 23(2): 177-190.

Baumol, W.J. and W.E. Oates (1988), *The Theory of Environmental Policy*, second edition (Cambridge University Press, New York).

Bean, M.J. (1997), "Shelter from the Storm: Endangered Species and Landowners Alike Deserve a Safe Harbor", *The New Democrat* (March/April):20-21.

Bellandi, R.L. and R.B. Hennigan (1980), "The Why and How of Transferable Development Rights", *Real Estate Review* 7:60-64.

Blackman, A. and W. Harrington (1999), "The Use of Economic Incentives in Developing Countries: Lessons from the International Experience with Industrial Air Pollution", Discussion Paper no. 99-39 (Resources for the Future, Washington, DC).

Bluffstone, R. and B.A. Larson (1997), eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK).

Bohi, D. (1994), "Utilities and State Regulators Are Failing to Take Advantage of Emissions Allowance Trading", *The Electricity Journal* 7:20-27.

Bohi, D. and D. Burtraw (1997), "SO_2 Allowance Trading: How Do Expectations and Experience Measure Up?" *The Electricity Journal*: 67-75.

Bohlin, F. (1998), "The Swedish Carbon Dioxide Tax: Effects on Biofuel Use and Carbon Dioxide Emissions", *Biomass and Bioenergy* 15(4/5): 213-291.

Bohm, P. (1981), *Deposit-Refund Systems: Theory and Applications to Environmental, Conservation, and Consumer Policy* (Resources for the Future, Johns Hopkins University Press, Baltimore, MD).

Bohm, P. (1999), personal communication.

Bowes, M.D. and J.V. Krutilla (1989), *Multiple-Use Management: The Economics of Public Forestlands* (Resources for the Future, Washington, D.C.).

Bradsher, K. (1997), "Light Trucks Increase Profits But Foul Air More than Cars", *New York Times* (30 November):A1, A38-A39.

Brennan, T.J., K.L. Palmer, R.J. Kopp, A.J. Krupnick, V.Stagliano and D. Burtraw (1996), *A Shock to the System: Restructuring America's Electricity Industry* (Resources for the Future, Washington, D.C.).

Bressers, H.Th.A. and J. Schuddeboom (1994), "A Survey of Effluent Charges and Other Economic Instruments in Dutch Environmental Policy", in: Organization for Economic Cooperation and Development, *Applying Economic Instruments to Environmental Policies in OECD and Dynamic Non-Member Countries* (OECD, Paris):153-172.

Brotzman, T. (1996), "Opening the Floor to Emissions Trading", *Chemical Marketing Reporter* (27 May):SR8.

Brunenieks, J., A. Kozlovska and B.A. Larson (1997), "Implementing Pollution Permits and Charges in Latvia", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 75-101.

Bryner, G.C. (1999), "New Tools for Improving Government Regulation: An Assessment of Emissions Trading and Other Market-Based Regulatory Tools", Report, PricewaterhouseCoopers Endowment for The Business of Government, Arlington, VA.

Bui, LT.M. and C.J. Mayer (1997), "Public Disclosure of Private Information as a Means of Regulation: Evidence from the Toxic Release Inventory in Massachusetts", Mimeo.

Burtraw, D. (1996), “The SO_2 Emissions Trading Program: Cost Savings Without Allowance Trades”, *Contemporary Economic Policy* 14:79-94.

Burtraw, D., A.J. Krupnick, E. Mansur, D. Austin and D. Farrell (1998), “The Costs and Benefits of Reducing Air Pollution Related to Acid Rain”, *Contemporary Economic Policy* 16:379-400.

Burtraw, D. and E. Mansur (1999), “The Environmental Effects of SO_2 Trading and Banking”, *Environmental Science and Technology* 33(20):3489-3494.

Cadiou, A. and N.T. Duc (1994), “The Use of Pollution Charges in Water Management in France”, in: Organization for Economic Cooperation and Development, *Applying Economic Instruments to Environmental Policies in OECD and Dynamic Non-Member Countries* (OECD, Paris):131-151.

Cansier, D. and R. Krumm (1998), “Air Pollution Taxation: An Empirical Survey”, *Ecological Economics*, forthcoming.

Carlson, C., D. Burtraw, M. Cropper and K. Palmer (2000), “Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?,” Discussion Paper no. 98-44-REV (Resources for the Future, Washington, DC).

Cason, T.N. (1995), “An Experimental Investigation of the Seller Incentives in EPA’s Emission Trading Auction”, *American Economic Review* 85:905-922.

China Council Working Group on Trade and Environment (1996), “Report of the Working Group on Trade and Environment of CCICED”, International Institute for Sustainable Development World Wide Web site, available at http://iisd1.iisd.ca/trade/cciced/wgreport96.htm.

Clean Air Act Amendments of 1990, Public Law No. 101-549, 104 Statute 2399, 1990.

Coase, R. (1960), “The Problem of Social Cost”, *Journal of Law and Economics* 3:1-44.

Cook, E., ed. (1996), *Ozone Protection in the United States: Elements of Success* (World Resources Institute, Washington, D.C.).

Crandall, R.W., H.K. Gruenspecht, T.E. Keeler and L.B. Lave (1986), *Regulating the Automobile* (The Brookings Institute, Washington, D.C.).

Crocker, T.D. (1966), “The Structuring of Atmospheric Pollution Control Systems”, in: H. Wolozin, ed., *The Economics of Air Pollution* (W. W. Norton & Company, Inc., New York)

Dales, J. (1968), *Pollution, Property and Prices* (University Press, Toronto).

Dasgupta, S., B. Laplante and N. Mamingi (1997), “Capital Market Responses to Environmental Performance in Developing Countries”, World Bank Development Research Group Working Paper No. 1909, October.

Dao, J. (2000), “Acid Rain Law Found to Fail in Adirondacks”, *New York Times*, March 27.

Dixon, R.K. (1999), *The U.N. Framework Convention on Climate Change Activities Implemented Jointly (AIJ) Pilot: Experiences and Lessons Learned* (Kluwer Academic Publishers, Netherlands).

Doucet, J. and T. Strauss (1994), “On the Bundling of Coal and Sulphur Dioxide Emissions Allowances”, *Energy Policy*, 22:9:764-770.

Downing, P.B. and L.J. White (1986), “Innovation in Pollution Control”, *Journal of Environmental Economics and Management* 13:18-27.

Dudek, D.J. and J.B. Wiener (1996), "Joint Implementation, Transaction Costs, and Climate Change" (OECD, Paris).

Efaw, F. and W.N. Lanen (1979), "Impact of User Charges on Management of Household Solid Waste", Report prepared for the U.S. Environmental Protection Agency under Contract No. 68-3-2634 (Mathtech, Inc., Princeton, NJ).

Ekins, P. and S. Speck (1998), "Evaluation of the Environmental Effects of Environmental Taxes", Mimeo (Forum for the Future and Keele University).

Ekins, P. and S. Speck (1999), "Competitiveness and Exemptions From Environmental Taxes in Europe", *Environmental and Resource Economics* 13:369-396.

Ekins, P. (1999), "European environmental taxes and charges: recent experience, issues and trends", *Ecological Economics* 31:39-62.

El-Ashry, M.T. and D.C. Gibbons (1986), *Troubled Waters: New Policies for Managing Water in the American West* (World Resources Institute, Washington, D.C.).

Ellerman, D., P. Joskow, R. Schmalensee, J. Montero and E. Bailey (2000), *Markets for Clean Air: The U.S. Acid Rain Program* (Cambridge University Press, New York).

Ellerman, D. and J. Montero (1998), "The Declining Trend in Sulfur Dioxide Emissions: Implications for Allowance Prices", *Journal of Environmental Economics and Management* 36:26-45.

Ellerman, D., R. Schmalensee, P. Joskow, J. Montero and E. Bailey (1997), *Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance* (MIT Center for Energy and Environmental Policy Research, Cambridge).

Environment and Development Foundation (1999), Taiwan Greenmark Program World Wide Web site, available at http://www.greenmark.itri.org.tw/eng/english/htm.

European Commission, Directorate-General for Environment, Nuclear Safety and Civil Protection (1998), *Database on environmental taxes in the European Union Member States, plus Norway and Switzerland: Evaluation of environmental effects of environmental taxes* (Forum for the Future, London).

European Union (1999), Eco-label World Wide Web site, available at http://europa.eu.int/comm/ dg11/ ecolabel/.

Farrell, A., R. Carter and R. Raufer (1999), "The NOx Budget: market-based control of tropospheric ozone in the northeastern United States", *Resource and Energy Economics* 21:103-124.

Federal Republic of Germany (1998), Blue Eco-Angel World Wide Web site, available at http://www.blauer-engel.de.

Feldman, R.D. (1991), U.S. Environmental Protection Agency (7 January).

Ferrall, B.L. (1991), "The Clean Air Act Amendments of 1990 and the use of Market Forces to Control Sulfur Dioxide Emissions", *Harvard Journal on Legislation* 28:235-252.

Field, B.C. and J.M. Conrad (1975), "Economic Issues in Programs of Transferable Development Rights", *Land Economics* 51:331-340.

Fischer, C. and M. Toman (1998), "Environmentally- and Economically-Damaging Subsidies: Concepts and Illustrations", Climate Issue Brief no. 14 (Resources for the Future, Washington, DC).

Fisher, B., S. Barrett, P. Bohm, M. Kuroda, J. Mubazi, A. Shah and R. Stavins (1996), "Policy Instruments to Combat Climate Change", in: J.P. Bruce, H. Lee and E.F. Haites, eds., *Climate Change 1995: Economic and Social Dimensions of Climate Change* (Cambridge University Press, New York):397-439.

Fisher-Vanden, K. (1999), "Structural Change and Technological Diffusion in Transition Economies: Implications for Energy Use and Carbon Emissions in China", unpublished Ph.D. dissertation, (Harvard University, Cambridge, Massachusetts).

Foster, V. and R.W. Hahn (1995), "Designing More Efficient Markets: Lessons from Los Angeles Smog Control", *Journal of Law and Economics* 38:19-48.

Frederick, K.D., ed., (1986), *Scarce Water and Institutional Change* (Resources for the Future, Washington, D.C.).

Fullerton, D. and T.C. Kinnaman (1995), "Garbage, Recycling and Illicit Burning or Dumping", *Journal of Environmental Economics and Management* 29:78-92.

Fullerton, D. and T.C. Kinnaman (1996), "Household Responses to Pricing Garbage by the Bag", *American Economic Review* 86:971-984.

Fullerton, D. and G. Metcalf (1997), "Environmental Controls, Scarcity Rents, and Pre-Existing Distortions", NBER Working Paper 6091.

Fulton, W. (1996), "The Big Green Bazaar", *Governing Magazine* (June):38.

Goldberg, P.K. (1997), "The Effects of the Corporate Average Fuel Efficiency Standards", Working Paper, Department of Economics, Princeton University.

Goldstein, J.B. (1991), "The Prospects for Using Market Incentives to Conserve Biological Diversity", *Environmental Law* 21.

Gornaja, L., E. Kraav, B.A. Larson and K. Türk (1997), "Estonia's Mixed System of Pollution Permits, Standards and Charges", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 46-74.

Goulder, L., I. Parry and D. Burtraw (1997), "Revenue-Raising vs. Other Approaches to Environmental Protection: The Critical Significance of Pre-Existing Tax Distortions", *RAND Journal of Economics*.

Greenhouse Gas Emissions Trading Pilot Program (1999), "Offers and Trades: Project Applications", GERT World Wide Web site, available at http://www.gert.org.

Gupta, S., G. Van Houtven and M. Cropper (1996), "Paying for permanence: an economic analysis of EPA's cleanup decisions at Superfund sites", *RAND Journal of Economics 27*(3):563-582.

Hahn, R.W. (1989), "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders", *Journal of Economic Perspectives* 3:95-114.

Hahn, R.W. (1990), "Regulatory Constraints on Environmental Markets", *Journal of Public Economics* 42:149-175.

Hahn, R.W. and G.L. Hester (1989a), "Marketable Permits: Lessons for Theory and Practice", *Ecology Law Quarterly* 16:361-406.

Hahn, R.W. and G.L. Hester (1989b) "Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program", *Yale Journal of Regulation* 6:109-153.

Hahn, R.W. and A.M. McGartland (1989), "Political Economy of Instrumental Choice: An Examination of the U.S. Role in Implementing the Montreal Protocol", *Northwestern University Law Review* 83:592-611.

Hahn, R. and R. Noll (1982), "Designing a Market for Tradeable Permits", in: W. Magat, ed., *Reform of Environmental Regulation* (Ballinger Publishing Co., Cambridge, MA).

Hahn, R.W. and R.N. Stavins (1991), "Incentive-based Environmental Regulation: a New Era from an Old Idea?" *Ecology Law Quarterly* 18:1-42.

Hahn, R.W. and R.N. Stavins (1992), "Economic Incentives for Environmental Protection: Integrating Theory and Practice", *American Economic Review* 82(May):464-468.

Hahn, R.W. and R.N. Stavins (1995), "Trading in Greenhouse Permits: A Critical Examination of Design and Implementation Issues", in: H. Lee, ed., *Shaping National Responses to Climate Change: A Post-Rio Policy Guide* (Island Press, Cambridge, MA):177-217.

Haites, E. (1996), "Trading for Ozone-Depleting Substances", Mimeo, Margaree Consultants, Toronto, Canada.

Haites, E. (1997), "Heavy-Duty Vehicle Engine Emissions", Mimeo, Margaree Consultants, Toronto, Canada.

Haites, E. (1999), personal communication.

Hamilton, J.T. (1993), "Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities", *RAND Journal of Economics* 24:101-125.

Hamilton, J. (1995), "Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data", *Journal of Environmental Economics and Management* 28:98-113.

Hamilton, J. and K. Viscusi (1999), *Calculating Risks? The Spatial and Political Dimensions of Hazardous Waste Policy* (MIT Press, Cambridge, MA).

Harrison, D., Jr. (1999), "Turning Theory into Practice for Emissions Trading in the Los Angeles Air Basin", in: S. Sorrell and J. Skea, eds., *Pollution for Sale: Emissions Trading and Joint Implementation* (Edward Elgar, London).

Hartje, V., K. Gauer and A. Urquiza (1994), "The Use of Economic Instruments in the Environmental Policy of Chile", *Proceedings of the International Conference on Market-Based Instruments of Environmental Management in Developing Countries* (German Foundation for International Development, Berlin) 61-80.

Haugland, T. (1993), "A Comparison of Carbon Taxes in Selected OECD Countries", Environment Monographs no. 78 (OECD, Paris).

Helfand, G.E.(1991), "Standards versus Standards: The Effects of Different Pollution Restrictions", *American Economic Review* 81:622-634.

Hernandez, R. (2000), "Albany Battles Acid Rain Fed by Other States", *New York Times*, May 2.

Hockenstein, J.B., R.N. Stavins and B.W. Whitehead (1997), "Creating the Next Generation of Market-Based Environmental Tools", *Environment* 39(4):12-20, 30-33.

Huber, R.M., J. Ruitenbeek and R. Serôa da Motta (1998), *Market-Based Instruments for Environmental Policymaking in Latin American and the Caribbean: Lessons from Eleven Countries*, Discussion Paper no. 381 (World Bank, Washington, DC).

Hyde, W.F. (1981), “Timber Economics in the Rockies: Efficiency and Management Options”, *Land Economics* 57:630-37.

International Institute for Sustainable Development, *Green Budget Reform: An International Casebook on Leading Practices* (EarthScan, London).

Jaffe, A.B., S.R. Peterson, P.R. Portney and R.N. Stavins (1995), “Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tells Us?” *Journal of Economic Literature* 33:132-163.

Jaffe, A.B. and R.N. Stavins (1995), “Dynamic Incentives of Environmental Regulation: The Effects of Alternative Policy Instruments on Technology Diffusion”, *Journal of Environmental Economics and Management* 29:S43-S63.

Jenkins, R.R. (1993), *The Economics of Solid Waste Reduction: The Impact of User Fees* (Edward Elgar, Cheltenham, UK).

Jepma, C. (1999), “Planned and Ongoing AIJ Pilot Projects”, *Joint Implementation Quarterly* 5(3):14.

Johnson, S.L. and D.M. Pekelney (1996), “Economic Assessment of the Regional Clean Air Incentives Market: A New Emissions Trading Program for Los Angeles”, *Land Economics* 72:277-297.

Johnston, J.L. (1994), “Pollution Trading in La La Land”, *Regulation* (3):44-54.

Jorgenson, D. and P. Wilcoxen (1994), “The Economic Effects of a Carbon Tax”, Paper presented to the IPCC Workshop on Policy Instruments and their Implications, Tsukuba, Japan, (17-20 January).

Joskow, P.L. and R. Schmalensee (1998), “The Political Economy of Market-based Environmental Policy: The U.S. Acid Rain Program”, *Journal of Law and Economics* 41:81-135.

Joskow, P.L., R. Schmalensee and E.M. Bailey (1998), “Auction Design and the Market for Sulfur Dioxide Emissions”, *American Economic Review*, forthcoming.

Jung, C., K. Krutilla and R. Boyd (1996), “Incentives for Advanced Pollution Abatement Technology at the Industry Level: An Evaluation of Policy Alternatives”, *Journal of Environmental Economics and Management* 30:95-111.

Kaplow, L. and S. Shavell (1997), “On the Superiority of Corrective Taxes to Quantity Regulation”, NBER Working Paper 6251 (National Bureau of Economic Research, Cambridge, Massachusetts).

Kashmanian, R. (1986), “Beyond Categorical Limits: The Case for Pollution Reduction Through Trading”, Unpublished paper presented at the 59th Annual Conference of the Water Pollution Control Federation.

Kelman, S. (1981), *What Price Incentives?: Economists and the Environment* (Auburn House, Boston).

Keohane, N.O., R.L. Revesz and R.N. Stavins (1998), “The Positive Political Economy of Instrument Choice in Environmental Policy”, in: P. Portney and R. Schwab, eds., *Environmental Economics and Public Policy* (Edward Elgar, London).

Kerr, S. and D. Maré (1997), “Efficient Regulation Through Tradeable Permit Markets: The United States Lead Phasedown”, Department of Agricultural and Resource Economics, University of Maryland, College Park, Working Paper 96-06 (January).

Kerr, S. and R. Newell (2000), “Policy-Induced Technology Adoption: Evidence from the U.S. Lead Phasedown”, draft manuscript, Resources for the Future, Washington, D.C.

Klaassen, G. (1999), “Emissions trading in the European Union: practice and prospects”, in: S. Sorrell and J. Skea, eds., *Pollution for Sale* (Edward Elgar, Cheltenham, UK) 83-100.

Klaassen, G. and A. Nentjes (1997), “Creating Markets for Air Pollution control in Europe and the USA”, *Environmental and Resource Economics* 10:125-146.

Klassen, R. and C. McLaughlin (1996), “The Impact of Environmental Management on Firm Performance”, *Management Science* 42(8):1199-1214.

Klier, T.H., R.H. Mattoon and M.A. Prager (1997), “A Mixed Bag: Assessment of Market Performance and Firm Trading Behaviour in the NO_x RECLAIM Programme”, *Journal of Environmental Planning and Management*, 40(6):751-774.

Kling, C.L (1994), “Emission Trading vs. Rigid Regulations in the Control of Vehicle Emissions”, *Land Economics* 70:174-188.

Konar, S. and M.A. Cohen (1997), “Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions”, *Journal of Environmental Economics and Management* 32:109-24.

Korb, B. (1998), “U.S. Experience with Economic Incentives for Emissions Trading”, in: Organization for Economic Cooperation and Development, *Applying Market-Based Instruments to Environmental Policies in China and OECD Countries* (OECD, Paris): 99-115.

Kozeltsev, M. and A. Markandya (1997), “Pollution Charges in Russia: The Experience of 1990-1995", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 128-143.

Kramer, R.A. and K.M. Banholzer (1999), “Tradable Permits in Water Resource Management and Water Pollution Control”, in: Organization for Economic Cooperation and Development, *Implementing Domestic Tradable Permits for Environmental Protection* (OECD, Paris).

Kriz, M. (1996), “A Jolt to the System”, *National Journal* (3 August):1631-1636.

Krupp, F. (1986), “New Environmentalism Factors in Economic Needs”, *Wall Street Journal* (20 November):34.

Lanoie, P. and B. Laplante (1994), “The Market Response to Environmental Incidents in Canada: a Theoretical and Empirical Analysis”, *Southern Economic Journal* 60:657-672.

Laplante, B., P. Lanoie and M. Roy (1997), “Can Capital Markets Create Incentives for Pollution Control?” World Bank Policy Research Department Working Paper No. 1753, April.

Larsen, B.N. and R. Nesbakken (1997), “Norwegian Emissions of CO_2, 1987-1994", *Environmental and Resource Economics* 9: 275-290.

Lave, L. and H. Gruenspecht (1991), “Increasing the Efficiency and Effectiveness of Environmental Decisions: Benefit-Cost Analysis and Effluent Fees”, *Journal of Air and Waste Management* 41:680-690.

Lents, J. (1998), “The RECLAIM Program at Three Years”, Working Paper (April).

Liroff, R.A. (1986), *Reforming Air Pollution Regulations: The Toil and Trouble of EPA’s Bubble* (Conservation Foundation, Washington, D.C.).

Lövgren, K. (1994) "Economic Instruments for Air Pollution Control in Sweden", in: G. Klaassen and F. R. Forsund, eds., *Economic Instruments for Air Pollution Control* (Kluwer Academic, Boston, MA); 107-121.

Lowry, R.C. (1993), "The Political Economy of Environmental Citizen Groups", Unpublished Ph.D. thesis, Harvard University.

Macauley, M.K., M.D. Bowes and K.L. Palmer (1992), *Using Economic Incentives to Regulate Toxic Substances* (Resources for the Future, Washington, D.C.).

MacDonnell, L.J. (1990), *The Water Transfer Process As a Management Option For Meeting Changing Water Demands, Volume I*, Submitted to the U.S. Geological Survey, Washington, D.C. (April).

Main, J. (1988), "Here Comes the Big New Cleanup", *Fortune* (November):102-118.

Malueg, D.A. (1989), "Emission Credit Trading and the Incentive to Adopt New Pollution Abatement Technology", *Journal of Environmental Economics and Management* 16:52-57.

McFarland, J.M. (1972), "Economics of Solid Waste Management", in: Sanitary Engineering Research Laboratory, College of Engineering and School of Public Health, University of California, Berkeley, *Comprehensive Studies of Solid Waste Management, Final Report*, Report no. 72-3:41-106.

McMorran, R.T. and D.C.L. Nellor (1994), "Tax Policy and the Environment: Theory and Practice", Working Paper no. 94/106 (International Monetary Fund Fiscal Affairs Department, Washington, DC).

Menell, P. (1990), "Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste", *Ecology Law Quarterly* 17:655-739.

Merrill, P.R. and A.S. Rousso (1990), "Federal Environmental Taxation", Presented at the Eighty-third Annual Conference of the National Tax Association, San Francisco, California (November 13).

Milliman, S.R. and R. Prince (1989), "Firm Incentives to Promote Technological Change in Pollution Control", *Journal of Environmental Economics and Management* 17:247-265.

Mills, D.E. (1980), "Transferable Development Rights Markets", *Journal of Urban Economics* 7:63-74.

Minnesota Pollution Control Agency (1997), "Case Study: Minnesota--Pollutant Trading at Rah Malting Co.", *Environmental Regulatory Innovations Symposium* (November 5-7), available at http://www.pca.state.mn.us/hot/es-mn-r.html.

Miranda, M.L., J.W. Everett, D. Blume and B.A. Roy, Jr. (1994), "Market-Based Incentives and Residential Municipal Solid Waste", *Journal of Policy Analysis and Management* 13:681-698.

Montero, J.P. (1999), "Voluntary Compliance with Market-Based Environmental Policy: Evidence from the U.S. Acid Rain Program", *Journal of Political Economy*, 107:998-1033.

Montero, J.P. and J.M. Sánchez (1999), "A Market-Based Environmental Policy Experiment in Chile", Mimeo, Department of Industrial Engineering, Catholic University of Chile.

Montgomery, D. (1972), "Markets in Licenses and Efficient Pollution Control Programs", *Journal of Economic Theory* 5:395-418.

Morandi, L. (1992), "An Outside Perspective on Iowa's 1987 Groundwater Protection Act", (National Conference of State Legislatures).

Morris, G.E., J. Tiderenczl and P. Kovács (1997), "Environmental Emission Charges and Air Quality Protection in Hungary: Recent Practice and Future Prospects", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 156-186.

Morris, J. and L. Scarlett (1996), "Buying Green: Consumers, Product Labels and the Environment", Policy Study No. 202 (The Reason Foundation, Los Angeles, CA).

Morris, W. (1988), "IID Approves State's First Water Swap with MWD", *Imperial Valley Press* (9 November).

Muoghalu, M., D. Robison and J. Glascock (1990), "Hazardous waste lawsuits, stockholder returns, and deterrence", *Southern Economic Journal* 57:357-370.

National Academy of Public Administration (1994), *The Environment Goes to Market: The Implementation of Economic Incentives for Pollution Control* (July).

New Zealand Ministry for the Environment (1997), *The State of New Zealand's Environment 1997* (Ministry for the Environment, Wellington).

Newell, R.G., A.B. Jaffe and R.N. Stavins (1999), "The Induced Innovation Hypothesis and Energy-Saving Technological Change", *Quarterly Journal of Economics* 114(3):941-975.

Newell, R.G. and W. Pizer (2000), "Regulating Stock Externalities Under Uncertainty", Discussion Paper 98-02 (revised) (Resources for the Future, Washington, D.C.).

Newell, R. and R.N. Stavins (1999), "Abatement Cost Heterogeneity and Potential Gains from Market-Based Instruments", Working paper, John F. Kennedy School of Government, Harvard University.

Nichols, A.L (1997), "Lead in Gasoline", in: R.D. Morgenstern, ed., *Economic Analyses at EPA: Assessing Regulatory Impact* (Resources for the Future, Washington, D.C.):49-86.

Nichols, A., J. Farr and G. Hester (1996), "Trading and the Timing of Emissions: Evidence from the Ozone Transport Region", National Economic Research Associates, Cambridge, Massachusetts.

Oates, W.E., P.R. Portney and A.M. McGartland (1989), "The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting", *American Economic Review* 79:1233-1243.

O'Connor, D. (1994), "The Use of Economic Instruments in Environmental Management: The East Asian Experience", in: Organization for Economic Cooperation and Development, *Applying Economic Instruments to Environmental Policies in OECD and Dynamic Non-Member Countries* (OECD, Paris) 33-58.

OECD Centre for Co-operation with the European Economies in Transition (1994), "Taxation and Environment in European Economies in Transition", (OECD, Paris).

OECD Centre for Co-operation with the European Economies in Transition (1995), Environmental Funds in Economies in Transition (OECD, Paris).

Opschoor, J.B. (1994), "Developments in the Use of Economic Instruments in OECD Countries", in: G. Klaassen and F. R. Forsund, eds., *Economic Instruments for Air Pollution Control* (Kluwer Academic, Boston, MA).

Organization for Economic Cooperation and Development (1989), *Economic Instruments for Environmental Protection* (OECD, Paris).

Organization for Economic Cooperation and Development (1991), *Environmental Policy: How to Apply Economic Instruments* (OECD, Paris).

Organization for Economic Cooperation and Development (1993a), "Applying Economic Instruments to Packaging Waste: Practical Issues for Product Charges and Deposit-Refund Systems", Environment Monographs no. 82 (OECD, Paris).

Organization for Economic Cooperation and Development (1993b), *Environmental Performance Reviews: Germany* (OECD, Paris).

Organization for Economic Cooperation and Development (1993c), *Environmental Performance Reviews: Iceland* (OECD, Paris).

Organization for Economic Cooperation and Development (1993d), *Taxation and the Environment, Complementary Policies* (OECD, Paris).

Organization for Economic Cooperation and Development (1994a), *Applying Economic Instruments to Environmental Policies in OECD and Dynamic Non-Member Countries* (OECD, Paris).

Organization for Economic Cooperation and Development (1994b), *The Distributive Effects of Economic Instruments for Environmental Policy* (OECD, Paris).

Organization for Economic Cooperation and Development (1994c), *Evaluating Economic Incentives for Environmental Policy* (OECD, Paris)

Organization for Economic Cooperation and Development (1994d), *Managing the Environment — The Role of Economic Instruments* (OECD, Paris).

Organization for Economic Cooperation and Development (1994e), "Public Policies for the Protection of Soil Resources", Environment Monographs no. 89 (OECD, Paris).

Organization for Economic Cooperation and Development (1995a), *Environmental Performance Reviews: Austria* (OECD, Paris).

Organization for Economic Cooperation and Development (1995b), *Environmental Performance Reviews: Canada* (OECD, Paris).

Organization for Economic Cooperation and Development (1995c), *Environmental Performance Reviews: Netherlands* (OECD, Paris).

Organization for Economic Cooperation and Development (1995d), "Environmental Taxation in OECD Countries" (OECD, Paris).

Organization for Economic Cooperation and Development (1996), *Environmental Performance Reviews: Sweden* (OECD, Paris).

Organization for Economic Cooperation and Development (1997a), *Environmental Performance Reviews: Finland* (OECD, Paris).

Organization for Economic Cooperation and Development (1997b), *Environmental Performance Reviews: France* (OECD, Paris).

Organization for Economic Cooperation and Development (1997c), *Environmental Performance Reviews: Korea* (OECD, Paris).

Organization for Economic Cooperation and Development (1997d), *Environmental Performance Reviews: Spain* (OECD, Paris).

Organization for Economic Cooperation and Development (1997e), *Putting Markets to Work: The Design and Use of Marketable Permits and Obligations*, Public Management Occasional Paper No. 19 (OECD, Paris).

Organization for Economic Cooperation and Development (1998a), *Applying Market-Based Instruments to Environmental Policies in China and OECD Countries* (OECD, Paris).

Organization for Economic Cooperation and Development (1998b), *Environmental Performance Reviews: Australia* (OECD, Paris).

Organization for Economic Cooperation and Development (1998c), *Environmental Performance Reviews: Belgium* (OECD, Paris).

Organization for Economic Cooperation and Development (1998d), *Environmental Performance Reviews: Mexico* (OECD, Paris).

Organization for Economic Cooperation and Development (1998e), *Environmental Performance Reviews: Switzerland* (OECD, Paris).

Organization for Economic Cooperation and Development (1999a), *Environmental Performance Reviews: Czech Republic* (OECD, Paris).

Organization for Economic Cooperation and Development (1999b), *Environmental Performance Reviews: Denmark* (OECD, Paris).

Organization for Economic Cooperation and Development (1999c), *Implementing Domestic Tradable Permits for Environmental Protection* (OECD, Paris).

Organization for Economic Cooperation and Development (2001), *Environmentally Related Taxes in OECD Countries — Issues and Strategies* (OECD, Paris).

Owen, T.H., J. Myjavec and D. Jassikova (1997), "Implementation of Pollution Charge Systems in a Transition Economy: The Case of Slovakia", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 209-220.

Palmer, K. and D. Burtraw (1997), "Electricity Restructuring and Regional Air Pollution", *Resource and Energy Economics* 19:139-174.

Panayotou, T. (1998), *Instruments of Change: Motivating and Financing Sustainable Development* (Earthscan Publications for UNEP, London).

Panayotou, T., R. Bluffstone and V. Balaban (1994), "Lemons and Liabilities: Privatization, Foreign Investment, and Environmental Liability in Central and Eastern Europe", *Environmental Impact Assessment* 14:157-168.

Peskin, H.M. (1986), "Nonpoint Pollution and National Responsibility", *Resources* (Spring):10-11, 17.

Peszko, G. and T. òylicz (1998), "Environmental Financing in European Economies in Transition", *Environmental and Resource Economics* 11(3-4):521-538.

Pigou, A.C. (1920), *The Economics of Welfare* (Macmillan, London).

Pilot Emissions Reduction Trading (PERT) Project (1999), "Emission Trading in Canada: The PERT Experience", Draft Discussion Paper (Toronto, Ontario), available at http://www.pert.org.

Porter, R. (1978), "A Social Benefit-Cost Analysis of Mandatory Deposits on Beverage Containers", *Journal of Environmental Economics and Management* 5:351-375.

Porter, R. (1983), "Michigan's Experience with Mandatory Deposits on Beverage Containers", *Land Economics* 59:177-194.

Pototschnig, A. (1994), "Economic Instruments for the Control of Acid Rain in the UK", in: G. Klaassen and F.R. Førsund, *Economic Instruments for Air Pollution Control* (Kluwer, Dordrecht) 22-45.

Reiling, S.D. and M.J. Kotchen (1996), "Lessons Learned from Past Research on Recreation Fees", in: A.L. Lundgren, ed., *Recreation Fees in the National Park Service: Issues, Policies and Guidelines for Future Action*, Minnesota Extension Service Pub. No. BU-6767 (Cooperative Park Studies Unit, Department of Forest Resources, University of Minnesota, St. Paul).

Reinhardt, F.L. (2000), *Down to Earth: Applying Business Principles to Environmental Management* (Harvard Business School Press, Boston).

Repetto, R., R. Dower, R. Jenkins and J. Geoghegan (1992), *Green Fees: How a Tax Shift Can Work for the Environment and the Economy* (World Resources Institute, Washington, D.C.).

Repetto, R. and M. Gillis, eds. (1988), *Public Policies and the Misuse of Forest Resources* (Cambridge University Press, New York).

Revesz, R.L. (1997), *Foundations in Environmental Law and Policy* (Oxford University Press, New York).

Rhee, H.S. (1994), "The Use of Economic Instruments in Environmental Protection in Korea", in: Organization for Economic Cooperation and Development, *Applying Economic Instruments to Environmental Policies in OECD and Dynamic Non-Member Countries* (OECD, Paris) 97-104.

Rico, R. (1995), "The U.S. Allowance Trading System for Sulfur Dioxide: An Update of Market Experience", *Environmental and Resource Economics*, 5(2):115-129.

Roberts, M.J. and M. Spence (1976), "Effluent Charges and Licenses under Uncertainty". *Journal of Public Economics, 5*(3-4), 193-208.

Rose, K. (1997), "Implementing an Emissions Trading Program in an Economically Regulated Industry: Lessons from the SO_2 Trading Program", in: R.F. Kosobud and J.M. Zimmerman, eds., *Market Based Approaches to Environmental Policy: Regulatory Innovations to the Fore* (Van Nostrand Reinhold, New York).

Russell, C.S. (1988), "Economic Incentives in the Management of Hazardous Wastes", *Columbia Journal of Environmental Law* 13:257-274.

Schärer, B. (1994), "Economic Incentives in Air Pollution Control: The Case of Germany", *European Environment* 4(3):3-8.

Schärer, B. (1999), "Tradable emission permits in German clean air policy: considerations on the efficiency of environmental policy instruments", in: S. Sorrell and J. Skea, eds., *Pollution for Sale* (Edward Elgar, Cheltenham, UK) 141-153.

Schlegelmilch, K. (1998), "Energy Taxation in the EU and some Member States: Looking for Opportunities Ahead", (Wuppertal Institute for Climate, Environment and Energy on behalf of the Heinrich-Böll-Foundation, Brussels).

Schmalensee, R. (1996), *Greenhouse Policy Architecture and Institutions*, Paper prepared for National Bureau of Economic Research conference, "Economics and Policy Issues in Global Warming: An Assessment of the Intergovernmental Panel Report", Snowmass, Colorado (July 23-24).

Schmalensee, R., P.L. Joskow, A.D. Ellerman, J.P. Montero and E.M. Bailey (1998), "An Interim Evaluation of Sulfur Dioxide Emissions Trading", *Journal of Economic Perspectives* 12, no. 3:53-68.

Scodari, P., L. Shabman and D. White (1995), "Commercial Wetland Mitigation Credit Markets: Theory and Practice", IWR Report 95-WMB-7, Institute for Water Resources, Water Resources Support Center (U.S. Army Corps of Engineers, Alexandria, Virginia).

Sect. 9501 of Internal Revenue Code of 1954.

Seligman, D.A. (1994), *Air Pollution Emissions Trading: Opportunity or Scam? A Guide for Activists* (Sierra Club, San Francisco).

Senator Richard Bryan, Statements before Senate, Oct. 28, 1997; Conference Report on Interior Appropriations Act.

Serôa da Motta, R. (1998), "Application of Economic Instruments for Environmental Management in Latin America: from Theoretical to Practical Constraints", Paper presented at the Organization of American States Meeting on Sustainable Development in Latin America and the Caribbean: Policies, Programs and Financing, Washington, D.C. (30 October).

Shelby, M., R. Shackleton, M. Shealy and A. Cristofaro (1997), *The Climate Change Implications of Eliminating U.S. Energy (and Related) Subsidies* (U.S. Environmental Protection Agency, Washington, D.C.).

Sigman, H.A. (1995), "A Comparison of Public Policies for Lead Recycling", *RAND Journal of Economics* 26(3):452-478.

Singh, M. (1995), "Pollution Control through the Provision of Information: Assessing the Impact of the Toxics Release Inventory Singh,-Manjula", unpublished Ph.D. thesis, Boston University.

Skumatz, L.A. (1990), "Volume-Based Rates in Solid Waste: Seattle's Experience", Report for the Seattle Solid Waste Utility (Seattle Solid Waste Utility, Seattle, WA).

Smith, R. (2000), "Azurix is Launching Online Exchange For Buying and Selling Water in the West", *The Wall Street Journal* (9 February).

Solomon, B.D. (1999), "New directions in emissions trading: the potential contribution of new institutional economics", *Ecological Economics* 30:371-387.

Solomon, B.D. and H.S. Gorman (1998), "State-Level Air Emissions Trading: The Michigan and Illinois Models", *Journal of the Air & Waste Management Association* 48(12):1156-1165.

Sonneborn, C.L. (1999), "An overview of greenhouse gas emissions trading pilot schemes and activities", *Ecological Economics* 31:1-10.

Sorrell, S. (1999), "Why sulphur trading failed in the UK", in: S. Sorrell and J. Skea, *Pollution for Sale: Emissions Trading and Joint Implementation* (Edward Elgar, Cheltenham, UK) 170-207.

Sorrell, S. and J. Skea (1999), *Pollution for Sale: Emissions Trading and Joint Implementation* (Edward Elgar, Cheltenham, UK).

Speck, S. (1998), "A Database of Environmental Taxes and Charges", The Eco-Tax Database of Forum for the Future at Keele University, in: European Commission, *Database on environmental taxes in the European Union Member States, plus Norway and Switzerland* (Forum for the Future, London) 37-153.

State of Michigan, Department of Environmental Quality (2000), Water Quality Trading Program World Wide Web site, available at http://www.deq.state.mi.us/ swq/trading/tem5x.htm.

Stavins, R.N. (1983), *Trading Conservation Investments for Water* (Environmental Defense Fund, Berkeley, CA).

Stavins, R.N., ed. (1988), *Project 88: Harnessing Market Forces to Protect Our Environment,* sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania, Washington, D.C.

Stavins, R.N., ed. (1991), *Project 88 - Round II Incentives for Action: Designing Market-Based Environmental Strategies,* sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania, Washington, D.C.

Stavins, R.N. (1995), "Transaction Costs and Tradable Permits", *Journal of Environmental Economics and Management* 29:133-148.

Stavins, R.N. (1996), "Correlated Uncertainty and Policy Instrument Choice", *Journal of Environmental Economics and Management* 30:218-232.

Stavins, R.N. (1997), "Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?" *The University of Chicago Legal Forum*:293-329.

Stavins, R.N. (1998), "What Have We Learned from the Grand Policy Experiment: Lessons from SO_2 Allowance Trading", *Journal of Economic Perspectives* 12(3):69-88.

Stavins, R.N. (2000), "Market-Based Environmental Policies", in: P.R. Portney and R.N. Stavins, eds., *Public Policies for Environmental Protection* (Resources for the Future, Washington, D.C.), forthcoming.

Stavins, R.N. and B.W. Whitehead (1992), "Pollution Charges for Environmental Protection: A Policy Link Between Energy and Environment", *Annual Review of Energy and the Environment* 17:187-210.

Steele, P. (1999), "Market-based Instruments for Environmental Policy in Developing Countries – from Theory to Practice with a Case Study of Sri Lanka's Recent Experience", in: T. Sterner, ed., *The Market and the Environment* (Edward Elgar, Cheltenham, UK) 274-300.

Stepanek, Z. (1997), "Integration of Pollution Charge Systems with Strict Performance Standards: The Experience of the Czech Republic", in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK) 144-155.

Sterner, T. (Draft, 1999), "The Selection and Design of Policy Instruments", Draft Manuscript.

Sterner, T., ed. (1999), *The Market and the Environment* (Edward Elgar, Cheltenham, UK).

Sterner, T. and L. Hoglund (1998), "Refunded Emission Payments: A Hybrid Instrument with Some Attractive Properties", working paper (Resources for the Future, Washington, D.C.).

Stevens, B.J. (1978), "Scale, Market Structure, and the Cost of Refuse Collection", *The Review of Economics and Statistics* 40:438-448.

Svendsen, G.T. (1998), *Public Choice and Environmental Regulation: Tradable Permit Systems in the United States and CO_2 Taxation in Europe* (Edward Elgar, Cheltenham, UK).

Swift, B. (2000), "Allowance Trading and SO_2 Hot Spots — Good News from the Acid Rain Program", *Environment Reporter*, May 12.

TerraChoice Environmental Services Inc. (1999), Environmental Choice Program World Wide Web site, available at http://www.environmentalchoice.com.

Thailand Environment Institute (1999), Thai Green Label World Wide Web site, available at http://www.tei.or.th/bep/GreenLabel.cfm.

Thompson, D.B. (1997), "The Political Economy of the RECLAIM Emissions Market for Southern California", Working paper, University of Virginia (March).

Tietenberg, T. (1980), "Transferable Discharge Permits and the Control of Stationary Source Air Pollution: A Survey and Synthesis", *Land Economics* 56:391-416.

Tietenberg, T. (1985), *Emissions Trading: An Exercise in Reforming Pollution Policy* (Resources for the Future, Washington, D.C.).

Tietenberg, T. (1995), "Tradeable Permits for Pollution Control When Emission Location Matters: What Have We Learned?" *Environmental and Resource Economics* 5:95-113.

Tietenberg, T. (1997a), "Information Strategies for Pollution Control", Paper presented at the Eighth Annual Conference, European Association of Environmental and Resource Economists, Tilburg, The Netherlands (June 26-28).

Tietenberg, T. (1997b), "Tradeable Permits and the Control of Air Pollution in the United States", Paper prepared for the 10th Anniversary Jubilee edition of *Zeitschrift Fürangewandte Umweltforschung*.

Tietenberg, T. and D. Wheeler (1998), "Empowering the Community: Information Strategies for Pollution Control", Frontiers of Environmental Economics Conference (Airlie House, Virginia).

Tripp, J.T.B. and D.J. Dudek (1989), "Institutional Guidelines for Designing Successful Transferable Rights Programs", Yale Journal of Regulation 6:369-391.

U.S. Congress (1951), "Independent Offices Appropriations Act of 1951", ch 375, §501, 654 Stat. 290. 31 U.S.C. §9701 (31 August).

U.S. Congress (1978), "Gas Guzzler Tax", 26 U.S.C. Sec. 4064.

U.S. Congress (1986), "Job Training Partnership Act Amendments of 1986", 99th Congress, 1st session, P.L. 99-499, Sec. 522(a) (16 October).

U.S. Congress (1989), "Omnibus Budget Reconciliation Act of 1989", 101st Congress, 1st session, P.L. 101-239 (19 December).

U.S. Congress (1989), "Omnibus Budget Reconciliation Act of 1989", 101st Congress, 1st session, P.L. 101-239, Sec. 7506, "Excise Tax on the Sale of Chemicals Which Deplete the Ozone Layer and of Products Containing Such Chemicals" (19 December).

U.S. Congress (1995), "Appliance Labeling Rule", 16 C.F.R., Ch. 1, Federal Trade Commission, Part 305 (16 March).

U.S. Congress (1997), "The Electric Consumers' Power to Choose Act", 105th Congress, 1st session, H.R. 655 (10 February).

U.S. Congress, Office of Technology Assessment (1992), *Building Energy Efficiency* (Washington, D.C.).

U.S. Congress, Office of Technology Assessment (1995), *Environmental Policy Tools: A Users Guide* (Washington, D.C.).

U.S. Congressional Budget Office (1990), *Reducing the Deficit: Spending and Revenue Options.* (Washington, D.C.).

U.S. Department of State (1997), *U.S. Climate Action Report*, Publication 10496 (Washington, D.C.).

U.S. Environmental Protection Agency (1982), "Regulation of Fuel and Fuel Additives — Final Rule", 24 F.R. 49322 (29 October).

U.S. Environmental Protection Agency (1986), "Emissions Trading Policy Statement — Final Policy Statement", 51 F.R. 43814 (4 December).

U.S. Environmental Protection Agency (1990), *Environmental Investments: The Cost of a Clean Environment*, report of the administrator to Congress (U.S. EPA, Washington, D.C.).

U.S. Environmental Protection Agency (1991), *Economic Incentives, Options for Environmental Protection*, Document P-2001 (EPA, Washington, D.C.).

U.S. Environmental Protection Agency (1992), *The United States Experience with Economic Incentives to Control Environmental Pollution*, EPA-230-R-92-001 (Washington, D.C.).

U.S. Environmental Protection Agency (2001), *The United States Experience with Economic Incentives for Protecting the Environment*, EPA-240-R-01-001 (Washington, D.C.).

U.S. Environmental Protection Agency (1998), "EPA Proposes Emissions Trading Program to Help Protect Eastern U.S. from Smog", Press Release (29 April).

U.S. Environmental Protection Agency, Office of Policy Analysis (1984), "Case Studies on the Trading of Effluent Loads, Dillon Reservoir", Final Report.

U.S. Environmental Protection Agency, Office of Policy Analysis (1985), *Costs and Benefits of Reducing Lead in Gasoline, Final Regulatory Impact Analysis* (Washington, D.C.).

U.S. Federal Energy Regulatory Commission (1996), "Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities", Order 888 (24 April).

U.S. General Accounting Office (1986), *Vehicle Emissions: EPA Program to Assist Leaded-Gasoline Producers Needs Prompt Improvement,* GAO/RCED-86-182 (U.S. GAO, Washington, D.C.).

U.S. General Accounting Office (1990), *Solid Waste: Trade-offs Involved in Beverage Container Deposit Legislation*, GAO/RCED-91-25 (U.S. GAO, Washington, D.C.).

U.S. General Accounting Office (1992), *Toxic Chemicals: EPA's Toxics Release Inventory Is Useful But Could be Improved*,(U.S. GAO, Washington, D.C.).

Vincent, J., R. Ali and Associates (1997), *Environment and Development in a Resource-Rich Economy* (Harvard University Press, Cambridge, Massachusetts).

Vincent, J. and S. Farrow (1997), "A Survey of Pollution Charge Systems and Key Issues in Policy Design" in: R. Bluffstone and B.A. Larson, eds., *Controlling Pollution in Transition Economies* (Edward Elgar, Cheltenham, UK).

Voigt, P.C. and L.E. Danielson (1996), "Wetlands Mitigation Banking Systems: A Means of Compensating for Wetlands Impacts", Applied Resource Economics and Policy Group Working Paper AREP96-2, Department of Agricultural and Resource Economics, North Carolina State University.

Wahl, R.W. (1989), *Markets for Federal Water: Subsidies, Property Rights, and the Bureau of Reclamation* (Resources for the Future, Washington, D.C.).

Wang, H. and D. Wheeler (1996), "Pricing Industrial Pollution in China: An Econometric Analysis of the Levy System", (World Bank Policy Research Department, Washington, DC).

Wang, H. and D. Wheeler (1999), "China's Pollution Levy: An Analysis of Industry's Response", presented to the Association of Environmental and Resource Economists Workshop, "Market-Based Instruments for Environmental Protection", John F. Kennedy School of Government, Harvard University, July 18-20.

Wang, J. and X. Lu (1998), "Economic Policies for Environmental Protection in China: Practice and Perspectives", in: Organization for Economic Cooperation and Development, *Applying Market-Based Instruments to Environmental Policies in China and OECD Countries* (OECD, Paris): 15-29.

Weitzman, M. (1974), "Prices vs. Quantities", *Review of Economic Studies* 41:477-491.

Wertz, K.L. (1976), "Economic Factors Influencing Households' Production of Refuse", *Journal of Environmental Economics and Management* 2:263-72.

Wheeler, D. et al. (2000), *Greening Industry: New Roles for Communities, Markets and Governments* (Oxford University Press for the World Bank, New York).

Woerdman, E. and W. Van der Gaast (1999), "A Review of the Cost-Effectiveness of Activities Implemented Jointly: Projecting JI and CDM Credit Prices", Working paper (September).

World Bank (1997a), *China 2020: Clear Water, Blue Skies. China's Environment in the New Century* (World Bank, Washington, D.C.): Chapter 5.

World Bank (1997b), *Five Years after Rio: Innovations in Environmental Policy, Environmentally Sustainable Development*, Studies and Monographs Series no. 18 (World Bank, Washington, DC).

World Bank (1999), "Using Market-based Instruments in the Developing World: The Case of Pollution Charges in Colombia", New Ideas in Pollution Regulation World Wide Web site, available at http://www.worldbank.org/nipr/lacsem/columpres/index.htm.

Wuppertal Institute (1996), "Japan Back as World-Beater -- This Time with Green Taxes?" Wuppertal Bulletin on Ecological Tax Reform 2(3):1-2.

Yang, J., D. Cao and D. Wang (1998), "The Air Pollution Charge System in China: Practice and Reform", in: Organization for Economic Cooperation and Development, *Applying Market-Based Instruments to Environmental Policies in China and OECD Countries* (OECD, Paris): 67-86.

Zou, J. and H. Yuan (1998), “Air Pollution, Energy and Fiscal Policies in China: A Review”, in: Organization for Economic Cooperation and Development, *Applying Market-Based Instruments to Environmental Policies in China and OECD Countries* (OECD, Paris): 119-137.

òylicz, T. (1996), “Economic instruments in Poland’s environmental policy”, Paper prepared for Central and Eastern European Environmental Economics and Policy Project, Harvard Institute for International Development.

òylicz, T. (1999), “Towards tradability of pollution permits in Poland”, in: S. Sorrell and J. Skea, *Pollution for Sale* (Edward Elgar, Cheltenham, UK) 124-138.

òylicz, T. (2000), personal communication.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI
Fondazione Eni Enrico Mattei Working Papers Series
Our working papers are available on the Internet at the following addresses:
***Server WWW*: WWW.FEEM.IT**
***Anonymous FTP*: FTP.FEEM.IT**
http://papers.ssrn.com/abstract_id=XXXXXX

SUST	1.2001	*Inge MAYERES and Stef PROOST*: Should Diesel Cars in Europe be Discouraged?
SUST	2.2001	*Paola DORIA and Davide PETTENELLA*: The Decision Making Process in Defining and Protecting Critical Natural Capital
CLIM	3.2001	*Alberto PENCH*: Green Tax Reforms in a Computable General Equilibrium Model for Italy
CLIM	4.2001	*Maurizio BUSSOLO and Dino PINELLI*: Green Taxes: Environment, Employment and Growth
CLIM	5.2001	*Marco STAMPINI*: Tax Reforms and Environmental Policies for Italy
ETA	6.2001	*Walid OUESLATI*: Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital
CLIM	7.2001	*Umberto CIORBA, Alessandro LANZA and Francesco PAULI:* Kyoto Commitment and Emission Trading: a European Union Perspective
MGMT	8.2001	*Brian SLACK* (xlv): Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy
VOL	9.2001	*Giulia PESARO:* Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors
VOL	10.2001	*Cathrine HAGEM*: Climate Policy, Asymmetric Information and Firm Survival
ETA	11.2001	*Sergio CURRARINI and Marco MARINI*: A Sequential Approach to the Characteristic Function and the Core in Games with Externalities
ETA	12.2001	*Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS*: Inflation and Welfare in an OLG Economy with a Privately Provided Public Good
KNOW	13.2001	*Paolo SURICO:* Globalisation and Trade: A "New Economic Geography" Perspective
ETA	14.2001	*Valentina BOSETTI and Vincenzina MESSINA:* Quasi Option Value and Irreversible Choices
CLIM	15.2001	*Guy* ENGELEN (xlii): Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making
SUST	16.2001	*Julie Catherine SORS:* Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches
SUST	17.2001	*Julie Catherine SORS:* Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools
CLIM	18.2001	*Johan ALBRECHT and Niko GOBBIN*: Schumpeter and the Rise of Modern Environmentalism
VOL	19.2001	*Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO* (xliii): Participation Incentives and the Design of Voluntary Agreements
ETA	20.2001	*Paola ROTA*: Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs
ETA	21.2001	*Paola ROTA*: Empirical Representation of Firms' Employment Decisions by an (S,s) Rule
ETA	22.2001	*Paola ROTA*: What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes
PRIV	23.2001	*Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD:* Optimal Privatisation Design and Financial Markets
KNOW	24.2001	*Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI*: Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy
ETA	25.2001	*Klaus CONRAD:* Locational Competition under Environmental Regulation when Input Prices and Productivity Differ
PRIV	26.2001	*Bernardo BORTOLOTTI, Juliet D'SOUZA, Marcella FANTINI and William L. MEGGINSON:* Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry
CLIM	27.2001	*Frédéric BROCHIER and Emiliano RAMIERI:* Climate Change Impacts on the Mediterranean Coastal Zones
ETA	28.2001	*Nunzio CAPPUCCIO and Michele MORETTO:* Comments on the Investment-Uncertainty Relationship in a Real Option Model
KNOW	29.2001	*Giorgio BRUNELLO*: Absolute Risk Aversion and the Returns to Education
CLIM	30.2001	*ZhongXiang ZHANG:* Meeting the Kyoto Targets: The Importance of Developing Country Participation
ETA	31.2001	*Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN*: An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control
MGMT	32.2001	*Roberta SALOMONE and Giulia GALLUCCIO:* Environmental Issues and Financial Reporting Trends
Coalition Theory Network	33.2001	*Shlomo WEBER and Hans WIESMETH:* From Autarky to Free Trade: The Impact on Environment
ETA	34.2001	*Margarita GENIUS and Elisabetta STRAZZERA*: Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods

NRM	35.2001	*Carlo GIUPPONI*: The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture
KNOW	36.2001	*Raffaele PACI and Francesco PIGLIARU*: Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe
PRIV	37.2001	*Bernardo BORTOLOTTI:* Privatisation, Large Shareholders, and Sequential Auctions of Shares
CLIM	38.2001	*Barbara BUCHNER*: What Really Happened in The Hague? Report on the COP6, Part I, 13-25 November 2000, The Hague, The Netherlands
PRIV	39.2001	*Giacomo CALZOLARI and Carlo SCARPA*: Regulation at Home, Competition Abroad: A Theoretical Framework
KNOW	40.2001	*Giorgio BRUNELLO*: On the Complementarity between Education and Training in Europe
Coalition Theory Network	41.2001	*Alain DESDOIGTS and Fabien MOIZEAU* (xlvi): Multiple Politico-Economic Regimes, Inequality and Growth
Coalition Theory Network	42.2001	*Parkash CHANDER and Henry TULKENS* (xlvi): Limits to Climate Change
Coalition Theory Network	43.2001	*Michael FINUS and Bianca RUNDSHAGEN* (xlvi): Endogenous Coalition Formation in Global Pollution Control
Coalition Theory Network	44.2001	*Wietze LISE, Richard S.J. TOL and Bob van der ZWAAN* (xlvi): Negotiating Climate Change as a Social Situation
NRM	45.2001	*Mohamad R. KHAWLIE* (xlvii): The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean
NRM	46.2001	*Mutasem EL-FADEL and E. BOU-ZEID* (xlvii): Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation
NRM	47.2001	*Eva IGLESIAS, Alberto GARRIDO and Almudena GOMEZ* (xlvii): An Economic Drought Management Index to Evaluate Water Institutions' Performance Under Uncertainty and Climate Change
CLIM	48.2001	*Wietze LISE and Richard S.J. TOL* (xlvii): Impact of Climate on Tourist Demand
CLIM	49.2001	*Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI*: Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol
SUST	50.2001	*Roberto ROSON* (xlviii): Carbon Leakage in a Small Open Economy with Capital Mobility
SUST	51.2001	*Edwin WOERDMAN* (xlviii): Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?
SUST	52.2001	*Richard N. COOPER* (xlviii): The Kyoto Protocol: A Flawed Concept
SUST	53.2001	*Kari KANGAS* (xlviii): Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe
SUST	54.2001	*Xueqin ZHU and Ekko VAN IERLAND* (xlviii)*:* Effects of the Enlargement of EU on Trade and the Environment
SUST	55.2001	*M. Ozgur KAYALICA and Sajal LAHIRI* (xlviii): Strategic Environmental Policies in the Presence of Foreign Direct Investment
SUST	56.2001	*Savas ALPAY* (xlviii): Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights
SUST	57.2001	*Roldan MURADIAN, Martin O'CONNOR, Joan MARTINEZ-ALER* (xlviii): Embodied Pollution in Trade: Estimating the "Environmental Load Displacement" of Industrialised Countries
SUST	58.2001	*Matthew R. AUER and Rafael REUVENY* (xlviii): Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe
SUST	59.2001	*Onno J. KUIK and Frans H. OOSTERHUIS* (xlviii): Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland
ETA	60.2001	*Carlo CARRARO, Alessandra POME and Domenico SINISCALCO* (xlix): Science vs. Profit in Research: Lessons from the Human Genome Project
CLIM	61.2001	*Efrem CASTELNUOVO, Michele MORETTO and Sergio VERGALLI:* Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto
PRIV	62.2001	*Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO:* On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects
CLIM	63.2001	*Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH:* A Note on Testing for Environmental Kuznets Curves with Panel Data
CLIM	64.2001	*Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI*: Endogenous Induced Technical Change and the Costs of Kyoto
CLIM	65.2001	*Guido CAZZAVILLAN and Ignazio MUSU* (l): Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset
CLIM	66.2001	*Giovanni BAIOCCHI and Salvatore DI FALCO* (l): Investigating the Shape of the EKC: A Nonparametric Approach
CLIM	67.2001	*Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI* (l): Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence
CLIM	68.2001	*Alexey VIKHLYAEV* (xlviii): The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context
NRM	69.2001	*Gary D. LIBECAP and Zeynep K. HANSEN* (li): U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s

NRM	70.2001	*Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER* (li): Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon
CLIM	71.2001	*Claudia KEMFERT*: Economy-Energy-Climate Interaction – The Model WIAGEM -
SUST	72.2001	*Paulo A.L.D. NUNES and Yohanes E. RIYANTO*: Policy Instruments for Creating Markets for Bodiversity: Certification and Ecolabeling
SUST	73.2001	*Paulo A.L.D. NUNES and Erik SCHOKKAERT* (lii): Warm Glow and Embedding in Contingent Valuation
SUST	74.2001	*Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP* (lii): Ecological-Economic Analysis and Valuation of Biodiversity
VOL	75.2001	*Johan EYCKMANS and Henry TULKENS* (li): Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem
PRIV	76.2001	*Axel GAUTIER and Florian HEIDER*: What Do Internal Capital Markets Do? Redistribution vs. Incentives
PRIV	77.2001	*Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO*: Privatisation around the World: New Evidence from Panel Data
ETA	78.2001	*Toke S. AIDT and Jayasri DUTTA* (li): Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation
ETA	79.2001	*Alberto PETRUCCI*: Consumption Taxation and Endogenous Growth in a Model with New Generations
ETA	80.2001	*Pierre LASSERRE and Antoine SOUBEYRAN* (li): A Ricardian Model of the Tragedy of the Commons
ETA	81.2001	*Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT*: An Evolutionary Approach to the Climate Change Negotiation Game
NRM	82.2001	*Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD:* Is the Irrigation Water Demand Really Convex?
NRM	83.2001	*Unai PASCUAL and Edward BARBIER*: A Model of Optimal Labour and Soil Use with Shifting Cultivation
CLIM	84.2001	*Jesper JENSEN and Martin Hvidt THELLE*: What are the Gains from a Multi-Gas Strategy?
CLIM	85.2001	*Maurizio MICHELINI* (liii): IPCC "Summary for Policymakers" in TAR. Do its results give a scientific support always adequate to the urgencies of Kyoto negotiations?
CLIM	86.2001	*Claudia KEMFERT* (liii): Economic Impact Assessment of Alternative Climate Policy Strategies
CLIM	87.2001	*Cesare DOSI and Michele MORETTO:* Global Warming and Financial Umbrellas
ETA	88.2001	*Elena BONTEMPI, Alessandra DEL BOCA, Alessandra FRANZOSI, Marzio GALEOTTI and Paola ROTA:* Capital Heterogeneity: Does it Matter? Fundamental Q and Investment on a Panel of Italian Firms
ETA	89.2001	*Efrem CASTELNUOVO and Paolo SURICO*: Model Uncertainty, Optimal Monetary Policy and the Preferences of the Fed
CLIM	90.2001	*Umberto CIORBA, Alessandro LANZA and Francesco PAULI*: Kyoto Protocol and Emission Trading: Does the US Make a Difference?
CLIM	91.2001	*ZhongXiang ZHANG and Lucas ASSUNCAO:* Domestic Climate Policies and the WTO
SUST	92.2001	*Anna ALBERINI, Alan KRUPNICK, Maureen CROPPER, Nathalie SIMON and Joseph COOK* (lii): The Willingness to Pay for Mortality Risk Reductions: A Comparison of the United States and Canada
SUST	93.2001	*Riccardo SCARPA, Guy D. GARROD and Kenneth G. WILLIS* (lii): Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England
CLIM	94.2001	*Ming CHEN and Larry KARP*: Environmental Indices for the Chinese Grain Sector
CLIM	95.2001	*Larry KARP and Jiangfeng ZHANG*: Controlling a Stock Pollutant with Endogenous Investment and Asymmetric Information
ETA	96.2001	*Michele MORETTO and Gianpaolo ROSSINI*: On the Opportunity Cost of Nontradable Stock Options
SUST	97.2001	*Elisabetta STRAZZERA, Margarita GENIUS, Riccardo SCARPA and George HUTCHINSON*: The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites
NRM	98.2001	*Frédéric BROCHIER, Carlo GIUPPONI and Alberto LONGO*: Integrated Coastal Zone Management in the Venice Area – Perspectives of Development for the Rural Island of Sant'Erasmo
NRM	99.2001	*Frédéric BROCHIER, Carlo GIUPPONI and Julie SORS*: Integrated Coastal Management in the Venice Area – Potentials of the Integrated Participatory Management Approach
NRM	100.2001	*Frédéric BROCHIER and Carlo GIUPPONI*: Integrated Coastal Zone Management in the Venice Area – A Methodological Framework
PRIV	101.2001	*Enrico C. PEROTTI and Luc LAEVEN*: Confidence Building in Emerging Stock Markets
CLIM	102.2001	*Barbara BUCHNER, Carlo CARRARO and Igor CERSOSIMO*: On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol
SUST	103.2001	*Riccardo SCARPA, Adam DRUCKER, Simon ANDERSON, Nancy FERRAES-EHUAN, Veronica GOMEZ, Carlos R. RISOPATRON and Olga RUBIO-LEONEL*: Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan
SUST	104.2001	*R. SCARPA, P. KRISTJANSON, A. DRUCKER, M. RADENY, E.S.K. RUTO, and J.E.O. REGE:* Valuing Indigenous Cattle Breeds in Kenya: An Empirical Comparison of Stated and Revealed Preference Value Estimates
SUST	105.2001	*Clemens B.A. WOLLNY*: The Need to Conserve Farm Animal Genetic Resources Through Community-Based Management in Africa: Should Policy Makers be Concerned?
SUST	106.2001	*J.T. KARUGIA, O.A. MWAI, R. KAITHO, Adam G. DRUCKER, C.B.A. WOLLNY and J.E.O. REGE:* Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study
SUST	107.2001	*W. AYALEW, J.M. KING, E. BRUNS and B. RISCHKOWSKY*: Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program

SUST	108.2001	*Gianni CICIA, Elisabetta D'ERCOLE and Davide MARINO*: Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse
SUST	109.2001	*Clem TISDELL*: Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment
SUST	110.2001	*M.A. JABBAR and M.L. DIEDHOU*: Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa
SUST	1.2002	*K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW*: Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa
ETA	2.2002	*Efrem CASTELNUOVO and Paolo SURICO*: What Does Monetary Policy Reveal about Central Bank's Preferences?
WAT	3.2002	*Duncan KNOWLER and Edward BARBIER*: The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea
CLIM	4.2002	*Andreas LÖSCHEL*: Technological Change in Economic Models of Environmental Policy: A Survey
VOL	5.2002	*Carlo CARRARO and Carmen MARCHIORI*: Stable Coalitions
CLIM	6.2002	*Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA*: Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets
ETA	7.2002	*Effrosyni DIAMANTOUDI and Eftichios S. SARTZETAKIS*: Stable International Environmental Agreements: An Analytical Approach
KNOW	8.2002	*Alain DESDOIGTS*: Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus
NRM	9.2002	*Giuseppe DI VITA:* Renewable Resources and Waste Recycling
KNOW	10.2002	*Giorgio BRUNELLO*: Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries
ETA	11.2002	*Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE*: Endogenous Fluctuations and the Role of Monetary Policy
KNOW	12.2002	*Reyer GERLAGH and Marjan W. HOFKES:* Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?
NRM	13.2002	*Michele MORETTO and Paolo ROSATO*: The Use of Common Property Resources: A Dynamic Model
CLIM	14.2002	*Philippe QUIRION*: Macroeconomic Effects of an Energy Saving Policy in the Public Sector
CLIM	15.2002	*Roberto ROSON*: Dynamic and Distributional Effects of Environmental Revenue Recycling Schemes: Simulations with a General Equilibrium Model of the Italian Economy
CLIM	16.2002	*Francesco RICCI* (l): Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity
ETA	17.2002	*Alberto PETRUCCI*: Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy
Coalition Theory Network	18.2002	*László Á. KÓCZY* (liv)*:* The Core in the Presence of Externalities
Coalition Theory Network	19.2002	*Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR* (liv): Single-Peakedness and Disconnected Coalitions
Coalition Theory Network	20.2002	*Guillaume HAERINGER* (liv): On the Stability of Cooperation Structures
NRM	21.2002	*Fausto CAVALLARO and Luigi CIRAOLO:* Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems
CLIM	22.2002	*Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI*: Back to Kyoto? US Participation and the Linkage between R&D and Climate Cooperation
CLIM	23.2002	*Andreas LÖSCHEL and ZhongXIANG ZHANG:* The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech
ETA	24.2002	*Marzio GALEOTTI, Louis J. MACCINI and Fabio SCHIANTARELLI*: Inventories, Employment and Hours
CLIM	25.2002	*Hannes EGLI:* Are Cross-Country Studies of the Environmental Kuznets Curve Misleading? New Evidence from Time Series Data for Germany
ETA	26.2002	*Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS*: Environmental Policy and Technological Change
SUST	27.2002	*Joseph C. COOPER and Giovanni SIGNORELLO*: Farmer Premiums for the Voluntary Adoption of Conservation Plans
SUST	28.2002	*The ANSEA Network*: Towards An Analytical Strategic Environmental Assessment
KNOW	29.2002	*Paolo SURICO*: Geographic Concentration and Increasing Returns: a Survey of Evidence
ETA	30.2002	*Robert N. STAVINS:* Lessons from the American Experiment with Market-Based Environmental Policies
NRM	31.2002	*Carlo GIUPPONI and Paolo ROSATO:* Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon
NRM	32.2002	*Robert N. STAVINS*: National Environmental Policy During the Clinton Years
KNOW	33.2002	*A. SOUBEYRAN and H. STAHN* : Do Investments in Specialized Knowledge Lead to Composite Good Industries?
KNOW	34.2002	*G. BRUNELLO, M.L. PARISI and Daniela SONEDDA:* Labor Taxes, Wage Setting and the Relative Wage Effect
CLIM	35.2002	*C. BOEMARE and P. QUIRION* (lv): Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences

CLIM	36.2002	*T.TIETENBERG* (lv): The Tradable Permits Approach to Protecting the Commons: What Have We Learned?
CLIM	37.2002	*K. REHDANZ and R.J.S. TOL* (lv): On National and International Trade in Greenhouse Gas Emission Permits
CLIM	38.2002	*C. FISCHER* (lv): Multinational Taxation and International Emissions Trading
SUST	39.2002	*G. SIGNORELLO and G. PAPPALARDO:* Farm Animal Biodiversity Conservation Activities in Europe under the Framework of Agenda 2000
NRM	40.2002	*S .M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS:* Muffled Price Signals: Household Water Demand under Increasing-Block Prices
NRM	41.2002	*A. J. PLANTINGA, R. N. LUBOWSKI and R. N. STAVINS:* The Effects of Potential Land Development on Agricultural Land Prices
CLIM	42.2002	*C. OHL* (lvi): Inducing Environmental Co-operation by the Design of Emission Permits
CLIM	43.2002	*J. EYCKMANS, D. VAN REGEMORTER and V. VAN STEENBERGHE* (lvi): Is Kyoto Fatally Flawed? An Analysis with MacGEM
CLIM	44.2002	*A. ANTOCI and S. BORGHESI* (lvi): Working Too Much in a Polluted World: A North-South Evolutionary Model
ETA	45.2002	*P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET* (lvi): Chasing the Smokestack: Strategic Policymaking with Multiple Instruments
ETA	46.2002	*Z. YU* (lvi): A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect
SUST	47.2002	*Y. H. FARZIN*: Can an Exhaustible Resource Economy Be Sustainable?
SUST	48.2002	*Y. H. FARZIN*: Sustainability and Hamiltonian Value
KNOW	49.2002	*C. PIGA and M. VIVARELLI*: Cooperation in R&D and Sample Selection
Coalition Theory Network	50.2002	*M. SERTEL and A. SLINKO* (liv): Ranking Committees, Words or Multisets
Coalition Theory Network	51.2002	*Sergio CURRARINI* (liv): Stable Organizations with Externalities
ETA	52.2002	*Robert N. STAVINS*: Experience with Market-Based Policy Instruments

(xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.
(xliii)This paper was presented at the International Workshop on “Voluntary Approaches, Competition and Competitiveness” organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26,2000.
(xliv) This paper was presented at the International Workshop on “Green National Accounting in Europe: Comparison of Methods and Experiences” organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000
(xlv) This paper was presented at the International Workshop on “New Ports and Urban and Regional Development. The Dynamics of Sustainability” organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.
(xlvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001
(xlvii) This paper was presented at the RICAMARE Workshop “Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits”, organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001
(xlviii) This paper was presented at the International Workshop “Trade and the Environment in the Perspective of the EU Enlargement ”, organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001
(xlix) This paper was presented at the International Conference “Knowledge as an Economic Good”, organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001
(l) This paper was presented at the Workshop “Growth, Environmental Policies and Sustainability” organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001
(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on “Property Rights, Institutions and Management of Environmental and Natural Resources”, organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001
(lii) This paper was presented at the International Conference on “Economic Valuation of Environmental Goods”, organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001
(liii) This paper was circulated at the International Conference on “Climate Policy – Do We Need a New Approach?”, jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001
(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002
(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001
(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy “The International Dimension of Environmental Policy”, organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001.

2002 SERIES

CLIM	*Climate Change Modelling and Policy* (Editor: Marzio Galeotti)
VOL	*Voluntary and International Agreements* (Editor: Carlo Carraro)
SUST	*Sustainability Indicators and Environmental Evaluation* (Editor: Carlo Carraro)
NRM	*Natural Resources Management* (Editor: Carlo Giupponi)
KNOW	*Knowledge, Technology, Human Capital* (Editor: Dino Pinelli)
MGMT	*Corporate Sustainable Management* (Editor: Andrea Marsanich)
PRIV	*Privatisation, Regulation, Antitrust* (Editor: Bernardo Bortolotti)